The Impacts of Small-Scale Gold Mining on Food Security in Ghana

Thesis

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THE IMPACTS OF SMALL-SCALE GOLD MINING ON FOOD SECURITY IN GHANA

Jacob Obodai BA (Hons), MPhil

June 2022
THE IMPACTS OF SMALL-SCALE GOLD MINING ON FOOD SECURITY IN GHANA

Jacob Obodai BA (Hons), MPhil

Thesis submitted for the degree of Doctor of Philosophy in Geography

Geography
Faculty of Arts and Social Sciences
The Open University

June 2022
Abstract
Small-scale gold mining has expanded in many countries in Sub-Saharan Africa and other parts of the world including Peru and the Philippines, over the last two decades. Numerous factors, including rising gold prices, agricultural poverty, and administrative difficulties, have been cited as explanations for the rapid growth. The rapid growth of small-scale gold mining has a plethora of implications for agriculture, particularly smallholder farming. This is because the primary resource (land) on which mining, and agriculture are based is scarce, and mineral deposits frequently coincide with land suitable for agriculture. Additionally, mining and agriculture both consume large amounts of water and are labour intensive. Thus, a direct link between the expansion of small-scale gold mining and its impact on smallholder agriculture has been established in various countries throughout Sub-Saharan Africa, though opinions vary on whether the relationship is complementary or competitive. Additionally, the impacts of these connections on food security have received relatively little attention, and they are heavily underrepresented in the literatures on small-scale mining and food security. This thesis closes this knowledge gap by shedding light on the impact of small-scale gold mining on food security and contributing to the debate over the relationship between small-scale gold mining and smallholder farming. I argue, using a mixed method case study in Ghana, that mining has a negative impact on food security and that women and children bear a disproportionate share of the burden. Additionally, I demonstrated how competitive and conflict-ridden the relationship between small-scale mining and smallholder farming is.

This study was guided by a novel synthesis of the capability approach and a political ecology perspective. I begin by examining how structural and economic reforms have influenced mining and agricultural activities in Ghana over time, as well as the consequences of these reforms, with a particular emphasis on the often-overlooked ecological footprints. Second, I quantify and predict the pattern of land use and land cover change that would occur under various scenarios, as well as the factors that would cause these changes. Thirdly, I examine the factors affecting miners and smallholder farmers' access to critical resources (land, water, and labour), as well as the key actors in the mining and smallholder farming subsectors, as well as their power hierarchy and relationship. Finally, I examine the relationships between mining and smallholder farming and the state of individual food security (availability, access, utilisation, and stability).
The key findings are as follows: first, that the promotion of export-oriented commodities such as gold and cash crops such as cocoa and oil palm at the expense of peasant farmers' food crops is associated with severe ecological impacts that remain shielded in the absence of required environmental legislation until they exacerbate. There are also flashpoints of conflict between mining and smallholder farming, which has been aggravated by recent reforms and lays the groundwork for future conflicts. Second, four distinct periods of land use and land cover dynamics for mining footprints were identified using a combination of social science and geospatial methods: periods of none to limited increase, gradual to accelerated increase, sharp increase, and gradual decrease in mining footprints. These land use and land cover dynamics were found to be associated with three major ecological impacts of mining: land degradation, deforestation, and water pollution. Over a 34-year period, a total of 27,333 ha (36% of forest cover) was lost, along with severe land degradation and water pollution. If mining activities continue at their current pace, the study predicts increased ecological impacts. Third, the previously coexisting mining and smallholder farming subsectors are now fiercely competing for access to critical resources (land, labour, and water), a situation shaped by unequal power relations between the two subsectors' key actors. Finally, small-scale gold mining significantly contributes to food insecurity and, as a result, to the poor health and well-being of many people, particularly women and children. Half of the study participants experienced moderate food insecurity, while 13% experienced severe food insecurity. Additionally, 79% of women of reproductive age (15 to 49) were unable to meet the Minimum Dietary Diversity (MDD) requirements, a measure of micronutrient adequacy and, thus, food quality. Furthermore, local challenges with food availability, as well as associated challenges with food access and utilisation, erode food stability over time, forcing more people to adopt alternative coping strategies.

The findings of this study provide novel empirical evidence on the impacts of small-scale gold mining on food security and highlight the importance of integrating mixed and geospatial methods. Additionally, the findings demonstrate the value of combining political ecology and capability approaches in natural resource governance and food security research.
Dedication

This thesis is dedicated to my foster mother, Madam Juliet Tawiah Larsey, commonly known as Antaaa, for her love and sacrifice in getting me through school. Also, to my two boys, Josiah, and Jason.
Acknowledgements

Whatever is good and perfect comes to us as a gift from God our Father... (James 1:16). To begin, I want to express my gratitude to God for providing me with the gift of life, intelligence, and strength that enabled me to pursue and complete this thesis. Second, I would like to express my appreciation to the Open University for financially assisting me in pursuing this goal and to the Strategic Research Areas (SRA) in International Development and Inclusive Innovation for sponsoring my trip to the United Kingdom and covering my post-fieldwork travel expenses related to COVID-19.

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<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.2</td>
<td>Contributions of the study</td>
<td>3</td>
</tr>
<tr>
<td>1.3</td>
<td>Organisation of the thesis</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>CHAPTER TWO...</td>
<td>9</td>
</tr>
<tr>
<td>2.1</td>
<td>Introduction</td>
<td>9</td>
</tr>
<tr>
<td>2.2</td>
<td>The global expansion of the small-scale mining sector, its obstinate</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>‘informality and ‘illegality’ and the drive to formalise it</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Contrary perspectives on the relationship between small-scale mining</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>and smallholder farming</td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>The concept of food security and the challenges associated with its</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>achievement</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>The application of geospatial analytical tools and techniques in</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>mining and agriculture discourses</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CHAPTER THREE...</td>
<td>32</td>
</tr>
<tr>
<td>3.1</td>
<td>Introduction</td>
<td>32</td>
</tr>
<tr>
<td>3.2</td>
<td>Capability approach: history, definition, and key tenets</td>
<td>33</td>
</tr>
<tr>
<td>3.3</td>
<td>Political ecology: history, definitions, and key tenets</td>
<td>37</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Power relations analysis in political ecology</td>
<td>39</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Multi-scalar analysis</td>
<td>41</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Historical analysis: remote sensing and geographical information</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>system (GIS) applications</td>
<td></td>
</tr>
</tbody>
</table>

Table of Contents
3.4 Understanding the impacts of gold mining on food security through a novel blend and conceptualisation of political ecology and capability approach ........................................ 45
3.5 Chapter summary and conclusions ........................................................................ 48

CHAPTER FOUR ........................................................................................................ 49
RESEARCH METHODOLOGY .................................................................................. 49
4.1 Introduction ........................................................................................................... 49
4.2 Pragmatism: the philosophical underpinnings of this research ......................... 50
4.3 A mixed method case study research design ..................................................... 53
  4.3.1 Ghana as a country case study ........................................................................ 54
  4.3.2 ‘Cases within a case study’: Amansie West and South Districts ..................... 55
4.4 Sampling design and sample size estimates ....................................................... 57
4.5 Fieldwork processes ............................................................................................ 61
  4.5.1 Feasibility studies .......................................................................................... 61
  4.5.2 Main fieldwork .............................................................................................. 63
4.6 Impacts of COVID-19 on fieldwork and overall research ................................ 64
4.7 Datasets and collection methods ........................................................................ 66
  4.7.1 Quantitative datasets: secondary data and questionnaire ............................. 66
4.8 Data analytic strategies and presentation ......................................................... 78
  4.8.1 Quantitative data analysis and presentation .................................................. 78
  4.8.2 Qualitative data analysis and presentation .................................................... 82
4.9 Ethical considerations ......................................................................................... 85
4.10 Geospatial tools and methods ......................................................................... 86
  4.10.1 Digital data acquisition, pre-processing, and analysis ............................... 87
  4.10.2 Land use land cover classification .............................................................. 88
  4.10.3 Accuracy assessment .................................................................................. 90
  4.10.4 Change detection ....................................................................................... 90
  4.10.5 Land use land cover change scenarios ...................................................... 91
  4.10.6 Change prediction ..................................................................................... 91
4.11 Chapter summary ............................................................................................... 96

CHAPTER FIVE .......................................................................................................... 97
HISTORICAL POLITICAL ECOLOGY OF GHANA’S MINING AND AGRICULTURAL SUBSECTORS ......................................................... 97
5.1 Introduction ......................................................................................................... 97
5.2 Overview of the mining sector in Ghana ........................................................... 99
  5.2.1 Pre-colonial period: traditional governance and none/negligible ecological footprints .................................................................................................................. 101
  5.2.2 1874–1956: colonial capitalism, the decline in traditional powers and the emergence of ecological footprints ................................................................. 101
5.2.3 1957 to 85: post-independence reforms, nationalisation of mines and gradual increase in ecological footprints ................................................................. 104
5.2.4 1986–2008: liberalisation of mines and acceleration of increases in ecological footprints ................................................................. 106
5.2.5 2009–2015: a return to resource nationalism and sharp increases in ecological footprints ................................................................. 111
5.2.6 2016 to 2021: persistence of resource nationalism and gradual decrease in ecological footprints ................................................................. 114

5.3 Overview of the agricultural sector of Ghana ................................................................. 117
1980s–2000: Liberalisation of agricultural system and continued promotion of export crops 119
5.3.1 Pre-colonial: subsistence agriculture and limited ecological footprints ......... 120
5.3.2 1874–1957: Colonial era and attempts at commercialising agriculture with its associated emergence of increasing ecological footprints .......... 120
5.3.3 1957 - 1970s: Early post-independence reforms and its associated increasing ecological footprints ................................................................. 122
5.3.4 1980s - 2000: Liberalisation of agricultural system, continued promotion of export crops and its associated increasing ecological footprints ........ 124
5.3.5 2000-Date: Agricultural modernisation, rural development, and poverty alleviation ................................................................. 130

5.4 The flashpoints of conflict between the mining and farming subsectors, as well as how they may have played out ................................................................. 134

5.5 Chapter summary and conclusions ........................................................................ 136

CHAPTER SIX .............................................................................................................. 140
GOLD MINING’S ECOLOGICAL FOOTPRINTS, DRIVERS, AND FUTURE PREDICTIONS ................................................................. 140

6.1 Introduction ........................................................................................................... 140

6.2 Changes in land use and land cover in case study ............................................. 142
6.2.1 None to limited mining footprints ............................................................... 145
6.2.2 Gradual to accelerated increase in mining footprints .................................. 146
6.2.3 Sharp increase in mining footprints ............................................................ 147
6.2.4 Gradual decrease in mining footprints ......................................................... 149

6.3 Analysis of the trend and patterns of the land use and land cover changes .... 150
6.4 Analysis of the change rates ............................................................................... 157
6.5 The forces that initiate and sustain the observed land use and land cover changes 161

6.6 Future land use and land cover predictions ......................................................... 168
6.7 Chapter discussion and conclusions .................................................................. 172

CHAPTER SEVEN ....................................................................................................... 177
THE CONTENDED INTERCONNECTIONS BETWEEN SMALLHOLDER FARMING AND MINING IN GHANA ................................................................. 177
7.1 Introduction .................................................................................................................. 177
7.2 Land Access capabilities ......................................................................................... 179
  7.2.1 The plurality of interests and ease of accessing land for mining ....................... 179
  7.2.2 The plurality of interests and ease of accessing land for smallholder farming .. 185
7.3 Labour access capabilities ....................................................................................... 186
7.4 Water access capabilities ....................................................................................... 190
7.5 Power hierarchy and relations among key actors .................................................... 195
  7.5.1 Power hierarchies among key actors ............................................................... 196
  7.5.2 Power relations between and among the different key actors ......................... 200
7.6 Chapter summary and conclusions ....................................................................... 206

CHAPTER EIGHT .................................................................................................................. 209
THE IMPLICATIONS OF THE RELATIONSHIP BETWEEN MINING AND SMALLHOLDER
FARMING FOR FOOD SECURITY ......................................................................................... 209

8.1 Introduction .............................................................................................................. 209
8.2 Personal and socio-economic conversion factors .................................................... 211
8.3 Relationship between mining and smallholder farming and the implications on food
security outcomes ............................................................................................................. 213
  8.3.1. Availability of food ......................................................................................... 217
  8.3.2. Access to food ............................................................................................... 221
  8.3.3. Food utilisation ............................................................................................. 225
  8.3.4. Food stability ............................................................................................... 228
8.4 Chapter summary and conclusions ....................................................................... 230

CHAPTER NINE .................................................................................................................. 233
SUMMARY AND CONCLUSIONS ....................................................................................... 233

9.1 Introduction .............................................................................................................. 233
9.2 The overarching and specific research questions.................................................... 234
9.3 A combined capability and political ecology approach ............................................ 234
9.4 A snapshot of the integrated mixed methods and geospatial methodologies ......... 235
9.5 Summary of key research findings ....................................................................... 236
  9.5.1 Historical political ecology of mining and agriculture in Ghana ....................... 236
  9.5.2 Gold mining's ecological footprints, drivers, and future predictions ............... 237
  9.5.3 The contested interconnections between smallholder farming and mining ...... 237
  9.5.4 The implications of mining and smallholder farming relationships on food
security .............................................................................................................................. 238
9.6 Policy recommendation .......................................................................................... 239
  9.3.1 Land reclamation for food security .................................................................. 239
  9.3.2 Improved transportation and the establishment of market centres .................. 240
  9.3.3 Land use regulation enactment and enforcement ............................................. 240
9.3.4 Update of existing laws and regulations to reflect the complexity and heterogeneity of small-scale mining .......................................................... 240
9.3.5 Interconnected policies within the mining and agricultural sector ............ 241
9.3.6 Streamlining small-scale mining activities to generate revenue through taxation 241

9.7 Direction for future research ................................................................. 241
9.8 Conclusions ......................................................................................... 242

Bibliography .............................................................................................. 244
Appendices ................................................................................................. 263
List of Maps

Map 2.1: An Overlay of Agroecological Zones with gold areas in Ghana.................................15
Map 4.1: Map of selected ‘cases within Ghana’........................................................................56
Map 4.2: Suitability maps for each land use and land cover class and the input datasets used in its generation. (a) Water (b) cropland (c) mining (d) Closed Forest (e) Settlements/ bare lands (f) open forest are suitability maps. (g) slope (h) DEM (i) Population Density (j) river (k) secondary roads (l) tertiary roads (m) major settlements are input maps...........................................95
Map 5.1: Satellite image showing the dramatic footprints of mining in southwestern parts of Ghana as of March 2020........................................................................................................114
Map 6.1: Land use and land cover classification maps of the case study area .........................143
Map 6.2: The gains and losses in land use and land cover classes over the period 1986 to 2020. ...........................................................................................................................................156
Map 6.3: A collage of 2021 satellite images illustrating the extent of land degradation from mining in some communities in the study district...............................................................163
Map 6.4: Simulated and predicted land use and land cover maps (a) Simulated land use and land cover map for 2020 (b) Predicted land use and land cover map for 2030 under the ‘remedial’ scenario (c) 2030 land use and land cover map predicted under a ‘business as usual’ scenario. .................................................................168
List of Tables

Table 2.1: Major Approaches and examples of indicators adopted in the assessment of food security at different levels.................................................21
Table 4.1: Dimensions of contrast among key paradigms underpinning social research........51
Table 4.2: Proportional sample estimation .............................................................................59
Table 4.3: Total number of study participants at various scales...........................................60
Table 4.4: The Food Insecurity Experience Scale Survey Module by FAO .......................69
Table 4.5: Food Groups, examples, and response options.........................................................72
Table 4.6: Raw score parameters and statistics ...........................................................................80
Table 4.7: Item Severity...........................................................................................................81
Table 4.8: Aggregation of food groups from the questionnaire to create MDD-W Indicator .83
Table 4.9: The available Landsat satellite images .................................................................88
Table 4.10: Description of land use and land cover (LULC) types ...........................................89
Table 5.1: Periodisation of the mining sector of Ghana: actors; ecological footprints and reforms/actions .................................................................................100
Table 5.2: Periodisation of the agricultural sector of Ghana: actors; key policies/reforms...119
Table 6.1: Area of land use and land cover (LULC) classes of the classification and the percentage area change results........................................................................144
Table 6.2: Net Area of Change and the percentage changes in the observed Land use and land cover (LULC) classes ........................................................................153
Table 6.3a: The rate of land use and land cover (LULC) change during the period 1986 to 2002 .........................................................................................158
Table 6.3b: The rate of land use and land cover (LULC) change during the period 2002 to 2008 .........................................................................................158
Table 6.3c: The rate of land use and land cover (LULC) change during the period 2008 to 2015 .........................................................................................160
Table 6.3d: The rate of land use and land cover (LULC) change during the period 2015 to 2020 .........................................................................................160
Table 6.4: Proximate and underlying causes of land use and land cover changes in the case study.........................................................................................161
Table 6.5: Area and percentage of land use and land cover (LULC) classes of 2020 classified and the predicted LULC for 2030 under remedial and business as usual scenarios..........170
Table 8.1: Personal and Socio-economic characteristics of the sample ................................211
Table 8.2: Positive and negative relationships between mining and smallholder farming ....214
Table 8.3: Food Insecurity parameters .................................................................................222
Table 8.4: Associations between socio-economic variables and food insecurity: Multivariate pooled linear analysis ............................................................... 223

Table 8.5: Minimum Dietary Diversity of women of reproductive age ................. 227

Table 8.6: Relationship between dietary diversity and socio-demographic characteristics. . 228
List of Figures

Figure 1.1: Summary of chapters in relation to research questions........................................5
Figure 3.1: Conceptual Framework of the novel blend of Political Ecology and the Capability Approach.................................46
Figure 4.1: Sampled settlements from each traditional area council..................................58
Figure 4.2: Global Standard Threshold..................................................................................70
Figure 4.3: Researcher participating in digging and loading of extracted mineralised material into gold extraction machine.................................................................77
Figure 4.4: Item parameters and statistics for the 8 FIES items...........................................80
Figure 4.5: Methodological Flowchart for this chapter.........................................................87
Figure 4.6: Summary of Key Approaches Methods...............................................................96
Figure 5.1: World gold price (US$/troy ounce), 2000 to 2020.............................................113
Figure 5.2: Percentage share of total employment in the economy......................................117
Figure 5.3: (a) Production output for cocoa and oil palm fruit (b) Production output for other cash crops..............................................................126
Figure 5.4: Production output for major food crops from 1980 to 2000.................................127
Figure 5.5: The size of Ghana’s cropland from 1980 to 2019..............................................129
Figure 5.6: Production output for major food crops from 2000 to 2019.................................132
Figure 6.2: Mining pit in the Oda Forest Reserve at Amansie Central..................................167
Figure 7.1: Metal dig and wash board (left) and wooden dig and wash board (right)........183
Figure 7.2: Picture of an old woman and friend waiting to pan in a mining site....................184
Figure 7.3: Young women working in a small-scale mining site as load transporters..........187
Figure 7.4: (a) The polluted Oda River at Watreso (b) the polluted Offin River at Keniago 191
Figure 7.5: Turbid water from Oda River undergoing treatment to be used as drinking water .........................................................193
Figure 7.6: Major power hierarchy of state and non-state actors........................................196
Figure 8.1: Production of major food crops........................................................................217
Figure 8.2: Perception of current access to food compared to 10 years ago ......................221
Figure 8.3: Bivariate Analysis of the relationship between gender and food security........224
Figure 8.4: Proportions of study participants consuming different food groups during the previous day of the survey.................................................................226
## Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHP</td>
<td>Analytical Hierarchy Process</td>
</tr>
<tr>
<td>ASM</td>
<td>Artisanal Small-Scale Mining</td>
</tr>
<tr>
<td>AWSD</td>
<td>Amansie West and South District</td>
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<td>CAPI</td>
<td>Computer-assisted personal interviewing</td>
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<td>DEM</td>
<td>Digital Elevation Model</td>
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<td>DD</td>
<td>Dietary Diversity</td>
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<td>DFID</td>
<td>Department for International Development</td>
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<td>ERP</td>
<td>Economic Recovery Programme</td>
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<td>FAO</td>
<td>Food and Agriculture Organisation</td>
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<td>FIES</td>
<td>Food Insecurity Experience Scale</td>
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<tr>
<td>FGD</td>
<td>Focus Group Discussions</td>
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<td>FORIG</td>
<td>Forestry Research Institute of Ghana</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GIS</td>
<td>Geographical Information Systems</td>
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<td>GPS</td>
<td>Global Position Systems</td>
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<td>HREC</td>
<td>Human Research Ethics Committee</td>
</tr>
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<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
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<td>ILO</td>
<td>International Labour Organisation</td>
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<td>IMF</td>
<td>International Monetary Fund</td>
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<tr>
<td>IRT</td>
<td>Item Response Theory</td>
</tr>
<tr>
<td>LSGM</td>
<td>Large Scale Gold Mining</td>
</tr>
<tr>
<td>LULC</td>
<td>Land Use and Land Cover</td>
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<tr>
<td>LUSPA</td>
<td>Land Use and Spatial Planning Authority</td>
</tr>
<tr>
<td>SAP</td>
<td>Structural Adjustment Programme</td>
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<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>UNICEF</td>
<td>United Nations Children's Fund</td>
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<td>SDG</td>
<td>Sustainable Development Goals</td>
</tr>
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<td>SL</td>
<td>Sustainable Livelihood</td>
</tr>
<tr>
<td>SRID</td>
<td>Statistic, Research, and Information Directorate</td>
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<tr>
<td>RS</td>
<td>Remote Sensing</td>
</tr>
<tr>
<td>MCE</td>
<td>Multi-Criteria Evaluation</td>
</tr>
<tr>
<td>MDD</td>
<td>Minimum Dietary Diversity</td>
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<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>MDD-W</td>
<td>Minimum Dietary Diversity for WRA</td>
</tr>
<tr>
<td>MLNR</td>
<td>Ministry of Land and Natural Resources</td>
</tr>
<tr>
<td>MoFA</td>
<td>Ministry of Food and Agriculture</td>
</tr>
<tr>
<td>PCC</td>
<td>Post Classification Comparison</td>
</tr>
<tr>
<td>PNDC</td>
<td>Provisional National Defence Council</td>
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<td>SGMC</td>
<td>State Gold Mining Corporation</td>
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<td>SRTM</td>
<td>Shuttle Radar Topography Mission</td>
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<td>TOA</td>
<td>Top-of-atmosphere</td>
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<td>WRA</td>
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CHAPTER ONE
INTRODUCTION

1.1 Introduction
The artisanal and small-scale mining sector is an important component of the resource extractive economy that has garnered considerable attention from a variety of researchers and institutions. The high level of interest in the artisanal and small-scale mining (hereafter ‘small-scale mining’) sector stems from debates over the critical role of the sector in sustainable development. In contrast to large-scale mining, small-scale mining is defined as any form of mineral extraction and processing carried out by individuals or groups of people using primitive tools and requiring a great deal of labour (Hilson et al. 2017). There is a clear distinction between artisanal and small-scale mining in some countries, such as Sierra Leone, Zambia, Mali, Niger, Burkina Faso, Peru, Ecuador, and Tanzania, whereas there is none in others, such as Ghana (UNEP 2012; UNDP Ghana 2017). Separate areas are also designated for each activity in countries that make this distinction between artisanal and small-scale mining, along with procedures for acquiring such lands. In Ghana, where such distinctions do not exist, artisanal and small-scale mining coexist, and the terms are frequently used interchangeably. However, distinctions are made between legal small-scale gold mining activities and those that operate illegally and without official permits. The term 'galamsey' refers to small-scale gold mining activities that are carried out illegally in Ghana. Small-scale mining will be utilised throughout this thesis to encompass all mining that is not large-scale, with distinctions made between legal, illegal, and artisanal as needed.

1Large scale mining is a method of extracting and processing minerals that involves the use of sophisticated and high-tech (capital-intensive) machinery. These operations are classified as formal because they are registered under existing legal frameworks. They are primarily multimillion-dollar investments by multinational corporations in mineral-rich countries.

2While small-scale mining remains labour intensive in Ghana, the use of rudimentary techniques cannot be said to be uniform across the country due to the introduction of foreign nationals and power elites into the sector. Numerous small-scale mining locations make extensive use of excavators and other specialised machinery.

3Galamsey is a Ghanaian slang term for all illegal small-scale mining activities, derived from the phrase ‘gather and sell’. It is comparable to ‘garimpeiros’ in Brazil, ‘penambang tanpa injin’ and ‘gurandils’ in Indonesia, ‘makorokozas’ in Zimbabwe, ‘mchoji’ or ‘mtafutaji’ in Tanzania, ‘orpailleage’ in Côte d’Ivoire, and ‘ninjas’ in Mongolia.
Chapter 1: Introduction

Over the last two decades, the small-scale mining sector has grown rapidly in many parts of the world (Intergovernmental Forum on Mining, Minerals Metals and Sustainable Development (IGF) 2017). Although the precise number of workers in the sector is unknown, various institutions and scholars have provided estimates. The World Bank (2020) estimates that small-scale mining employ least 44.75 million people in 80 countries. Small-scale mining occurs in most cases in developing countries throughout Africa, Asia, Oceania, Central and South America.

The rapid growth of the small-scale gold mining sector has several implications for agriculture, particularly smallholder farming, a type of farming practiced by marginal and sub-marginal households with less than 2.0 ha of land (Singh et al., 2002). The various implications arise because the primary resource (land) upon which these two livelihoods are based is scarce, and mineral deposits typically occur on land suitable for agriculture. Additionally, both sectors rely heavily on water and are labour intensive. In various countries across Sub-Saharan Africa, a direct relationship between small-scale mining and smallholder farming has been established (Okoh and Hilson 2011; Kamlongera 2011; Maconachie 2011; Hilson and Garforth 2012, 2013; Hilson 2016a; African Center For Economic Transformation 2017; Snapir et al. 2017; Awotwi et al. 2018; Hausermann and Ferring 2018; Chigumira 2018; Mkodzongi and Spiegel 2019; Obodai et al. 2019; Ferring and Hausermann 2019), though opinions differ on whether the relationship is complementary or competitive. Additionally, the impacts of these connections on food security continue to be an important component worth investigating, but they are underrepresented in the small-scale mining literature. This thesis seeks to close this knowledge gap by shedding light on the impact of small-scale gold mining on food security and contributing to the ongoing debate about the relationship between small-scale mining and smallholder farming. The study was driven by the following overarching research question: What relationships exist between small-scale mining and smallholder farming, and what impacts do these relationships have on achieving improved food security outcomes at the individual and community levels? Four interrelated research questions (RQ) were posed to address this question:

4 Food security is defined as “having physical and economic access to sufficient, safe, and nutritious food that fits their dietary needs and preferences for an active and healthy life at all times” (World Food Summit, 1996). Food security is divided into four components, according to the FAO (2006): food availability, food access, food use, and food stability. These aspects of food security are discussed in detail in the following section of this chapter.
Chapter 1: Introduction

RQ. 1. How have structural and economic reforms influenced the mining and agricultural sectors of Ghana over time? What are the consequences of these reforms?

RQ. 2. What has been the pattern of land use and land cover change over time in selected mining hotspot landscapes in south-eastern Ghana, and what factors may have contributed for these changes? How would future land use and land cover look in the next decade under ‘business as usual’ and ‘remedial’ scenarios?

RQ. 3. What factors affect the ability of miners and smallholder farmers to access critical resources (land, water, and labour)? Who are the key actors in the mining and smallholder farming subsectors, and how are their power hierarchies and relationships structured?

RQ. 4. How are mining and smallholder farming related? What is the state of food security (availability, access, utilisation, and stability) in a mining hotspot in the south-eastern part of Ghana?

I use a novel combination of political ecology and capability approaches in this thesis to critically examine the relationships between small-scale gold mining and smallholder farming as well as the resulting implications for food security. Based on the findings, I argue that the relationship between small-scale gold mining and smallholder farming is highly competitive and conflict-ridden, jeopardizing the food security outcomes of many people in mining hotspots, particularly women of reproductive age. This chapter serves as a preface to the thesis. The thesis is introduced in the first section. The second and third sections discuss possible contributions and the organisation of the thesis, respectively.

1.2 Contributions of the study

This research is timely and has considerable potential for informing policy and practice, and it makes three significant contributions to debates about the impacts of mining and the relationship between mining and smallholder farming.

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5 Political ecology provides an excellent lens through which to view power dynamics between key actors in the mining and agricultural subsectors from historical and multi-scale perspectives, as well as the relationships between actors and their natural environments. These perspectives complement the capability approach, which examines individual well-being in terms of their functional abilities. Thus, by combining the two approaches for data collection and analysis in this study, a comprehensive assessment of the research questions is possible. Chapter 3 discusses these approaches in detail and how they are conceptualised in this study.
To begin, and in a broader sense, the findings of this study, which focuses on Ghana, have the potential to significantly contribute to narratives about the interconnections between mining and smallholder farming in Africa. Additionally, it can shed light on the impact of the link between mining and smallholder farming on food security, which has received scant attention in the literature. These potential contributions are enabled by new and comprehensive empirical evidence derived from the research setting and subjects. I build on previous research to demonstrate the historical ecological footprints of mining and agriculture, as well as how economic and structural reforms contribute to these footprints. I demonstrate the complex, heterogeneous, and competitive relationships between mining and smallholder farming in terms of core resource capabilities (land, labour, and water). Finally, I demonstrate how these intricate relationships contribute to the functioning (food insecurity) of an individual, which has significant implications for women.

Second, this research can help improve the methodological rigour of natural resource and food security studies. Now, many studies, particularly in the social sciences, employ either qualitative or quantitative methods, with only a few considering geospatial analysis, whereas those in the physical sciences heavily rely on geospatial techniques to comprehend ecological changes. I demonstrate the value of combining social science approaches with geographical information systems (GIS) and remote sensing techniques to produce a detailed, robust, and nuanced analysis of mining-agriculture relationships. I use GIS to decipher the spatial relationship between mining and agroecological zones in Ghana. Additionally, I combine remote sensing/GIS with social science techniques such as interviews, focus groups, and observations to quantify and predict future ecological changes, as well as the drivers of these changes.

Finally, the study makes significant contributions to theory. To my knowledge, the application of political ecology and capability approaches to understanding the impact of the mining sector on food security is novel, particularly in broad natural resource discourses and, more precisely, in mining discourses. I demonstrate how capability and political ecology approaches can be combined to conceptualise food security, as well as the power relations and hierarchies of various actors, from a multi-scalar perspective. I employ the capability approach to conceptualise food security (‘beings’), mining, and smallholder farming (‘doings’) as important ‘functionings’ of human wellbeing, and the political ecology approach to provide a detailed and in-depth understanding of the power dynamics among different actors at various scales as
conversion factors affecting the capabilities of achieving food security, mining, and crop farming.

1.3 Organisation of the thesis

This thesis is divided into nine chapters. Figure 1.1 diagrammatically depicts a summary of the chapters of the study and the specific research questions that they address.

**Overall Research Question (RQ):**
What relationships exist between artisanal and small-scale mining and smallholder farming, and what impacts do these relationships have on achieving improved food security outcomes at the individual and community levels?

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Figure 1.1: Summary of chapters in relation to research questions
Chapter 1: Organisation of the thesis

Chapter 2 contains an overview of the literature on the small-scale mining sector, narratives about the relationship between small-scale mining and smallholder agriculture, the concept of food security, and the application of geospatial analytical frameworks in mining and agriculture discourses. I discuss the global expansion of small-scale mining, its stubborn 'informality' and 'illegality,' and the movement to formalise it. I then discussed the opposing viewpoints on the relationship between small-scale mining and smallholder agriculture. Additionally, I discuss the concept of food security and the theoretical perspectives that surround it. Finally, I summarise the relevant literature and identified knowledge gaps that serve as the foundation for the research questions posed in this study. This chapter lays the groundwork for the research questions that guide this study and serve as a bridge to Chapter 3.

Chapter 3 proposes a novel approach that combines capability and political ecology perspectives. In this chapter, I demonstrate the value of combining the capability and political ecology approaches to conceptualise and provide a robust and comprehensive understanding of the relationships between small-scale mining and smallholder farming, as well as the implications for food security. This chapter summarises the political ecology and capability approaches, highlighting their central tenets and the components utilised in this thesis. Additionally, I discuss how the two frameworks were integrated and conceptualised, which I illustrate and explain diagrammatically.

In Chapter 4, I discuss the methodology used in this study, which combined qualitative, quantitative, and geospatial approaches while adhering to the pragmatic research paradigm. The chapter demonstrates how the pragmatic paradigm was used in this study, focusing on the outcome of the research, the significance of the questions, and allowing for the use of a variety of methods to arrive at useful insights for both theory and practice. The chapter then discusses the mixed methods research and the geospatial methods that were used to supplement it, demonstrating the value of combining social research methods with geospatial tools and techniques. This chapter discusses the multistage sampling designs and sample size estimates used, as well as the selection and justification of the case study and selected communities, as well as the sampling procedures used to obtain a representative sample. Additionally, this chapter discusses the data collection, management, and analysis processes in relation to the research topics of the study.
Chapter 5 discusses how changing structural and economic reforms have impacted mining and agriculture over time. I examine mining and agriculture subsectors of Ghana in relation to pre-colonial and post-colonial structural and economic reforms. Despite the existence of such historical records, this chapter builds on previous work and, more importantly, examines the ecological footprints associated with these reforms over time. Additionally, I discuss the points of contention between mining and agriculture in relation to the implementation of the reforms over time. To my knowledge, this is the first time the effects of reforms in Ghana on the two subsectors has been examined concurrently to demonstrate how analogous reforms implemented in the two subsectors achieved both similar results and antagonistic effects. This lays the groundwork for future interactions between these subsectors, as I demonstrate.

Assessments of historical and projected changes in land use and land cover in mining landscapes shed light on the ecological footprint of mining. Thus, in Chapter 5, I discuss the observed changes in land use and land cover over the last 34 years in the study districts. Additionally, the chapter discusses the trends and patterns of changes in land use and land cover, as well as the rates of change. This is done to quantify the ecological footprint changes associated with the structural and economic reforms discussed in Chapter 5 as they pertain to the study districts. Additionally, this chapter discusses the driving forces attributed to these changes by study participants. Finally, I analyse the future land use and land cover changes predicted under the ‘business as usual’ and ‘remedial’ scenarios for the next ten years.

In Chapter 7, I discuss the capability of miners and smallholder farmers to access critical resources (land, water, and labour), highlighting the resource relationships between the two distinct subsectors. I then identify the key actors operating within these two subsectors, as well as their power hierarchy and interactions. The power hierarchy and their relationships are important because they have a direct impact on the ecological footprints described in Chapter 6 and the food security outcomes discussed in Chapter 8.

Chapter 8 continues the story from Chapter 7. I examine the relationships between mining and smallholder agriculture in this chapter, as well as the impact of mining on all four dimensions of food security (availability, access, utilisation, and stability). The chapter begins by describing the sociodemographic characteristics of the study participants, which influence their food security attainment. Additionally, I discuss the broad ties that exist between mining and
Chapter 1: Organisation of the thesis

smallholder crop farming. Further, I discuss the implications of this relationship for the four dimensions of food security.

Chapter 9 summarises and discusses the major findings. Additionally, the chapter makes some policy recommendations and suggests future research directions. Further, the contributions of this study are summarised, and conclusions drawn.
CHAPTER TWO
THE SMALL-SCALE GOLD MINING SECTOR, FOOD SECURITY AND GEOSPATIAL APPLICATIONS: A REVIEW

2.1 Introduction
This chapter reviews pertinent literature that serves as a foundation for the research topics addressed in this thesis and as a bridge to the theoretical lens of the study, which is discussed in Chapter 3. The chapter makes use of secondary sources such as peer-reviewed publications, reports, archives, and online document sources.

The chapter is divided into six major sections. Section 2.2, which follows the introduction piece, delves deeper into the narratives underlying the global expansion of the small-scale mining sector and why, despite efforts to formalise it, the sector remains mostly informal and illegal. Section 2.3 reviews significant literature on diametrically opposed opinions on mining and agriculture. I examine the concept of food security and the theoretical framework that underpins its assessment in Section 2.4. I then discussed how remote sensing and geographic information systems have been successfully applied in mining and agricultural contexts in Section 2.5. Finally, in Section 2.6, I summarised the knowledge gaps revealed in this research and the research topics offered to overcome them, as indicated in Chapter 1.

2.2 The global expansion of the small-scale mining sector, its obstinate ‘informality and ‘illegality’ and the drive to formalise it
The small-scale mining sector has grown rapidly over the past two decades (IGF, 2017). The sector has also grown in complexity (Fisher 2007; Verbrugge 2015; Tschakert 2016; Verbrugge and Besmanos 2016). A study of the small-scale mining sector in the Philippines, for example, which began with rudimentary tools, has evolved enormously with the introduction of a diverse group of financiers (Verbrugge and Besmanos, 2016). The small-scale mining sector in the Philippines is now characterised by a "rising degree of heterogeneity, with artisanal mining persisting alongside more mechanised medium-scale operations; a growing differentiation between a class of ASM-entrepreneurs and a massive workforce; and a multi-tiered division of labour and complex arrangements for the distribution of risks and benefits across the sector’s diverse participants" (Verbrugge and Besmanos 2016 p. 136).
Chapter 2: Expansion of the small-scale mining sector

This description is also applicable to other mining countries in Sub Saharan Africa, such as Tanzania (Fisher 2007, 2008), Zimbabwe (Mkodzi and Spiegel 2019) and Ghana (Crawford et al. 2016; Tschakert 2016), where different financiers and labour arrangements have evolved over the last decade. Fisher (2007), for example, observed a case as early as 1987 in which a local representative of a Swiss-owned mining company obtained a license for exploration in some regions in Tanzania but, rather than carrying out production on their own, hired ‘sub-contractors’ who bought gold from artisanal miners. Despite the fact that the company lost its license due to fraud, this complex arrangement developed further, giving the ex-sub-contractor power over other artisanal miners, resulting in social exclusion and exploitation of the majority of the artisanal miners. Some Chinese nationals in the small-scale gold mining sector in Ghana are also reported to provide “immediate access to equipment, start-up funds, and land to be mined” (Tschakert 2016 p. 126), despite the fact that other nationals are not permitted to engage in small-scale gold mining. The involvement of other nationals in the ASGM has resulted in pronounced differentiation, as observed by Verbrugge and Besmanos (2016) in the Philippines, and provided impetus for labour exploitation, as discovered by Fisher (2007).

The rapid rise in small-scale mining can be attributed to a variety of global and local factors. Globally, an unprecedented demand for natural resources has been identified as a result of population growth and economic prosperity (Roy et al. 2012). For example, Bryceson et al. (2014) identified a distinct new era of mining in Africa in the twenty-first century, based on the global market, culminating in the growth of both small-scale mining and large-scale mining. The increased demand for natural resources by emerging economies such as China (Balatsky et al. 2015; Preston et al. 2016) in order to sustain and accelerate their economic growth and development has fueled increased demand for natural resources, with implications for both small-scale mining and large-scale mining activities in a number of countries. Additionally, the increase in the prices of natural resources, most notably gold and diamonds, has fueled small-scale mining activities (Bryceson et al. 2014; Seccatore et al. 2014; Tschakert 2016; Hausermann et al. 2018; Chigumira 2018; Barenblitt et al. 2021). The unprecedented rise in gold prices following the 2008 financial crisis has been cited as a significant global driver of the recent expansion of small-scale gold mining activities in a number of countries, including Peru (Alvarez-Berrios et al. 2016), Tanzania (Bryceson et al. 2014), Ghana (Hausermann et al. 2018), Indonesia (Bose-O’Reilly et al. 2016), and Mongolia (Krätz et al. 2017). The growing mining activities aimed at profiting from the high prices of gold have been dubbed ‘gold rush mining’ in the literature and have occurred in a wide variety of mining countries, including
those with no historical mining records (Bryceson and MacKinnon 2012). For example, between 2012 and 2013, nearly 50,000 Chinese nationals were reported to have migrated to Ghana for the purpose of small-scale gold mining (Crawford et al. 2016). This modern gold rush is comparable to the one described by Lestari (2007, 2011 cited in Lahiri-Dutt 2018 p. 50) in West Java, Indonesia, involving an estimated 26,000 illegal artisanal miners as a result of the 1997 Asian financial crisis and the fall of the autocratic Suharto regime.

Additionally, the rapid growth of the small-scale mining sector has been attributed to specific drivers in host mining countries, which I refer to in this context as local drivers. The debates over these local drivers have been shaped by two major opposing narratives (Hilson and Garforth 2012). The first narrative, which primarily reflect the perspectives of policymakers and development partners, attribute the burgeoning small-scale mining sector to an increasing number of people “looking to 'get rich quick' ” (Banchirigah 2008; Hilson and Garforth 2012, p.436). This narrative, which views the small-scale mining sector as an ideal environment for indigenous entrepreneurship, is believed to have influenced decision-making and policy action in the 1970s and 1980s (Alpan, 1986, Noetstaller, 1987 cited in Hilson 2009; Hilson and McQuilken 2014). Although this narrative shifted significantly in the 1990s, similar arguments have recently surfaced in which elite and powerful entrepreneurs are accused of abusing flexible mining regulations to the detriment, marginalisation, and exclusion of indigenous poor mining workforces in the Philippines, Tanzania, and other countries (See Fisher 2007, 2008; Verbrugge 2015; Verbrugge and Besmanos 2016). The small-scale mining sector has been identified as a viable profession with high returns by powerful elites with political connections and financial capabilities, as well as other nationals with capital to invest (Crawford et al. 2016; Mkodzongi and Spiegel 2019).

The second narrative, which is a rebuttal to the perception of the small-scale mining as a magnet for ‘greedy’ and ‘get rich quick’ individuals, argues that the expansion of the small-scale mining sector is largely due to ’the declining fortunes of agriculture (Hilson and Garforth 2012, 2013; Bryceson et al. 2014; Afriyie et al. 2016). This argument is primarily concerned with livelihood diversification, particularly in Africa. According to a study by Bryceson et al. (2014, p. 26), since the late 1970s, contracting global markets for African smallholder agricultural exports have triggered large-scale de-agrarianisation processes and a search for alternative sources of income for impoverished rural households. Consequently, many African nationals employed in agriculture are seeking employment and survival in other sectors. Hilson and
Garforth (2012) asserted that while smallholder farmers are diversifying, small-scale mining does not entirely replace smallholder farming, as the term ‘de-agrarianisation’ implies, but rather coexists with subsistence farming. While this is true in some countries, including Sierra Leone, small-scale mining competes with smallholder agriculture in others (African Center For Economic Transformation 2017; Hausermann et al. 2018; Ferring and Hausermann 2019).

Related to the ‘poverty-driven’ narrative are the unintended consequences of the implementation of the Structural Adjustment Programme (SAP) in Sub Saharan Africa, which is believed to have favoured large-scale mining and enabled many laid-off workers and other individuals to work in the informal sector as a means of survival (Akabzaa and Darimani 2001; Hilson 2004; Banchirigah 2006, 2008; Yankson and Gough 2019). According to Banchirigah (2006, p. 167), many of the people left unemployed by SAPs in Sub-Saharan Africa were not absorbed into the large-scale mining sector, as one might expect, and thus turned to small-scale mining out of desperation. Yankson and Gough (2019), for example, found that the loss of wage employment opportunities in large-scale mining is a significant factor in the expansion of the small-scale mining sector in Ghana. Their conclusion is based on the fact that large-scale mining operations have impacted access to mineral lands, most notably through the reorganisation and transition of large-scale mining operations from underground labour-intensive operations to capital-intensive surface operations, resulting in labour retrenchment.

In light of the second narrative, there has been considerable debate over the necessity of formalising the small-scale mining sector (Maconachie and Hilson 2011; Salo et al. 2016; Hilson et al. 2018, 2019). The United Nations Environment Programme (2012, p. 2), defines formalisation as the process of integrating small-scale gold mining into the formal economy. The process entails enacting or amending mining (and other) laws or policies to address the challenges posed by small-scale gold mining, and it can only be completed successfully if programmes and public policy address the complex aspects of small-scale gold mining activities concurrently and comprehensively (ibid). The formalisation thesis asserts that the fact that small-scale mining is largely unregulated and operates outside of legal frameworks is to blame for the majority of the social and environmental problems of the sector. Thus, by incorporating small-scale mining into the formal economy and providing operators with a title recognising their “right to mine”, activities will become more ‘sustainable’ (Maconachie and Hilson 2011 p. 294). Additionally, they asserted that formalising the small-scale mining sector enables governments to better monitor and regulate small-scale mining sector activities, as well
as provide individual small-scale mining operators with the titles and registration necessary to secure the financial and technical assistance they so desperately need to expand their operations (Hilson et al. 2019 p. 259).

Despite efforts to formalise and regulate the sector, the small-scale mining industry retains an informal character. Tschakert (2016 p. 123) asserts that the informality of the small-scale mining sector is now “permanent rather than transitory”. Even in countries with formalisation frameworks, small-scale mining activities are conducted informally and outside the scope of applicable legal or regulatory frameworks (Siegel and Veiga 2009). This state of affairs has been attributed to a variety of factors in various countries, including a lack of capacity to enforce existing laws (Maconachie and Hilson 2011; Geenen and Radley 2014; UNDP Ghana 2017); corruption (Abdulai, 2017; Crawford and Botchwey (2017); elections and partisan polarisation (Abdulai 2017); administrative bureaucracy and rent-seeking behaviour of government officials (Hentschel et al. 2002; Van Bockstael 2014; UNDP Ghana 2017) and expansion of large-scale mining in some countries (Hilson and Potter 2005; Maconachie and Hilson 2011).

Banchirigah (2008, p. 29) succinctly summarises the persistent informality of the small-scale mining sector: “although the government has long legalised small-scale mining by requiring prospective applicants to adhere to a series of streamlined regulations to obtain a concession, ineffective policies and bureaucratic inefficiency have hampered formalisation, making illegal activity more appealing”. According to Maconachie and Hilson (2011 p. 298), policies aimed at reforming the mining sector in general have resulted in the emergence of a ‘tri-sector’ economy in a number of countries, which includes “foreign-propelled large-scale gold mining; licensed small-scale gold mining; and a burgeoning illegal artisanal gold mining industry”. According to this quote, illegal activities in the small-scale mining sector are a result of the failure of formalisation processes.

Recent narratives from the Philippines (Verbrugge 2015), but resonating with events in other parts of Sub-Saharan Africa, such as Zimbabwe (Mkodzongi and Spiegel 2019), Ghana (Teschner 2012; Tschakert 2016) and Tanzania (Fisher 2007, 2008), have called into question the fiscal, administrative, and political barriers attributed as primary reasons for the persistence of informality in the small-scale mining sector. The heterogeneous and complex nature of small-scale mining is argued in contrast to “rather simplistic images of a dual mining economy
divided between formal, capital-intensive large-scale mining and informal, poverty-driven, and rudimentary ASM” (Verbrugge 2015, p. 1029) by proponents of the ‘poverty driven’ narrative. It is argued that there is no such thing as an exclusively informal small-scale mining sector, but rather a mash-up of various types of arrangements that are all intertwined in varying degrees of legal registration. Fisher (2007; 2008), for example, demonstrates how artisanal gold miners in Tanzania are impacted by contradictory processes in which some artisanal gold miners are integrated into state institutions and legal processes, while the vast majority are either further excluded or incorporated in ways that exacerbate insecurity and exploitation, both of which are exacerbated by socioeconomic inequalities. According to Teschner (2012), the small-scale mining sector has “evolved into a highly intertwined group of ‘semi-formal’ sectors operating with varying degrees of legal registration and technological and market innovations with varying legal status”. As discussed previously, the rapid growth and complexity of the small-scale mining sector have ramifications for agriculture, particularly smallholder agriculture. These two sectors are heavily reliant on land, water, and labour, which can result in some intense competition. As a result of their divergent perspectives, some direct relationships between these two sectors have been established. The following paragraphs will examine these diametrically opposed narratives.

2.3 Contrary perspectives on the relationship between small-scale mining and smallholder farming

Mining zones frequently overlap with agroecological zones that support agricultural activities. For example, in Ghana, the forest zone produces 57% of total food crop tonnage (Diao et al. 2019), and also contains 61% of gold-bearing landscapes (See Map 2.1). That is, the same geography that facilitates the cultivation of food crops also facilitates gold mining. Thus, direct links between small-scale mining and smallholder farming activities can be established.
Chapter 2: Perspectives on the relationships between mining and farming

Map 2.1: An Overlay of Agroecological Zones with gold areas in Ghana

Source: Author’s Construct with data from Ghana Land Use and Spatial Planning Authority, and the Forestry Research Institute of Ghana (FORIG).

According to some authors (Kamlongera 2011; Maconachie 2011; Okoh and Hilson 2011; Hilson and Garforth 2012, 2013; Hilson 2016a; Chigumira 2018; Mkodzongi and Spiegel 2019) these relationships are complementary and ‘symbiotic’, whereas others (African Center For Economic Transformation 2017; Snapir et al. 2017; Hausermann et al. 2018; Ferring and Hausermann 2019) argue that they are competitive in some countries such as Ghana. For example, studies by Hilson and Garforth (2012, 2013) in Ghana and Chigumira (2018) in Zimbabwe both found that small-scale mining provides supplementary livelihood alternatives for smallholder farmers, allowing them to increase their incomes while also securing their tenure on their land holdings (Chigumira 2018).
Similarly, empirical evidence indicates that small-scale mining activities provide a market for farmers because of the influx of small-scale mining workers in thriving mining communities and the resulting high demand for food and other crops (Maconachie 2011; Hilson and Garforth 2013). Furthermore, the same authors revealed that earnings from small-scale mining activities can be used to reinvest in smallholder farming or agricultural businesses and trade, and vice versa. These positive synergies established between small-scale mining and smallholder farming are primarily one-sided and focus principally on the socio-economic aspects of the relationship. To round out the discussion, the environmental, as well as other important components of the relationships between small-scale mining and smallholder, deserve a more thorough examination. This is due to the fact that a one-sided argument usually results in the prescription of superficial recommendations that, when implemented, do not provide comprehensive solutions. Consequently, positive outcomes from these relationships may benefit only a small group of actors, while the costs associated with such relationships may be borne by the society as a whole. For example, the environmental cost of mercury polluted water that comes in touch with smallholder farming activities imposes significant negative externalities on persons and communities (Pigou 1920). Furthermore, the invasion of farmed areas for small-scale mining operations (Hausermann et al. 2018) encourages farmers to encroach on forest reserves, accelerating the rate of deforestation and its associated consequences, including a worsening of the effects of climate change suffered by all. Small-scale mining activities, in and of themselves, lead to deforestation, with the same societal repercussions.

Additionally, except for a study by Chigumira (2018), which utilised very basic digital maps, all the studies that established a complementary link between small-scale mining and smallholder farming employed qualitative or quantitative approaches rather than geospatial methods. Furthermore, the dynamic issues of land, water, and labour competition between these two sectors, whose field of operation (land) periodically overlaps, were not well addressed. For instance, in Ghana, mining is deemed to be more profitable than any other land use by the government, based on current legal structures (Hausermann et al. 2018). Thus, when a mineral is discovered on a piece of land and a mining title (license) is secured from or by the appropriate legal authorities6, other current land uses, such as crop farms, are considered

6 The Minerals Commission of Ghana is responsible for official licenses for mineral extraction site plans. The licensing procedure, among other things, entails comparing prospective mining site designs to Ghana’s master
irrelevant (Hausermann et al. 2018). The repercussions of such actions and policies have not been quantified objectively in discussions about small-scale mining and smallholder farming, particularly in the social sciences (except Snapir et al. 2017; Awotwi et al. 2018; Hausermann et al. 2018; Ferring and Hausermann 2019; Obodai et al. 2019). While small-scale mining may provide some farmers with additional revenue, the consequences in terms of collective land loss, labour competition, and pollution of agricultural water supplies are substantial (Snapir et al. 2017). Arable land and existing farms are occasionally lost to small-scale mining operations in regions where the two activities overlap, with a variety of ramifications for food security. Recent studies using remote sensing techniques by Ferring & Hausermann 2019; Obodai et al. 2019; Hausermann et al. 2018b; Awotwi et al. 2018; and Snapir et al. 2017, all discovered a rather negative symbiotic relationship between small-scale mining and smallholder farming, with varying implications for food security. Among the significant negative consequences of the relationship between small-scale mining and smallholder farming identified by the studies above are disruption of food systems and trade networks, displacement of farmers (outright dispossession with or without compensation), loss of supplementary income, and extensive land use and land cover changes in favour of small-scale mining activities relative to smallholder farming activities. It is worth mentioning that, with the exception of Danyo and Osei-Bonsu 2016; Hausermann et al. 2018b, who examined small-scale mining in direct relation to food security, albeit narrowly, the consequences of small-scale mining and smallholder farming on food security have gotten limited attention. I will address the concept of food security, the obstacles to achieving it, and the theoretical viewpoints that underpin it in the following parts.

geology and concession maps to ensure that proposed mining sites do not overlap with current concessions. Once this has been proven, approval is granted regardless of adjacent land uses. According to (Hausermann et al. 2018), this method assumes that mineral extraction is a more efficient, economic use of land than smallholder agriculture.

7 The art, science, and technology of identifying, measuring, and analysing the characteristics of object features/targets on, above, or even below the earth’s surface without direct contact between the sensors and the targets or events being observed (Awange and Kiema 2019).
2.4 The concept of food security and the challenges associated with its achievement

Food security is a multidimensional and multidisciplinary term that first emerged in the 1960s and 1970s worldwide development discourse (Von Braun et al. 1992; Anderson and Cook 1999; FAO 2006). Numerous institutions and specialists in the subject have now expanded the scope of the concept to encompass social, political, ethical, and human rights considerations. Food security exists when all people have physical and economic access to sufficient, safe, and nutritious food that always matches their dietary requirements and food preferences for an active and healthy life (World Food Summit 1996). The FAO (2006) defines food security in four dimensions: food availability, food access, food utilisation, and food stability. Food availability refers to the availability of sufficient amounts of appropriate quality food, which can be produced domestically or imported (including food aid). The access component refers to individuals’ access to necessary resources (entitlements) for acquiring foods that match their dietary requirements. Additionally, food utilisation is frequently defined as the method through which the body obtains the maximum amount of nutrients from food. Food utilisation is determined by the interaction of non-food elements such as safe drinking water, sanitation, health care, good care and feeding habits, food preparation, diet diversification, and intra-household food distribution. Together with proper biological utilisation of food consumed, this establishes the nutritional state of an individual. Finally, the component of food stability is always concerned with food supply and accessibility. It is concerned with the possibility that a population, household, or individual will be hungry. For example, even if a someone consumes a suitable amount of food today, they are still deemed food insecure if they often lack access to food, putting their nutritional status at danger.

Food security is widely recognised by policymakers and experts alike as a critical global development concern. Goal 2 of the seventeen Sustainable Development Goals (SDGs) aims to eliminate hunger, provide food security and nutrition, and promote sustainable agriculture. Despite this goal, which is backed by a variety of national, regional, and global policies and programmes, the challenge is far from done. According to the FAO, IFAD, UNICEF, WFP and WHO (2022) most current assessment on global food security, the world is not on track to meet the Sustainable Development Goal 2.1 Zero Hunger objective by 2030. This issue is aggravated further by the influence of Covid-19 on global food insecurity (Akpaki et al. 2020; Loopstra 2020; Niles et al. 2020; The Lancet Global Health 2020; Dabone et al. 2021; Gundersen et al. 2021). The total number of hungry people is gradually increasing, with Africa considerably falling short of the 2030 Zero Hunger target (FAO, IFAD, UNICEF, WFP and WHO, 2022).
Chapter 2: The concept of food security

According to the estimate referenced above, between 702 and 828 million people (8.9% and 10.5% of the world’s population) suffer from hunger in 2021, with Africa accounting for the biggest number at 278 million (20.2%). Additionally, nearly all African subregions are experiencing an increase in food insecurity. Africa has the greatest percentage of severe food insecurity (23.4%), with almost 58% of the region’s population experiencing moderate or severe food insecurity in 2021. These figures illustrate the magnitude of the challenge, which has been attributed to a variety of factors, including agricultural soil degradation and declining productivity; low rates of agricultural production; inadequate sanitation, health facilities, and water; high rates of population growth, poverty, conflicts and violence, climate variability and change; natural disasters; and access to and rights to land, education, gender, age, remittances, and social exclusion, among others (Stringer 2000; Abdullah et al. 2018; (FAO, IFAD, UNICEF, WFP and WHO, 2018, 2022; Krishna Bahadur et al. 2018). One obvious question that demands an answer is this: do small-scale mining activities have any effect on food security? This is an important question that this thesis attempts to address. To contextualise food security and gain a holistic knowledge of how the interaction between small-scale mining and smallholder farming affects it, it is crucial to analyse the theoretical viewpoints that have guided food security discourses across time. As such, I shall address the theoretical underpinnings of food security in the next section.

2.4.1 Theoretical perspectives on food security

Numerous theoretical perspectives have been advanced to comprehend the concept of food security. Sen (1983) identified two major approaches to the global food crisis in the 1980s, dubbed ‘nature-focused’ and ‘society-focused’. The nature-focused approaches emphasized natural sciences and engineering and connected the food problem to various technologies, whereas the society-focused approaches were more concerned with social issues such as politics and economics and approached the food problem socially. While the discovery of Sen (1983) is unrelated to food security, it has informed the many methodologies employed to date

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8 The Food Insecurity Experience Scale (FIES) is a survey that is used to identify severe food insecurity. The FIES survey consists of eight questions that have been carefully selected, tested, and shown to be successful at assessing the degree of respondents’ food insecurity across a range of cultural, linguistic, and developmental contexts. The following sections of this chapter explore this measure of food security in detail, while Chapter 3 discusses its measurement.

9 Severe food insecurity entails a drop in food consumption to the point of hunger. Moderate food insecurity is defined as an inability to obtain healthy and sufficient food on a consistent basis, even if this does not always result in hunger.
in assessing food security. As illustrated in Table 2.1, the major approaches that have shaped food security discourses over time include the Malthusian approach (food availability), the income-based approach, the basic needs approach (Food First), the entitlement approach, the sustainable livelihoods approach, the human development and capability approach, the place-based approach (Marta 2013), and the experience-based approach (Swindale and Bilinsky 2006a, b; Coates et al. 2007; Ballard et al. 2011; Marta 2013; Burchi and De Muro 2016; FAO 2017). These methodologies have been applied to many aspects of food security across time and at various levels of investigation.

Maxwell (1996, p.156) identified three key and overlapping paradigm shifts in food security thought. These include a change away from global and national perspectives toward family and individual perspectives, a shift away from a food-first to a livelihood perspective, and a shift away from objective indicators toward subjective perception. These three key alterations reflect altering theoretical perspectives on food security and the metrics used to assess it. As a result of these alterations in food security viewpoints, this thesis analyses food security through the lens of persons, livelihoods, and subjective thought.
### Chapter 2: The concept of food security

**Table 2.1: Major Approaches and examples of indicators adopted in the assessment of food security at different levels**

<table>
<thead>
<tr>
<th>Food availability /Malthusian Theory</th>
<th>Income Based</th>
<th>Basic Needs/Food First</th>
<th>Entitlement</th>
<th>Sustainable Livelihood</th>
<th>Capability</th>
<th>Experience-Based Food Insecurity Measurement Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food availability</td>
<td>Income Based</td>
<td>Basic Needs/Food First</td>
<td>Entitlement</td>
<td>Sustainable Livelihood</td>
<td>Capability</td>
<td>Experience-Based Food Insecurity Measurement Scale</td>
</tr>
<tr>
<td>Undernourishment</td>
<td>Undernourishment</td>
<td>Undernourishment</td>
<td>Undernourishment</td>
<td>Undernourishment</td>
<td>Undernourishment</td>
<td>Undernourishment</td>
</tr>
<tr>
<td>- Average nutrition gap and the distribution gap</td>
<td>- Global Hunger Index</td>
<td>- Household Dietary Diversity Score (HDDS)</td>
<td>- Food Consumption Score (FCS)</td>
<td>- Comprehensive Food Security &amp; Vulnerability Analysis</td>
<td>- Multi-level indicators</td>
<td>- Multi-level indicators</td>
</tr>
<tr>
<td>- Global Hunger Index</td>
<td>Household Income &amp; Expenditure surveys</td>
<td>Household Income &amp; Expenditure surveys</td>
<td>Multi-level indicators</td>
<td>Household</td>
<td>Individual &amp; Household</td>
<td>Household &amp; Individual</td>
</tr>
<tr>
<td>FAO, USDA</td>
<td>FAO, USDA</td>
<td>USAID</td>
<td>WFP</td>
<td>WFP</td>
<td>WFP</td>
<td>WFP</td>
</tr>
</tbody>
</table>

**Notes:**
- **Food availability** includes the basic understanding of the availability of food at a certain level.
- **Income Based** considers the income aspects of food availability.
- **Basic Needs/Food First** focuses on household income and expenditure surveys.
- **Entitlement** examines the multi-level indicators of food availability and access.
- **Sustainable Livelihood** utilizes comprehensive food security & vulnerability analysis.
- **Capability** employs comprehensive indicators at the household level.
- **Experience-Based Food Insecurity Measurement Scale** includes indicators such as the Food Insecurity Experience Scale (FIES), US Household Food Security Survey Module, Hunger Scale, Household Food Insecurity Access Scale, and Coping Strategy Index (CSI).
2.4.1.1 Food availability approach (Malthusian theory)
The food availability approach is conceptually founded on Robert Malthus's Essay on the Principle of Population, published in 1798 and widely referred to as the Malthusian theory/approach. The Malthusian idea is a significant theoretical perspective that has had a significant impact on development thought and a variety of other problems, including food security. This theory examined the relationship between food and population growth and concluded that food supply is out of step with population expansion. According to Malthus, food increased in an arithmetic progression while population increased geometrically, eventually eclipsing the former and culminating in famine. Malthus argued for moral precautions to avert this. When applied to food security, this theoretical perspective implies that aggregate food supply should be increased to outpace population expansion, resulting in the food availability strategy. Prior to the early 1970s, this theoretical perspective dominated food security discourses, as reflected in the 1974 World Food Conference definition of food security as “availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices” (UN, 1974 cited in Burchi and De Muro 2016).

During these periods, emphasis was placed on the aggregate availability of food to meet national, regional, and household demands. The necessity for an adequate and steady supply of food free of price volatility and rises takes centre stage in food security discussions. Many developing countries pursued Green Revolutionary policies. Institutions such as the International Fund for Agricultural Development (IFAD), World Food Programme (WFP), Consultative Group on International Agricultural Research (CGIAR), and Global Information and Early Warning Systems (GIEWS) were established (Anderson and Cook 1999, Pinstrup-Andersen and Watson, 2011 cited in Hadley and Crooks 2012).

As with any other theoretical perspective, the Malthusian theory of food is not without criticism. Sen and Sen (1982, p. 448), assert that “Malthusian pessimism has not been well vindicated by history”. In the nearly two centuries since the publication of Malthus' well-known Essay, his fears have proven to be not only unfounded, but fundamentally misguided, as the enormity of technical progress and the vast expansion of food production - far in excess of population growth, which has itself been very rapid - have demonstrated”. Despite increases in food production, it was noticed that access to such food supplies remains a barrier.
Achieved was the recognition of appropriate food availability as a prerequisite for food security, but not necessarily translating into food access for the poor, in particular (Smith et al. 2000; Carletto et al. 2013).

2.4.1.2 Basic needs approach
At the 1976 World Employment Conference, the International Labour Organisation (ILO) presented the basic needs approach as a development paradigm. This model aimed to incorporate the non-economic dimension of development in recognition of the persistence of developmental challenges such as poverty, unemployment, and underemployment even during periods of higher economic growth (Burchi and De Muro 2016). The basic needs approach to development seeks to create opportunity for individuals to reach their maximum potential (Streeten and World Bank 1979). From this theoretical approach, food was recognised to be an important basic need. This perspective affected food security debates, analysis, and measurement, resulting in what some experts refer to as the food first approach (Maxwell 1996; Maxwell and Smith 2002). Food is a priority, and whether individuals have adequate food on a micro level is secondary. Some authors defined food security in terms of meeting an average daily calorie need based on the basic needs approach (Rearson and Matlon 1989; Sarris 1989). According to Burchi and De Muro (2016), the basic needs approach was applied to measure food security in three ways. These included determining the number of meals consumed per day or the frequency with which specific food items were consumed; directly observing food consumption; and weighting and aggregating food items according to their nutritional composition. The approach based on basic needs is applied in newer indicators of food security, such as the dietary diversity approach. The approach to food security based on basic needs has been criticized for being excessively focused on the near term and not offering enough information on potential future food poverty (Burchi and De Muro, 2016). This perspective, in my opinion, places significantly more emphasis on the commodity of analysis than on the people and the intricate structures that surround the entire food system.

2.4.1.3 Entitlement approach
During the 1980s, the entitlement perspective became the most popular theoretical perspective on food security and food in general, coinciding with the second paradigm change in food security discourse as reported by (Maxwell 1996). Amartya Sen pioneered this method, arguing against Malthusian views of famine and hunger and emphasizing food access. The entitlement approach focuses on the “entitlements to commodity bundles” of each individual, including
food, and regards starvation as the outcome of a failure to obtain any bundle containing sufficient food (Sen 1981, p. 434). This perspective is predicated on three core conceptual categories: endowment set, entitlement mapping (or E-mapping for short), and entitlement set (Osmani 1993). The endowment set contains all the resources that a person legally possesses, whereas the entitlement set contains all the potential combinations of goods and services that a person may legally receive using the resources in his endowment set. On the other side, the E-mapping represents the relationship between endowment and entitlement, which Sen (1981) refers to as the exchange with people (trade) and the exchange with nature (production). The entitlement set is established by the endowment set and the E-mapping, with the E-mapping representing the legal, political, economic, and social qualities of the society and the position of the individuals within it (Sen 1981). The entitlement of an individual is established by his or her endowments (resources) and the set of commodities to which the individual has access through trade and production. Burchi and De Muro (2016) acknowledged the influence of entitlement perspective of Sen (1983) on two significant definitions of food security issued by the FAO and the World Bank during this dispensation or shift in food security conceptualisation and analysis. The following definitions are provided: Food security is defined as “all people at all times having both physical and economic access to the basic food they require” (FAO 1983), as well as people at “all times having access to enough food for an active, healthy life” (World Bank 1986).

In terms of food security, entitlement failure is an integral part of the entitlement approach. According to Sen (1981), an individual may be unable to escape starving if their endowment is reduced (direct entitlement failure) or if their exchange entitlement mapping is less favourable (trade entitlement failure). Osmani (1993) classifies entitlement failures into four categories: endowment loss, production failure, exchange failure, and transfer failure. Individuals might be impacted by failures in both direct and trade entitlements. While the entitlement approach was designed and proven primarily for the purpose of analysing famines, the same reasoning holds true for chronic hunger and endemic malnutrition (Burchi, 2011 cited in Burchi and De Muro 2016). If compared to the other approaches to food security covered thus far, the entitlement approach provides a framework for analysing the complex and multiple nature of food security. Despite this, Drèze and Sen (1989) confirmed that, while entitlements are important, a greater emphasis should be made on fundamental human capabilities. The authors emphasised the importance of broadening the conversation beyond food control to
include other effects, such as control over commodities that have a substantial impact on nutrition and health.

2.4.1.4 The sustainable livelihoods (SL) framework
As with the entitlement approach, the sustainable livelihoods (SL) paradigm gained notoriety in the 1980s with the release of Chambers' (1983) book, “Rural Development: Putting the Last First”. This approach is applied not only to food security research and discourse, but also to poverty and development discourse that is livelihood focused. Numerous development organisations have adopted and altered this approach to conduct analyses of various facets of food security as well as overall poverty. The World Food Programme, for example, analyses food and nutrition security using the DFID Sustainable Livelihoods Framework in addition to the UNICEF Nutrition Framework. Capital assets; vulnerability context; policies and institutions; and livelihood strategies and outcomes are the four different but interconnected components of the sustainable livelihood approach. The strength of the sustainable livelihoods approach is its capacity to generate a holistic and multidimensional profile of a micro-level setting—food, nutrition, livelihoods, and rights realisation—with a strong regional and national context, enabling for intervention scaling up (CARE, 2002 cited in WFP 2009). Burchi and De Muro (2016) emphasise two primary advantages of the sustainable livelihood approach in analysing food security: its long-term view and its contextual focus (political, economic, physical, social, cultural, etc.). Despite this, the sustainable livelihood approach places a premium on making a livelihood rather than broad human development, and on the ‘means’ of ensuring a living (ibid). Additionally, issues of freedom and agency are overlooked, and the complex relationship between people and food are not thoroughly examined (ibid, p. 4). Thus, approaches on human development and capability have been proposed for food security analyses. These approaches are discussed in greater detail in the following section.

2.4.1.5 Human development and capability approach
The capability approach to food security is attributed to Jean Drèze and Amartya Sen’s 1987 book ‘Hunger and Public Action’. This approach combines the capability and entitlement perspectives of Sen (1985, 1999) to provide a broad analytical framework for researching hunger (chronic or transitory), malnutrition, and famines (Burchi and De Muro 2016). The capability approach aims to widen the discussion about food consumption (command over food) to include other commodities that have a substantial impact on food nutrition and health. According to Drèze and Sen (1989, p. 15), the relationship between food intake and nutritional
attainment varies significantly depending on not only individual characteristics such as age, sex, pregnancy, metabolic rates, climatic conditions, and activities, but also on access to complementary inputs such as health care and drinking water. Thus, it is imperative to enable everyone to avoid malnutrition and the deprivations associated with hunger. Drèze and Sen (1989) remarked that the emphasis must be on human life as it can be lived, rather than on commodities, which are only means to an end and are contingent on need fulfilment rather than being appreciated in and of themselves. The authors' emphasis on human life reflects, in part, why recent assessments and understandings of food security are based on subjective experiences of individuals. In the following section, I will discuss the experiential perspectives on food security.

2.4.1.6 Experiential-based food insecurity approaches
Recent discourses on the understanding and measurement of food security, particularly the access dimension, have taken an experiential perspective. In comparison to other indirect measures of food insecurity, experiential-based techniques have gained popularity due to their use of scales based on the perception or experience of individuals or households directly affected by food insecurity. These approaches, which rely on surveys, monitor sample household food security experiences over time. The Food Insecurity Experience Scale (FIES) developed by the FAO, the US Household Food Security Survey Module (HFSSM) developed by the Economic and Research Service of the United States Department of Agriculture, the Household Food Insecurity Access Scale (HFIAS) developed by USAID, and the Coping Strategy Index (CSI) developed by CARE are among the well-known experience-based food insecurity measurement scales with varying degrees of validation used in assessing food (in)security (Carletto et al. 2013; Cafiero et al. 2018). For example, the FIES was chosen as the basis for measuring the prevalence of moderate or severe food insecurity in the population (Indicator 2.2.1 of the SDG indicator framework for Target 2.1)10 (Inter-Agency and Expert

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10 The 2030 Agenda for Sustainable Development was endorsed by all United Nations Member States in 2015 as a collaborative roadmap for peace and prosperity for people and the planet today and in the future. It includes 17 Sustainable Development Goals (SDGs), which are an urgent call to action from a global partnership perspective for all countries (developed and developing). The second goal is to “end hunger, achieve food security, improve nutrition, and promote sustainable agriculture”. Two targets have been established to accomplish this objective. By 2030, the first goal is to eradicate hunger and ensure that all people, particularly the poor and vulnerable, including babies, have year-round access to safe, nutritious, and sufficient food. The second goal is to eradicate all forms of malnutrition by 2030, which includes meeting internationally agreed-upon targets for stunting and wasting in children under the age of five by 2025, as well as meeting the nutritional needs of adolescent girls, pregnant and lactating women, and older adults. In 2016, the United Nations Statistical
Chapter 2: The concept of food security

Group on SDG Indicators (IAEG-SDGs) 2017; Cafiero et al. 2018). It is a severity experience matrix for food insecurity based on respondents’ instant responses to questions concerning their access to sufficient food security (Reagan 2018). Some of these experience based metrics capture food insecurity-related anxiety, attitudes, and social acceptability (Wolfe and Frongillo 2001).

The experiential-based food insecurity measure is believed to have been developed in the early 1980s by researchers at Cornell and Tufts Universities in the United States of America (USA) and a non-governmental organisation (Radimer 2002; Pérez-Escamilla and Segall-Corrêa 2008; Murphy et al. 2018). The researchers used qualitative research methodologies to acquire a better understanding of food insecurity among low-income women in upstate New York. Their findings were then integrated to create a ten-item scale that examined three dimensions of food insecurity: psychoemotional, dietary quality, and dietary quantity. The Cornell scale placed a priority on a lack of access to nutritious food as well as an inability to purchase enough food due to a financial constraint. Households were questioned about their food acquisition and consumption practices, and then categorised as food secure or food insecure, with or without hunger. This classification was determined using an algorithm based on affirmative responses to queries from households. In the 1990s, the United States Department of Agriculture produced the Household Food Security Survey Measure (HFSSM) in response to this substantial shift from past methodologies and documentation of evidence-based efforts in building an experiential-based measurement scale. It became law on a nationwide scale in 1995. The HFSSM consists of 15 questions and three subitems that are based on the theory and logic of the Cornell Scale but with major modifications to the algorithm used to classify households into various levels of food (in)security severity. As a result of this development, a variety of experience-based measures have been established and are being utilised by institutions and the academic community, with varied degrees of validation.

The popularity of experience-based approaches is due to their simplicity, ease, and rapid deployment at a low cost, their comparability across countries and cultures, and their direct measurement of food insecurity experiences (Hendriks 2005; Pérez-Escamilla and Segall-

Interagency and Expert Group on Sustainable Development Goal Indicators agreed on two distinct indicators for monitoring the first target (2.1), which were ratified in 2017. The following are the indicators: 1. The prevalence of undernourishment; and 2. The prevalence of moderate or severe food insecurity in the population, as measured by the Food Insecurity Experience Scale (FIES).
Chapter 2: The concept of food security

Corrêa 2008; Ballard et al. 2013; Carletto et al. 2013; Reagan 2018). Additionally, it is believed that experiential-based food insecurity measurement scales capture both the physical and psychosocial dimensions of food insecurity and can be used to map and understand the causes and consequences of food insecurity and hunger using the household as a unit of analysis (Pérez-Escamilla and Segall-Corrêa 2008). Furthermore, experience-based techniques are helpful because they may be employed in a wide variety of sociocultural contexts, with terminology that is contextually appropriate.

Certain shortcomings of the experience-based approach have been recognised, including its design as a unidimensional scale (food access), despite the fact that food security is multidimensional (Wolfe and Frongillo 2001). To circumvent this drawback the experience-based approach can be used in conjunction with other approaches (Ballard et al. 2013). Additionally, different studies (see Pérez-Escamilla et al., 2004a; Pérez-Escamilla et al., 2004b; Pérez-Escamilla et al., 2004; all cited in Pérez-Escamilla and Segall-Corrêa 2008) have employed a variety of reference period. This alternative method of defining the reference period is regarded as a disadvantage (Pérez-Escamilla and Segall-Corrêa 2008). However, the goal of a study may dictate the choice of a specific reference period. The FIES was used in conjunction with other methodologies to examine various aspects of food security in this study. Additionally, to adjust for seasonality, a 12-month reference period was chosen, consistent with previous studies (Details of these are provided in Chapter 4). As previously stated, research on the links between small-scale mining and agriculture has employed both social science (qualitative and quantitative) and natural scientific methodologies, such as remote sensing and Geographic Information Systems (GIS). I will discuss the application of remote sensing and GIS in mining and agricultural discourses in the following section.

2.5 The application of geospatial analytical tools and techniques in mining and agriculture discourses

Geoinformatics – defined as “the art, science, or technology dealing with the acquisition, storage, processing, production, presentation, and dissemination of geoinformation” (Ehlers 2008, p. 22) – has been increasingly used in recent years to improve our understanding of the relationships between humans and their environments and to provide programmatic and sustainable solutions. As previously proven in “the prior sections of this chapter, mining and agriculture operations build a connection between humans and their environment through the
direct and indirect usage of natural resources. Geospatial tools and techniques such as remote sensing and geographical information systems (GIS), as well as quantitative and qualitative methods, can be used to examine such interactions. In terms of mining, several studies have succeeded in elucidating the ecological consequences of changes in land use and land cover in areas where mining is prevalent (Basommi et al. 2015; Connette et al. 2016; Snapir et al. 2017; Awotwi et al. 2018; Padró et al. 2018; Lobo et al. 2018; Garai and Narayana 2018; Barenblitt et al. 2021). Garai and Narayana (2018) for example, used Landsat satellite imagery to study the dynamics of land use and land cover change in coal mining areas in Southern India over a 24-year period and discovered that mining has a direct effect on forest cover. Additionally, Lobo et al. (2018) successfully mapped mining areas in the Brazilian Amazon using Sentinel-2 images, identifying the scale and mineral type of each mapped mining area, and concluding that small scale gold and tin mining accounted for a greater proportion (64%) of the total mining area detected in the study area. Another study, conducted in the Peruvian Amazon of southeastern Peru by Espejo et al. (2018), illustrates the ecological impact of gold mining on deforestation and forest degradation using CLASlite and the Global Forest Change dataset.

Agriculture analysis has also benefited from the use of remote sensing and GIS technologies to provide insightful information about agricultural land use in support of food security and poverty reduction policies at various scales (Waldner et al. 2014; Jin et al. 2017, 2019; Wang et al. 2019a). Crop distribution maps at the global level, such as the Monthly Irrigated and Rainfed Crop Areas Around the Year 2000 [MIRCA2000] (Portmann et al. 2010) and the Spatial Production Allocation Model [SPAM] (You et al. 2014), provide information on cropland percentages for major crop types in a given year. Additionally, national, and regional crop type maps have been created using moderate resolution satellite imagery from MODIS, Landsat, and Sentinel archives. Cropland Data Layer (CDL) for the United States, Agriculture and Agri-Food Annual Crop Inventory for Canada, Sen2-Agri maps throughout Europe and parts of Africa are just a few examples.

I used remote sensing/GIS tools and techniques in conjunction with quantitative and qualitative social science methods to gain a comprehensive understanding of the relationship between small-scale mining and agriculture in this thesis (Details are discussed in Chapter 3 and 6). I summarised the body of information presented thus far, as well as the gaps uncovered and the purpose of the current study, in the following section.
Chapter 2: Review summary, gaps in knowledge and research questions

2.6 Summary of identified gaps in knowledge and key research questions

As evidenced by the preceding paragraphs of literature review, there is a wealth of knowledge accessible on the nature, intricacies, and driving forces of the small-scale mining industry in many regions of the world. Scholars and institutions alike have paid special attention to the rapid rise of the small-scale mining sector in the face of opposing narratives. Additionally, the review reveals the long-standing connections between small-scale mining and smallholder agriculture, as well as debates on the nature of those connections (either complementary or competitive). These distinctions were discovered to be concentrated on two dominating schools of thought, one focused on socio-economic consequences and the other on the environmental consequences of the sector. The review established that these discrepancies were partly due to the methodological approaches utilised to comprehend the link. A separate methodological dichotomy was established depending on the issue of inquiry. These were qualitative or qualitative and geospatial methods employed by social scientists and physical scientists, respectively.

Moreover, the literature review finds a dearth of research findings on the impacts of the small-scale mining-smallholder farming relationship on food security. The consequences of this link on all four dimensions of food security have received remarkably little consideration in the literature. As such, this study aims to address the overarching research question: What relationships exist between small-scale mining and smallholder farming, and what are the impacts of such relationships on achieving improved food security outcomes at both the individual and community level, to contribute to ongoing debates about the relationship between small-scale mining and smallholder farming and to offer new insights into how this relationship affects food security. To get at answers to the overarching research question, the specific research questions as enumerated in Section 1.1 of Chapter 1 must be addressed.

The review demonstrates that small-scale mining and smallholder farming are spatially interconnected and have similar resource requirements. As a result of this interconnections, actors within these two subsectors are inextricably linked and have varying degrees of power in terms of access to the resources necessary to conduct their operations. Thus, there is undoubtedly an interplay of often uneven power relations between various actors. This interplay of power relations and socioeconomic, environmental, and personal elements has a direct impact on individuals' food security outcomes and overall well-being. Thus, I employ
the capability approach as the theoretical lens to fully represent the general well-being of individuals and the various aspects influencing their beings and livelihoods in relation to food security. Given that the capability approach does not adequately capture power dynamics or the human-environment link, it was supplemented with a political ecology approach that does a better job of capturing these features from historical and multi-scalar perspectives. Thus, a novel synthesis of capability and political approaches was advocated to adequately address the study topics. In the following chapter, I will discuss the capability and political ecology approaches used in this study, as well as how they were conceptualised.
CHAPTER THREE  
A NOVEL BLEND OF THE POLITICAL ECOLOGY APPROACH AND CAPABILITY APPROACH

3.1 Introduction

In Chapter 2, I established that small-scale mining and smallholder farming are spatially linked and require similar key resources to function. Accordingly, many actors within these two subsectors interact and wield differing power hierarchies in terms of access to critical resources. These ties have been classified as either competitive or complementary, and they have a wide range of implications for the general well-being of significant actors in both sectors, particularly at the local level. The capability approach can be used to critically analyse the general well-being of individuals in relation to food security and the operations of small-scale mining and smallholder farming as livelihoods because of its evaluative prescription for comprehending the achieved wellbeing and freedoms of an individual (Robeyns 2017). While the capability approach views power relations as a significant condition that affects the attainment of achieved well-being, it groups them with social relations. However, due to their complexities, such power relationships should be addressed separately. Legislative and customary laws determine power relations and hierarchy within and between mining and smallholder farming actors, which vary at different scale. The illegality of some small-scale mining complicates power dynamics between participants in that sector, smallholder farming and other subsectors like forestry. These intricate connections have a direct impact on the ecosystem. For example, power dynamics surrounding land access for illicit small-scale mining are ingrained in enormous complexities at the local level, including the use of force. Political ecology is an effective theoretical lens to delve into such power dynamics on a multiple and historical scale. Additionally, political ecology can help explain the ecological impacts associated with such power dynamics by providing useful insights into human-environment interactions. Thus, in this chapter, I integrate the capability approach and political ecology to provide an elaborate and nuanced explanation of the interrelationships between small-scale mining and smallholder farming, as well as the implications for food security. I draw expansively on pertinent literature to explore the history, definitions and key tenets of the political ecology and capability approaches. Further, I illustrate how the two theoretical lenses were conceptualised. I use a diagrammatic representation of the major components of the two approaches to serve as a conceptual framework for analysing the empirical case studies in later chapters.
Chapter 3: Capability approach

The chapter is organized into five major sections. Section 3.1 provides an overview of the chapter. Sections 3.2 and 3.3, respectively, investigate the capability and political ecology. I explain how the two concepts were blended and conceptualised in Section 3.4. The chapter is summarised and concluded in Section 3.5.

3.2 Capability approach: history, definition, and key tenets

It is vital for individuals to have access to, use, and manage natural resources to increase their well-being. This is because there are linkages between human well-being and the use and value of natural resources (Millenium Ecosystem Assessment 2005; Sangha et al. 2015). The capability approach can be used to understand the achieved wellbeing of individuals in relation to food security (Burchi and De Muro 2016).

In the 1980s, Amartya Sen, an Indian economist and philosopher, pioneered the capability approach (Sen 1985, 1999). Numerous eminent scholars, including Martha Nussbaum, who collaborated closely with Sen, have since refined this perspective. The capability approach has had an impact on a wide range of humanities and social science study, as well as on actions and policies (Alkire 2005; Frediani 2010; Robeyns 2011, 2016b, a; Griewald and Rauschmayer 2014; Pelenc and Ballet 2015; Sangha et al. 2015; Burchi and De Muro 2016). Due to the popularity of the capability approach, the Human Development and Capability Association was founded in 2004. Additionally, the United Nations Development Programme (UNDP) incorporates the capability approach into its yearly Human Development Report.

The theoretical underpinnings of the capability approach are stated to be rooted in many distinct cultures, and probably all, as well as people and their lives (Nussbaum 2021, p. 13). Along with works from Ancient Greece, Rome, China, and India, as well as works by other prominent philosophers such as Plato, Socrates, Adam Smith, J.S Mills, T.H Green, Karl Marx, John Rawls, and Rabindranath Tagore, 'the political and ethical ideas of Aristotle are the first and most important Western historical source for the capability approach (Nussbaum 2021). 'The works of Karl Marx, according to Leopold (2021), may have provided a critical perspective on some contemporary versions of the capability approach, but this has gotten less attention than, for example, those involving Aristotle.
Chapter 3: Capability approach

The capability approach is a conceptual framework for a variety of evaluative exercises, most notably the following: (1) the assessment of an individual's achieved level of well-being and freedom from well-being; (2) the evaluation and assessment of social arrangements or institutions; and (3) the design of policies and other forms of social change in society (Robeyns 2017, p. 24). The capability approach is predicated on two fundamental normative claims: first, that the freedom to achieve well-being\textsuperscript{11} is of supreme moral importance; and second, that the freedom to attain well-being is contingent upon the capabilities of people. These two key ideas are referred to as ‘functionings’ and ‘capabilities’ (Sen 1992). The term functionings consists of ‘beings’ and ‘doings’ and refer to the various states of human beings and activities that an individual can engage in, such as being adequately nourished, educated, in good health, achieving self-respect, or being socially integrated, whereas capabilities refer to the individuals' actual freedoms and opportunities to achieve their functionings, such as access to food, education, and resources, and so on (ibid). For example, food (in)security, gold mining, and smallholder farming are all 'functionings' in the context of this study and are contingent on the real opportunities (capabilities) that individuals have, to achieve them, such as access to land, water, and labour, enabling policies and regulations, access to basic education, and access to an improved market system. Food (in)security is seen to be a 'being,' whereas gold mining and smallholder farming are considered to be 'doings.'

The capability approach was employed in this study to accomplish the first normative task of assessing individual well-being. In contrast to other accounts of wellbeing that place a premium on subjective categories (such as happiness) or on material means to well-being (such as income or wealth), this capability-based approach places a premium on the ‘beings’ and ‘doings’ of people, as well as their opportunities to realise those beings and doings (Robeyns 2017). The capability approach provides a framework for conceptualising and evaluating a phenomenon without providing an explanation for it (Robeyns, 2006: p. 353). On this premise, the capability approach is not a theory but rather a broad framework that can be further expanded in several ways into a more particular theory such as the theory of justice, the theory of human development, and so forth (ibid). Even though the capability approach is used in a wide variety of fields, its application may be broadly classified into two categories: primarily from a narrow perspective or primarily from a broad perspective (Crocker and Robeyns 2009)

\textsuperscript{11} The well-being of a person can be seen in terms of the quality (the ‘well-ness’, as it were) of the person’s being (Sen, 1992)
cited in Robeyns 2016a). From a narrow perspective, the capability approach gives the data necessary to assess 'the well-being (functionings and capabilities) of an individual. These data sets enable both intrapersonal and interpersonal comparisons of two individuals' well-being (or groups or societies). This limited approach frequently confines evaluation to the level of individual functioning or to both functioning and capabilities. Alternatively, and from a broader viewpoint, the capability approach is used to assess not just the well-being of an individual, but also other dimensions of value such as agency, empowerment, and efficiency.

Robeyns (2011) identify three significant advantages and one significant disadvantage of the capabilities approach. To begin, the author noted that the capability approach is both ethically and ontologically individualistic, making it ideal for assessing individual wellbeing because it considers the ‘functionings’ and ‘capabilities’ of an individual; without neglecting the concerns and actions of others. Second, in comparison to other market-based theories, the capability approach regards the evaluation of both market and non-market components of wellbeing as an essential component of its research (ibid). This is because an examination of non-market dimensions of wellbeing uncovers complexities and ambiguities in the distribution of wellbeing that an examination of income or wealth alone cannot convey (Robeyns 2011, p. 66). Thirdly, the capability approach is commended (Robeyns 2016) for openly recognising human diversity, including race, age, ethnic origin, gender, sexual orientation, and geographic location. This is demonstrated by its emphasis on the diversity of functionings and capabilities, as well as its explicit emphasis on personal, social, and environmental ‘conversion factors’ (Robeyns 2016).

Sen (1992) coined the phrase ‘conversion factor’ in response to criticism that he concentrated exclusively on outcomes rather than on the means (distribution of basic commodities and resources) by which they were achieved. According to Sen (1992), there are significant disparities in how resources and essential commodities are translated into freedoms. The relationship between a resource and the accomplishment of specific beings and doings is thus defined by the term ‘conversion factor,’ which simply refers to the capacity to convert the resources of an individual into functionings (Robeyns 2016). While Sen acknowledges the importance of resources and fundamental commodities in promoting freedom, he refutes this view using conversion factors. According to him, the translation of resources and goods into freedoms is hindered by both complex social variables and fundamental physical differences.
Consequently, ownership of natural resources or distribution of primary goods cannot be equated with realisation of freedom. According to Sen (1992), the ability of a poor person to prevent malnutrition is governed not just by his or her resources or primary goods (for example, the ability to buy food), but also by other qualities such as gender, climatic environment, and metabolic rates. This is similar to intersectionality theory, which is a way of comprehending and explaining the complexity of the world, people, and human experience (Collins and Bilge 2020).

Robeyns (2005, p. 99) classified these conversion factors as personal (metabolism, physical circumstances, sex, etc.), social (public policies, social norms, power relations, etc.), and environmental (climate, geographical location). These conversion factors, particularly the personal components, have shaped food security discourses across time and may provide the basis for anthropometric assessments\(^{12}\) of nutrition security. I reclassified Robeyns' (2005) classification of conversion factors into four broad categories to allow for in-depth analysis of these factors in this study, which seeks to examine the relationships between gold mining and smallholder farming as doings and their effects on food security as functionings. Political ecology is centred on power relation between distinct actors (the following section discusses political ecology in further detail). Accordingly, rather than discussing power relations as a component of the social conversion factor as defined by Robeyn (2005), it is essential to isolate and investigate power relations as a conversion factor in and of itself. Additionally, Robeyns' present classification incorporates economic factors into his broad social conversion factor. Economic considerations are indispensable in discussions about gold mining, crop cultivation, and food security, as mentioned in Chapter 2. Given the relevance of economic variables as a conversion factor in this study, the social conversion factor by Robeyn (2005) was dubbed the socio-economic conversion factor. Personal and environmental conversion factors are retained. Hence, the four conversion factors worth exploring in the context of this study are as follows: (1) power relation factors (2) socio-economic factors (3) environmental factors (4) personal factors.

\(^{12}\)Anthropometric assessments are a “series of quantitative measurements of the muscle, bone, and adipose tissue used to assess the composition of the body” (Casadei and Kiel 2019). Height, weight, body mass index (BMI), body circumferences (waist, hip, and limbs), and skinfold thickness are key elements of such measurements and represents diagnostic criteria for obesity and measuring of nutritional status in children and pregnant women (ibid)
3.3 Political ecology: history, definitions, and key tenets

As previously stated, political ecology analysis is centred on power relations, making it more appropriate for examining the complex and often unequal power relationships and hierarchies among important actors in the small-scale mining and smallholder agricultural sectors, as well as their consequences for food security. Additionally, political ecology facilitates better understanding of the human-environment interactions related with small-scale mining and smallholder farming. As such, it complements the capability approach, which aims to shed light on individuals' wellbeing in connection to food security.

Political ecology is a critical thinking of nature and nature-society relationships that originated in four institutional settings that are geographically connected: Africa, Brazil, South Asia, and Melanesia (Bridge et al. 2020; Watts 2020). The term ‘political ecology’ was coined by Frank Thone in 1935 (Minch 2011), and it was first used by anthropologist Eric Wolf in 1972 to refer to landed property relations and resource management politics. H. M Enzensberger used the term (along with the abbreviation ‘ecology’) in 1974 to refer to the bourgeois European and North American environmental movements of the 1960s and early 1970s, which he saw as fundamentally rooted in capitalist techno-science and thus incapable of addressing the structural causes of environmental crises (Bridge et al. 2020).

Political ecology can be traced back to the 1980s and the seminal works of Watts (1983a, b), Blaikie (1985) and Blaikie and Brookfield (1987), all of whom were influenced by and reacting against a variety of intellectual traditions, including 1960s and 1970s environmentalism and its obsession with ‘overpopulation’ and the depletion of (supposedly) finite resources (Bridge et al. 2020, p. 3). Furthermore, political ecology developed in the Anglophone academy in response to the apolitical nature of subjects such as cultural ecology and hazard studies (Watts 1983b), and it was concerned with issues such as “the relation of producers to the market, the commodification of land and labour, the forms of surplus extraction and the prismatic forms of social differentiations with peasant communities, the breakdown of the moral economy, emerging forms of class structure, and the changing relations of producers” (Watts 2020, p. 32). Popular explanations for famine in Nigeria, soil erosion in Nepal, and deforestation in Brazil, which were based on overpopulation, poor land management, and basic ignorance, were deconstructed in the early works of political ecology in favour of alternative explanations based on political economy, marginalisation, colonial capitalism, and predatory government abuses (Bridge et al. 2020).
Political ecology defies a single definition. It has been variously defined as “an epistemological project, which set out to shatter comfortable and simplistic ‘truths’ about the relationship between society and its natural environment” (Bridge et al. 2020); “concerns of ecology and broadly defined political economy” (Blaikie and Brookfield 1987, p. 17); “a set of theoretical propositions and ideas on the one hand and on the other a social movement referred to as the ‘ecology movement’ or, latterly, the Green movement” (Atkinson 1991, p. 18); “the politics of ecology as a scientific legitimisation of environmental policy” (Forsyth 2003, p. 4). Alternative definitions include “understanding the complex relationships between nature and society through a comprehensive examination of what one might call the forms of access and control over resources and their implications for environmental health and sustainable livelihoods” (Watts 2000, p. 257). This study adheres to Paul Robbins' definition of political ecology as a “community of practice united around a certain kind of text” (Robbins, 2020 p. 17). In broad terms, these works examine the “condition and change of social/environmental systems, with explicit consideration on the relations of power” (ibid).

Political ecology postulates a systemic interaction between humans and their environment, with any strain on any of the intertwined relationship's constituent elements resonating throughout the entire system (Robbins 2020). Even though all parties to the system are stressed, political ecologists accept the notion that the costs and benefits of environmental change are, for the most part, unequally distributed among actors (Bryant and Bailey 1997). Uneven cost-benefit distribution inevitably maintains or diminishes existing social and economic inequities, with political ramifications in terms of actors' changing power in respect to other actors (ibid).

To completely know the repercussions and impact of any environmental change, it is vital to engage different actors and to comprehend their respective interests, impacts, and power in any political ecology dialogue. This research involves a variety of actors with varying viewpoints, interests, power, and influence, including individual farmers, miners, opinion leaders, state or regulatory agencies, and development partners. To gain a critical understanding of how each actor influences or is influenced by the repercussions of the interaction between small-scale mining and smallholder farming and their implications for food security, it is necessary to research and understand the power dynamics and relationships among these important actors. The following paragraph digs into the analysis of power relations in relation to political ecology and, more specifically, this thesis.
Chapter 3: Political Ecology

3.3.1 Power relations analysis in political ecology

Political ecology is fundamentally about power dynamics between varied actors (Bryant 1997; Neumann 2015; Ahlborg and Nightingale 2018; Svarstad et al. 2018; Robbins 2019). Political ecology serves as a link between diverse actors and their physical environments. Svarstad et al. (2018) discovered three overlapping theoretical uses of power in political ecology discourses. To begin, there are actor-oriented power perspectives, in which actors exert power, in contrast to views in which power is viewed as a force that passes through individuals without awareness or accountability. While this approach connects power to agency, structures play a role in either facilitating or constraining the exercise of power (Dowding 2008 cited in Svarstad, 2018). The second perspective on power is neo-Marxist, emphasising how economic dominance and exploitation are used to express power. Marxist conceptions of power are focused with class relations under capitalism and the enduring forces perpetuated by these connections. While this power paradigm incorporates individual action, it is constrained by societal forces. In other words, human agency is viewed as being constrained and, to a large extent, formed by historically established social structures. For example, Hall et al. (2011), examined power dynamics in Southeast Asia using a Marxian-inspired power analysis within political ecology, with an emphasis on exclusion related to land use and access. Hall et al. (2011, p. 4) emphasized that exclusion is not a random process or occurs on a level playing field, based on the premise that exclusion associated with any land use and access is unavoidable. It is structured according to power dynamics. The authors discovered that land relations are influenced by a combination of four ‘powers of exclusion’: regulation\(^{13}\), market\(^{14}\), force\(^{15}\), and legitimation\(^{16}\). Michael Watts (1983) also used a Neo-Marxist perspective on power in his historical power analysis of small-scale farming in northern Nigeria to demonstrate how historically constructed social institutions shape the agency of individual smallholders. The third type of power perspective used in political ecology is variants of discursive power views based on poststructuralism, particularly the work of Michel Foucault (Svarstad, 2018, p. 356). The three power perspectives highlighted in this approach are discursive power, governmentality, and biopower. To begin, ‘discursive power’ is exercised

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\(^{13}\) Often but not exclusively associated with the state and legal instruments, sets the rules regarding access to land and conditions of use

\(^{14}\) The market is a power of exclusion as it limits access through price and through the creation of incentives to lay more individualised claims to land

\(^{15}\) Force excludes by violence or the threat of violence, and is brought to bear by both state and non-state actors

\(^{16}\) Legitimation establishes the moral basis for exclusive claims, and indeed for entrenching regulation, the market and force as politically and socially acceptable bases for exclusion
Chapter 3: Political Ecology

when actors like as businesses, government agencies, or non-governmental organisations (NGOs) develop discourses and effectively convince others to accept and contribute to their reproduction. In contrast to certain other fields of discourse analysis, political ecology discourses are usually investigated in conjunction with a critical realism epistemology (Ibid).

On the other side, governmentality refers to how governments direct individuals to perform in accordance with government objectives (Foucault 1991, 2008 cited in Svargstad, 2018). In terms of environmental governance, four distinct governmentalities emerge: disciplining 17, truth 18, neoliberal rationality 19, and sovereign power20 (Fletcher 2010 cited in Svargstad, 2018). Each of these governmental entities may operate independently, in conjunction with, or in competition with the others (ibid). Finally, Foucault (1978 p. 137 cited in Svargstad, 2018) defined biopower as the capacity to “make live or allow to die”. Governmental concerns about the characteristics of different populations, such as health and potential for change, have evolved because of biopower.

Ahlborg and Nightingale (2018, p. 383) argue for a “fundamentally relational and emergent” view of power that situates and produces it – in the numerous interactions between human and the non-human environment, drawing on Foucault and feminist theory to theorise power in political ecology. The authors maintain an analytical distinction between human agency as power and power manifested through network dynamics – referred to in Foucauldian tradition as ‘constitutive power’ or ‘structures’ in neo-Marxist traditions.

Combining multiple social conceptions of power is regarded as a significant benefit in political ecology (Svargstad, 2018). Hence, this thesis defines power as capacity or ability (Ribot and Peluso 2003; Svarstad et al. 2018; Peluso and Ribot 2020). This capacity or ability may be material or non-material, and it may be acquired using ‘power resources’ (Svargstad, 2018). Access to vital environmental resources is influenced by power (Byrant, 1997). The term power resources refer to the various forms of capital that various actors may employ to accomplish their objectives or purposes (Svargstad, 2018, p. 353). Power resources include social structures, economic institutions, class positions, land, financial capital, and political power.

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17 Implies that the government manages to get citizens to internalise certain “mentalties” in terms of social norms and ethical standards.
18 Means ruling of people through religion or other overarching truth-defining principles.
19 Implies that an incentive structure is established to maximize results
20 Means governing through defined rules and sanctions.
Access’ is described in this thesis as the ‘ability to benefit’ from power resources, as Ribot and Peluso (2003). To gain a better understanding of how important power resources – land, labour, and water – are controlled, power analyses at various scales were conducted among key actors, including the state and representative institutions, traditional leaders, opinion leaders, miners, and crop growers (as detailed in Chapter 7). Additionally, a historical assessment of the influence and power wielded by important actors in the development of Ghana's mining and agricultural policies was conducted (as detailed in Chapter 5). The next subsections detail the multi-scalar and historical analytic techniques used in this study.

3.3.2 Multi-scalar analysis

As previously explained, power takes on a multitude of forms at different scales (Bryant 1997; Bryant and Bailey 1997; Wisner 2020). As Wisner (2020, p. 56) states in his definition of political ecology, power relations occur “up and down a continuum of scales from global to local”. Scale has long been an important geographical concept in political ecology (Neumann 2009). Scale can be defined as the compartmentalisation of socially constructed space according to power systems and relationships (Brenner 2001; Green 2016). To put it another way, scales are “hierarchies of socioeconomic organisation” (Neumann 2009, p. 400). Scale comprises both the spaces of human-environment interaction in which processes occur and the geographies of power, which reflect both the socio-political identities of actors and the organisational structures within which they work (Brenner, 2001; Green 2016). Political ecologists begin with a central question (Robbins 2020) and investigate the effect of multiple variables from a multi-scalar perspective to find solutions to such central issues. These multiple scales are intended to work in unison and be integrative at times. Local decisions, for example, are influenced by regional and national policies, laws, and regulations, which are influenced by global events.

According to Neumann (2009, p. 399), scalar perspectives and power relations are central to what he refers to as the “political ecology of scale”. Thus, he examines how academics have integrated scale politics and political ecology. Neuman's (2009, p. 403) political ecology of scale revealed three themes, implying a broader theory of scale: (1) the interaction of power, agency, and scale; (2) socioecological processes and scaling; and (3) scaled networks. The author therefore concludes that political ecology of scale “incorporates the key precepts of the politics of scale – scale as socially constructed, relational, contingent, and contested – into an
Chapter 3: Political Ecology

existing framework that highlights power relations and a dialectical approach toward nature-society relations”. Neumann (2009) observes that despite progress in the usage of scale in political ecology, scale conceptualisation continues to pose difficulties. One challenge is that the literature does not adequately differentiate terms and concepts such as scale, level, site, network, and assemblage. So, Neumann (2009, p. 405) proposes a political ecology of scale that is “rigorous and concise in its conceptualisations and use of terminology, and clear in its epistemological and methodological choices”.

Green (2016) examines the emergence and change of scalar topographies in Tanzania as part of the politics and power dynamics of natural resource management in a recent work that mixes ideas from political ecology and a politics of scale. She examined the devolution of power from the state to the local level, as well as the ongoing renegotiations and scalar transformations of governance systems by actors at various levels. Her study emphasized the important role of socio-spatial elements in natural resource management politics, as well as the reality that scalar power configurations shape and modify the socio-politics and power dynamics associated with community-based natural resource management. She accomplished this by identifying three scales in Tanzania where power is being challenged in the administration of natural resources: institutional governance, community-based natural resource management, and unrecognized socioecological scales. These socially produced and contested spaces are vital for comprehending the power connections and conflicts that exist amongst the plethora of actors who inhabit them.

This thesis contextualises scale to refer to any socially constructed spaces occupied by diverse actors whose roles and activities shape gold mining and smallholder farming with multiple consequences for livelihoods and ecological systems, considering the foregoing and by integrating scaling politics and political ecology. This thesis employs three socially constructed hierarchical scales to describe the global, national/regional, and local areas occupied by various actors in the mining and smallholder farming subsectors. The thesis is concerned with the power and influence owned and exercised by various actors within these hierarchies of socioeconomic structure, as well as the ramifications associated with the exercise of such powers and influences (See details in Chapter 7).
3.3.3 Historical analysis: remote sensing and geographical information system (GIS) applications

Historical analysis has been a fundamental component of political ecology since its inception in the 1980s (Watts 1983b; Blaikie 1985; Blaikie and Brookfield 1987; Bryant and Bailey 1997; Robbins 2019). Both theoretically and empirically, historical methodologies continue to be significant in political ecology (Davis 2020). Since the early 2000s, scholars such as (Offen 2004; Davis 2009; Hecht 2013) have tried to establish an explicit subfield of historical political ecology. A historical political ecology can be defined as “a field-informed interpretation of society-nature relationship in the past, how and why those relations have changed (or not changed) over time and space and the significance of those interpretations for improving social justice and nature conservation today” (Offen 2004, p. 21). Furthermore, historical political ecology “explicitly addresses the political and economic forces of environmental change…” (Davis 2009, p. 285). According to Davis (2020, p. 263), the historical components of political ecology study serve to guard against ‘apolitical’ interpretation. The author explained that the underlying power relations in the topics studied by political ecologists can be revealed only through a sophisticated and critical understanding of the historical evolution of landscapes/environments, social interactions, and knowledge, as well as the privilege associated with it. Examining both the ecological and political-economic history of a phenomenon can provide significant insight into the long-term consequences of social and environmental changes. Thus, many political ecologists rely on historical evidence to make sense of current events and challenges.

Michael Watts' (1983b) Silence Violence is a seminal early study that makes extensive use of historical political ecology. This effort, which involved five months of archival research and more than a year of intensive fieldwork, took a historical approach to understanding the Nigerian famine from the sixteenth century through the late 1970s. Watts demonstrates that comprehending the historical complexities of how African peasants became entangled in global manoeuvrings of capitalism, both during the colonial period and since, is the only way to comprehend the roots and, more importantly, the contemporary reality of marginalisation and famine. Watt's work also demonstrates that we can grasp the distinction between apolitical explanations for drought and famine and the silent violence of historically specific changes in political economy and social relations that displaced a moral economy for a market economy.
Chapter 3: Political Ecology

at significant social and environmental cost only through such detailed historical understanding combined with contemporary fieldwork (Watts 1983b; Watts 2013).

Peluso's (1992) book “Rich Forests, Poor People: Resource Control and Resistance in Java” is another seminal work on historical political ecology. Peluso's work on forests and forest livelihoods combines long-term ethnography with documentary and historical research to demonstrate how critical it is to understand past and present conservation to comprehend political-economic power struggles and resistance. Her work exemplifies the power of scientific forestry to change the environment and society. Mathevet et al. (2015) also explored the changing dynamics of power relations under a variety of politico-economic configurations, as well as the ecology of marsh environment in southern France, using a framework of historical political ecology.

While historical analysis is a necessary component of political ecology, its approaches and objectives vary, and it can be broadly grouped into four areas: historical ecology, land-use/land-cover change, colonial legacies/resource disputes, and geohistorical revisionism (Offen, 2004). Frequently, these typologies are combined. Conflicts over land use/cover and colonial/resources were more prominent in this research. The proximate and underlying drivers (Geist and Lambin 2002) of the ecological footprints associated with gold mining and smallholder farming were researched over time. In other words, the historical, social, economic, political, and biophysical elements that contributed to the observed changes in the landscape of the study area were assessed. As discussed in Chapter 4, the evaluation of the changes was accomplished through a combination of geospatial (remote sensing and GIS) and oral history methods, as well as secondary documentation review and landscape observation. Conflicts over critical resource access and control were also examined as colonial legacies in postcolonial Ghana, namely in the mining and smallholder farming sectors. From pre-colonial to post-colonial Ghana, I trace the dominant actors, major policies, and accompanying ecological footprints associated with mining and agriculture, as well as the consequent conflicts between the two subsectors’ actors (Details are available in Chapters 5 and 7). The next section discusses how the two approaches of capability and political ecology are conceptualised and applied in this study.
3.4 Understanding the impacts of gold mining on food security through a novel blend and conceptualisation of political ecology and capability approach

I have established in the preceding sections how capability and political ecology can be used in tandem to gain a holistic understanding of the links between small-scale mining and smallholder farming and the resulting consequences. To reiterate, the capability approach can be used to conduct a critical analysis of ‘the overall well-being of an individual in relation to food security and the operations of small-scale mining and smallholder farming as livelihoods due to its evaluative prescription for comprehending ‘the attained well-being and freedoms of an individual (Robeyns 2017). I demonstrated how political ecology is an effective theoretical lens for understanding the power dynamics that convert opportunities to well-being outcomes and livelihoods, as well as the ecological consequences of such power dynamics through useful insights into human-environment interactions. Thus, when political ecology and capability approaches are combined, they complement one another. The following paragraphs demonstrate, using a conceptual framework (Figure 3.1), how capability and political ecology approaches are conceptualised and applied in this study to provide a nuanced understanding of the connections between small-scale mining and smallholder farming, as well as the implications for food security.
Chapter 3: Combining capability and political ecology

The conceptual framework depicted in Figure 3.1 outlines the main components of the political ecology and capability approaches, as well as the primary issues (gold mining, smallholder farming, and food security) of the study. The framework should be analysed from the bottom up since it represents a macro-level study with multiple layers, which corresponds to a micro-level analysis focused on the individual.
To begin, the base of the conceptual framework symbolises the interaction of humans with their environment, as best demonstrated and understood through political ecology. As previously stated, three key methodologies of political ecology – historical analysis, power analysis, and multi-scalar analysis – were utilised in this research to appreciate the context-specific analysis of human-environment interactions. First, I used historical political ecology approaches to analyse the current ecological footprints of mining by tracing the past pattern of land use and cover. I used remote sensing/GIS, oral history, and field observations to study environmental changes and the fundamental reasons of these changes. Additionally, I conducted pre- and post-colonial historical analyses of the mining and agriculture sectors of Ghana, concentrating on major actors, significant policy frameworks, and associated ecological footprints. This was done to contextualise the conflicts over natural resource needs for mining and farming livelihoods. Second, I employed power analysis to gain a deeper understanding of the major actors’ power dynamics. As previously indicated, power is defined as the capacity or ability to do anything. Thus, within the research environment, power hierarchies were explored in relation to the capabilities required to carry out gold mining and smallholder farming functionings, as well as their implications for food security functionings. Third, I examined power relations at three socially constructed scales: national/regional, local, and international, using the multi-scalar paradigm of political ecology. At these scales, the interests, influences, and associated consequences of major actors’ power interactions were explored.

Additionally, as seen in Figure 3.1, the capabilities of an individual are shaped by a range of factors (the conversion factor) that interact with one another. These elements encompass the four basic categories of conversion factors discussed in the prior section. As previously stated, the political ecology approach is better suited to identifying and comprehending these conversion aspects than the capability approach since it permits the use of mixed methodologies. I was able to fully appreciate the four conversion elements that influence individual capabilities because of the three approaches to political ecology discussed above. Furthermore, as illustrated in Figure 3.1, important capabilities such as access to land, water, labour, market systems, the policy/regulatory environment, and basic capabilities (e.g., education) have been identified as key factors affecting gold mining, smallholder farming, and, consequently, food security. It is imperative to clarify that the term ‘access’ refers to the capacity to benefit in this instance (Ribot and Peluso 2003). Thus, gold mining, smallholder farming, and food security were conceptualised as the ‘functionings’ of a person,’ which
ultimately define that person’s overall well-being. Food (in)security is defined specifically as the ‘state of being’ of an individual, whereas gold mining and smallholder farming are defined as an individual’s ‘doings’. As identified and detailed in Chapter 2, the relationship between gold mining and smallholder farming can be both positive and negative. These are denoted by the positive (+) and negative (-) signs, respectively (See Figure 3.1). According to the framework, an individual may be food secure or food insecure, and this can vary significantly amongst individuals, groups, and societies.

Finally, improved food security functioning results in increased individual and collective group well-being. Thus, the apex of the framework is ‘the total well-being of an individual’.

3.5 Chapter summary and conclusions

In this chapter, I conceptualised and illustrated how capability and political ecology approaches can be integrated to provide a nuanced understanding of the interconnected relationship between gold mining and smallholder farming and the resulting impact on food security. To do so, I first outlined the fundamental principles of the capability and political ecology approaches. I demonstrated how the capability approach can be used as a theoretical lens to critically analyse the overall well-being of an individual in relation to food security and the operations of small-scale mining and smallholder farming as livelihoods due to its evaluative prescription for comprehending ‘the attained well-being and freedoms of an individual (Robeyns 2017). Additionally, I established how political ecology is an effective theoretical lens for understanding the power dynamics that convert opportunities to well-being outcomes and livelihoods, as well as the ecological consequences of such power dynamics through useful insights into human-environment interactions.

The chapter concludes that combining capability and political ecology approaches can provide comprehensive and nuanced insights into the interconnected relationships between small-scale mining and smallholder farming by combining a macro-level analysis of human-environmental interactions with a micro-level understanding of their impact on individual well-being. This is essential for developing contextual and person-specific solutions aimed at improving individual well-being, which benefits society. In the following chapter, I will outline the mixed research methodologies that were used to provide answers to the four interrelated issues posed in Chapter 1 and reiterated in Chapter 2.
CHAPTER FOUR
RESEARCH METHODOLOGY

4.1 Introduction

As established in the preceding chapter, an integrated framework is fundamental for developing a nuanced and rigorous understanding of the relationships between small-scale mining and smallholder farming, as well as their implications for food security. The political ecology and capability approach that are combined to achieve this level of understanding facilitate the employment of a diverse range of research methods. Thus, in this chapter, I detail the various research methodologies that were employed to arrive at answers to the research questions that guided this study. I adopted a pragmatic paradigm research philosophy, guided by the conceptual framework presented in the previous chapter. This paradigm embraces variety of perspectives on social reality and employs both objective and subjective epistemologies. Additionally, it allows for both inductive and hypothetico-deductive logic and relationships to theories, which will guide realities on the ground while also assisting in the construction of knowledge and research on the relationship between small-scale mining and smallholder farming, as well as their implications for food security. I next discuss the mixed method research technique and how it was supplemented using geographical information systems (GIS) methods. I highlighted the value of merging social research methodologies with geospatial tools and techniques in this chapter, which, if implemented, will promote inter- and multidisciplinary research in the social and natural sciences, as well as a better understanding of nature-society relationships. Moreover, I discuss the multistage sampling design, procedures, and sample size estimations used. This chapter describes the selection and justification for the case study and sampled communities, as well as the sampling processes utilised to obtain a representative sample. Also, this chapter discusses the gathering, management, and analysis of data in relation to the research questions of the study. This chapter discusses the data gathering instruments, qualitative, quantitative, and geospatial tools and software utilised in data analysis, as well as the analytic frameworks used. Finally, I provide a chapter summary, which includes a diagrammatic representation of the methodologies taken and the conclusions reached.

The chapter is divided into eleven major sections. The chapter is introduced in Section 4.1. Sections 4.2 and 4.3 describe the research philosophy that drives this study, as well as the research design used. I explain the multi-stage sample methodologies used in Section 4.4, and
I discuss the fieldwork procedures in Section 4.5. In Section 4.6, I examine the impact of Covid-19 on my fieldwork as well as its implications for the entirety of the thesis. In Section 4.7, I go over datasets and the methods I used to collect them. In Section 4.8, I explained the data analysis procedures and presentation methods I used. Furthermore, in Section 4.9, I explain the ethical considerations of the study and how they were ensured. In Sections 4.10, I go into detail on the geospatial tools and procedures that were used to supplement the social research tools and processes. Finally, in Section 4.11, I provided a synopsis of the chapter.

4.2 Pragmatism: the philosophical underpinnings of this research

Philosophical assumptions underpin social research. These beliefs are referred to as paradigms (Guba and Lincoln 1994) or worldviews (Creswell 2014; Creswell and Clark 2018). The term ‘paradigm’ refers to a collection of beliefs or ideals that shape the way in which we do research (Guba and Lincoln 1994; Creswell 2015). Paradigms date all the way back to ancient times (Johnson and Gray 2010) and have a significant impact on the processes of research and inquiry (Creswell and Clark 2018). Paradigms include ontology, epistemology, axiology, rhetoric, methodology, and methods (Scotland 2012; Creswell and Clark 2018). Ontology is the scientific study of beings (Crotty 1998). Ontology examines the nature of social entities, including whether they can and should be regarded as objective entities having a reality apart from social actors, or if they may and should be considered social constructs based on social actors' perceptions and actions (Bryman 2016). It resolves the debate over whether reality is multifaceted or monolithic (Creswell 2015). Epistemology is concerned with the question of what constitutes (or should constitute) acceptable knowledge (Bryman, 2016). Alternatively, what kinds of evidence should be utilised to support statements (Creswell, 2015) or how do we acquire knowledge? (Creswell and Clark 2018). On the other hand, axiology and rhetoric are concerned with the function of value in research and research language, respectively (Creswell and Clark 2018). The process of doing research is referred to as methodology. It refers to the strategies and plans of action that underpin the selection and use of certain methods - the instruments and techniques utilised in data gathering and analysis (Crotty 1998). Most social research is based on four prominent paradigms, namely postpositivist/positivist, constructivist/interpretivism, transformative and pragmatist paradigms (Teddlie and Tashakkori 2009; Creswell and Clark 2018). Each of these paradigms differs in terms of their epistemology, ontology, axiology, methodology and methods. Table 4.1 summarises these differences.
### Table 4.1: Dimensions of contrast among key paradigms underpinning social research

<table>
<thead>
<tr>
<th>Dimensions of contrast</th>
<th>Constructivism</th>
<th>Pragmatism</th>
<th>Transformative</th>
<th>Postpositivism</th>
<th>Positivism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontology (nature of reality)</td>
<td>Ontological relativism - multiple, constructed realities</td>
<td>Diverse viewpoints regarding social realities; best explain explanations within personal value system</td>
<td>Diverse viewpoints regarding social realities; explanations that promote justice</td>
<td>Critical realism (external reality that is understood imperfectly and probabilistically)</td>
<td>Naïve realism (an objective, external reality that can be comprehended)</td>
</tr>
<tr>
<td>Epistemology (researcher/participant relationship)</td>
<td>Subjective point of view; reality co-constructed with participants</td>
<td>Both objective and subjective points of view depending on the stage of the research cycle</td>
<td>Both objectivity and interaction with participants valued by researcher</td>
<td>Modified dualism</td>
<td>Objective point of view (dualism)</td>
</tr>
<tr>
<td>Axiology (role of value)</td>
<td>Value-bound inquiry</td>
<td>Values important in interpreting results</td>
<td>All aspects of research are guided by social justice</td>
<td>Values in inquiry, but their influence may be controlled</td>
<td>Value-free inquiry</td>
</tr>
<tr>
<td>Methodology (Logic)</td>
<td>Inductive</td>
<td>Both inductive and hypothetico-deductive</td>
<td>Both inductive and hypothetico-deductive</td>
<td>Hypothetico-deductive</td>
<td>Hypothetico-deductive (originally inductive)</td>
</tr>
<tr>
<td>Methods</td>
<td>Qualitative</td>
<td>Both qualitative and quantitative; researchers answer questions using best methods</td>
<td>Both qualitative and quantitative; community of participants involved in methods decision</td>
<td>Primarily quantitative</td>
<td>Quantitative</td>
</tr>
<tr>
<td>Rhetoric (What is the language of research)</td>
<td>Informal style</td>
<td>Formal or informal</td>
<td>Advocacy, activist-oriented</td>
<td>Formal</td>
<td>Formal</td>
</tr>
</tbody>
</table>

*Source: Adapted from Teddlie and Tashakkori (2009)*
This overarching goal of this study is to offer insights into the impacts of small-scale mining on food security. To do this, a range of research questions are posed to better understand the ecological footprints of mining, issues associated with critical resource access, and the resulting consequences for food security and individual well-being. To provide proven and full answers to these issues, it is necessary to employ a variety of relevant approaches and methods, as well as insights from diverse actors with diverse views. A single strategy and procedure are insufficient to deliver the entire answers and practical recommendations. Thus, the pragmatism paradigm was used (Tashakkori and Teddlie 2003; Teddlie and Tashakkori 2009; Clark and Ivankova 2016; Creswell and Clark 2018). Pragmatists place a premium on the outcome of a research, the significance of the questions addressed above the procedures, and the judicious use of diverse data collection methods to provide insight on the subject under consideration (Creswell and Clark 2018). Thus, pragmatism is pluralistic and centered on “what works” and application in the actual world (ibid). The idea that epistemological issues exist on a continuum rather than at two opposing poles was used by pragmatists to refute the unambiguous distinction between objectivity and subjectivity epistemologies (Teddlie and Tashakkori 2009). The fact that pragmatists accept a certain explanation demonstrates that it is superior to another in terms of obtaining “expected or desired results” (Cherryholmes, p. 15). Alternatively, whereas postpositivists view reality as unitary and independent of the researcher, and constructivists view reality as multiple and from a variety of perspectives, pragmatists view reality as both singular and multiple (Creswell and Clark 2018). The pragmatist employs iterative deductive and inductive reasoning, depending on the research topic and study phase.

For this research, postpositivist paradigms guided the design, administration, analysis, and construction of reality related to food security. Food security variables and empirical data were contextualised within the experiential-based and capability theories of food security offered by researchers at Cornell and Tufts Universities in the United States of America (Radimer 2002), the FAO (Cafiero et al. 2018), FAO and FHI (2016), Burchi and De Muro (2016) and other food security specialists. A questionnaire was utilised to assess and monitor this scientifically. To supplement this data, a constructivist paradigm was employed to gather diverse viewpoints on the studied issues to acquire a deeper knowledge of them. This was accomplished by the inclusion of open-ended questions in the questionnaire and further data collection via interviews, focus groups, and field observations. I explain the mixed method case study research design used in the following section.
4.3 A mixed method case study research design

A case study research methodology is characterised as “an empirical method that investigates a contemporary phenomenon (‘the case’) in depth and within its real world context especially when the boundaries between phenomenon and context may not be clearly evident” (Yin, 2018, p. 15). The method enables the analysis of phenomena in their natural context, with a holistic focus on links and processes and the triangulation of multiple sources of evidence (Bryman 2016; Denscombe 2017; Yin 2018). Three main approaches to social research are qualitative, quantitative, and mixed methods techniques (Teddlie and Tashakkori 2009; Creswell 2014; Bryman 2016; Creswell and Clark 2018). In practice, quantitative and qualitative techniques are considered as occupying opposite extremities of a continuum (Newman and Benz, 1998 cited in Creswell 2014), with the mixed method approach filling the midpoint. As discussed in Chapter 2, there is a significant distinction between the methodologies employed by social scientists and natural scientists to describe the relationships between small-scale mining and agriculture: qualitative or quantitative approaches and geospatial methods.

Mixed methods research, which incorporates quantitative and qualitative research and data into a single study (Clark and Ivankova 2016; Creswell and Clark 2018), enables researchers to “address broader or more complicated research questions than case studies alone” (Yin, 2018, p. 64). Therefore, I used a mixed method case study to gain a thorough understanding of the links between small-scale mining and smallholder farming in an agrarian-mining context, as well as the resulting consequences for food security. The mixed method approach was chosen for four key reasons. To begin, it facilitates data triangulation. For instance, qualitative data acquired from semi-structured interviews, key informants and field observations were used to corroborate past ecological changes detected using remote sensing and GIS techniques. Qualitative data and secondary information were also used to select and rank relevant criteria for data prediction models. Second, it enables both subjective and objective evaluations and knowledge construction. To illustrate, and to provide a more thorough and verifiable conclusion, I used quantitative methodologies to assess and quantify perceived food insecurity and its associated causes via qualitative methods and instruments. Thirdly, utilising a mixed method approach minimised some of the disadvantages associated with either a quantitative or qualitative approach (Creswell and Clark 2018). Finally, the mixed method approach enabled me to test novel analytical techniques and tools.
Chapter 4: Research philosophy and design

I employed a convergent mixed method approach (Creswell and Clark 2018), in which data from both qualitative and quantitative components were collected concurrently and integrated as needed to provide a comprehensive understanding of the research themes. This approach enabled me to apply multiple data collecting and analysis procedures associated with each of the various approaches, so increasing my options. Additionally, this hybrid method was coupled with geospatial analytical frameworks to shed light on and confirm historical accounts of environmental changes and their repercussions in accordance with historical political ecology, as explained in Chapter 3.

4.3.1 Ghana as a country case study

Ghana (Refer to Map 2.1) was selected as a single country case study to provide a thorough examination of the impact of small-scale mining on food security. The gold mining sector of Ghana is one of the most established in Africa, with parallels to several other gold-mining countries in Sub-Saharan Africa. Ghana is currently the largest gold producer in Africa and sixth in the world (Ghana Chamber of Mines 2021; World Gold Council 2021). Gold mining in Ghana, particularly in the small-scale mining sector, has grown dramatically during the last two decades, owing in part to global market stimulants, such as higher gold prices (Hausermann et al. 2018b; Barenblitt et al. 2021). Among other things, these dramatic gains are the result of a complex interplay of power relations at various scales and among various individuals. Significant power relationships emerge, including those between the state and miners; the state and farmers; traditional authorities, miners, and farmers; and miners and farmers. These relationships are heavily influenced by existing policies, the majority of which are promoted by international actors.

These power relations are not without tensions and disputes, which have a variety of consequences for natural resource governance and food security results. For example, nationalism of natural resources in Ghana, combined with a liberalised mining sector, creates a ‘bias’ in favour of multinational large-scale gold mining (Hilson 2019). This bias results in direct negotiations for mineralised land with traditional authority and/or farmers by small-scale miners. In exercising their agency and with the assistance of political elites who act as funders and sources of protection, many small-scale miners have also resorted to severe mining methods, including mining in forest reserves and directly in natural river bodies using sophisticated machinery. In response, the state, citing the environmental consequences of such mining activities, imposed a nearly two-year ban on all small-scale mining activity.
Other severe measures have been taken since, including the burning of excavators and the prohibition of issuing mining permits for gold exploration/mining in forest reserve zones. Although the bold approach of the state has received overwhelming support from many Ghanaians, it has been widely criticized as being antagonistic to efforts to formalise the small-scale mining sector (Hilson 2017; Hilson and Maconachie 2020). For example, Hilson & Maconachie (2020, p. 10) argue that the decision of the state to prohibit small-scale mining on environmental grounds was nothing more than an “elaborate façade” used to position the state to gain revenue from the gold mining business. These objections are based on the socio-economic importance of the small-scale mining sector and the necessity to integrate it into bigger economic and rural development frameworks. Despite this, the significant ecological footprints left by small-scale mining are obvious, with direct and indirect consequences for the 'functionings' of individuals and society. As established in Chapter 2, food (in)security because of gold mining activities has not been extensively studied; thus, using Ghana as a case study, which has seen a steady increase in severe and moderate food insecurity (FAOSTAT, 2021) will generate new knowledge and contribute to debates about the impacts of gold mining.

4.3.2 ‘Cases within a case study’: Amansie West and South Districts

Gold mining is restricted to specific locations on a global scale. The Ashanti, Eastern, Central, Upper East, Brong Ahafo, Bono East, Ahafo, Western, and Western North regions of Ghana are all renowned for their gold mineral reserves and extraction (See Map 4.1). To gain a thorough contextual understanding of the impact of mining on food security, the Amansie West District (AWD), a predominantly agrarian district with significant gold mining activity (Ghana Statistical Service 2014a), was chosen as a case study within Ghana. The Amansie West District is located between Longitude 6.05°, 6.35° West and Latitude 1.40°, 2.05° North (Map 4.1). The AWD covers a total land area of 1230km² and accounts for 5% of the total land area of the Ashanti region. The district is drained by the Offin and Oda rivers and their tributaries, and it is classified as having a wet semi-arid climate with a double maxima rainfall regime (March to July: major season, and September to November: minor season). The vegetation of the AWD is of the rain forest type with wet semi-deciduous features, resulting in extremely fertile grounds that sustain agriculture as a primary source of subsistence districtwide. The district is home to four major forest reserves: Oda River, Apanprama, Jemira, and Gyeni River. With an average growth rate of 2.6, the total population of the district is calculated to be 174,218 in 2020.
Chapter 4: Research philosophy and design

Map 4.1: Map of selected ‘cases within Ghana’

Source: Author’s Construct, 2021

The Amansie West District was divided into two districts in 2018: Amansie West and Amansie South. According to the geospatial research of the topography in AWD and information from key sources, Amansie South contains most mining enclaves in the two districts and serves as a hub for both large-scale and small-scale mining activities. Additionally, settlements are located near natural resources in the district, such as forest reserves and natural river sources. As a result of growing small-scale mining activity in the area, many communities face increased risks of deforestation, land degradation, and water contamination, as well as the associated consequences. Six representative communities from this district were thus chosen as research units to give contextually rich insights into the nature-society relationship and its implications for individual well-being in line with the conceptual framework discussed in Chapter 3. To ensure representativeness, one community was chosen from each of the five traditional area
Chapter 4: Research sampling design and sample size estimate

councils, as well as Mem, a community with no\textsuperscript{21} continuing small-scale mining activities. Manso Adubia, Manso Datano, Watreso, Manso Keniago, and Odaho are the communities (See Map 4.2). I will discuss the uniqueness of the mixed methods utilised in the next sections, including the multi-stage sample designs, the datasets used and how they were collected and analysed, and the tools and techniques used in the research.

4.4 Sampling design and sample size estimates

Sampling comprises identifying the research area or site, the participants who will contribute data to the study and how they will be selected, and the minimum number of participants necessary to answer the research questions (Creswell & Clark, 2018, p. 175). In other words, it is the process of selecting units of analysis in such a way that the capacity of the researcher to answer the study's research questions is maximized (Tashakori and Teddlie, 2003, p. 715). This study employed a mixed method sampling strategy guided by the pragmatist perspective. The mixed method sampling strategy enabled the use of probability and non-probability sampling techniques at various stages, resulting in both a representative sample and information-rich cases (Teddlie and Tashakkori 2009). Therefore, complementary data was developed that encompassed both depth and breadth of knowledge. The following paragraphs detail the precise mixed method sampling strategy employed and how it was realistically used.

As established in Chapters 2 and 3, a variety of actors are involved in small-scale mining and smallholder farming operations, and these actors operate on a variety of socially constructed scales, consistent with the political ecology of scale thesis. To recruit participants at the national and local scale, a multi-stage mixed method sampling strategy (Tashakori and Teddlie, 2003) was used. The enumeration zones were established in two stages. To locate a cluster of households, the Amansie South District was utilised as the primary sampling unit. The local councils of Adubia, Datano, Watreso, Mem, and Keniago were among the five delegated administrative structures in the research region. These area councils were geographically dispersed around the region and covered several distinct locations.

\textsuperscript{21} Because the chief bans it, there are no continuing small-scale mining operations in this community. This is perhaps the only village where strong traditional authority has ruled out small-scale mining. The sole reason small-scale mining is frowned upon in this community, according to an interview with the Chief of this village, is the devastating impact of mining (ORH\_005\_MM). According to an interview with a key informant, superstitious beliefs are one of the reasons why small-scale mining does not grow in the community. People who try to mine unlawfully are said to have their gold converted into “charcoal” (KII\_011\_M\_LS) since the chief and certain members do not allow it. This is said to be the work of the river gods, who agree with the judgments of the chiefs.
Accordingly, each cluster serves as a stratum for the selection of study locations and participants. The District Planning Unit aided in the designation of agrarian settlements in the five local councils that contain mining operations. Second, a stratified sampling technique was employed to randomly select one community from each stratum. By giving a known and non-zero probability to each mining community in the local council, this probability technique assured total coverage of the sub-district population for increased statistical precision. Mem was included in the selected localities even though it is an agricultural settlement with no current mining activities. As a result, six communities were chosen as enumeration areas (EA). The organisation of the sampled communities is depicted in Figure 4.1.

![Figure 4.1: Sampled settlements from each traditional area council](image)

Individuals aged 18 and older from randomly selected households in each sampled community were then chosen as units of analysis for the computer assisted personal interviewing component of the study. A total sample size (n) of 460 study participants was used, who were uniformly distributed across the sampled localities. The minimal sample size was estimated using the sample size calculator by SurveyMonkey Online using the mathematical formula described in equation 4.1.

\[
 n = \frac{z^2 \times \rho (1-\rho)}{e^2} \times \frac{\rho (1-\rho)}{e^2 N} 
\]  

(Equation 4.1)
Chapter 4: Research sampling design and sample size estimate

where \( n \) is the sample size, \( N \) is the population size, \( e \) is the margin of error, \( p \) is the sample proportion and \( z \) is the z-score (number of standard deviations a given proportion is away from the mean).

The overall population of the district was calculated to be 81,512 in 2020, up from an estimated 77,382 in 2018 and a 2.6% population growth rate (Amansie South District, 2020). When this total population is put into equation 4.1, a minimum representative sample size of 385 is required with a 5% margin of error. However, assuming a non-response rate of 20% or less, the total sample size used was 460 participants from the six sampled towns. The minimum sample size of 460 was proportionately distributed among the sampled localities based on the communities' varying estimated population projections (Table 4.2).

**Table 4.2: Proportional sample estimation**

<table>
<thead>
<tr>
<th>Community</th>
<th>2010* Total population</th>
<th>2020** projected total population</th>
<th>Percentage of total population</th>
<th>Proportional sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datano</td>
<td>3692</td>
<td>4788</td>
<td>27.5</td>
<td>126</td>
</tr>
<tr>
<td>Odaho</td>
<td>3227</td>
<td>4185</td>
<td>24.0</td>
<td>110</td>
</tr>
<tr>
<td>Adubia</td>
<td>2,529</td>
<td>3280</td>
<td>18.8</td>
<td>87</td>
</tr>
<tr>
<td>Watreso</td>
<td>1694</td>
<td>2197</td>
<td>12.6</td>
<td>58</td>
</tr>
<tr>
<td>Keniago</td>
<td>615</td>
<td>798</td>
<td>4.6</td>
<td>21</td>
</tr>
<tr>
<td>Mem</td>
<td>1687</td>
<td>2188</td>
<td>12.5</td>
<td>58</td>
</tr>
<tr>
<td>Total</td>
<td>13444</td>
<td>17436</td>
<td>100.0</td>
<td>460</td>
</tr>
</tbody>
</table>

* Data was based on the 2010 Population and Housing Census obtained from the district

** Data based on computed population using geometric projections

Additionally, participants for the interviews and focus group discussions were carefully and consciously selected using purposive and referral sampling techniques. Purposive sampling is a sort of non-probability sample in which the researcher selects cases/participants purposefully to ensure that the results are pertinent to the study objectives (Bryman, 2016). Participants from the local and national scales were chosen based on their experience and comprehension, as well as their direct or indirect involvement in mining or agriculture operations. At the national level, key informants from government institutions such as the Ministry of Food and Agriculture, the Ministry of Land and Natural Resources, and other regulatory organisations with the necessary expertise in the subject area were carefully recruited. District officials familiar with mining and farming operations were also recruited specifically to provide insight and validate findings obtained through various research instruments and methodology used at the local level.
Among them were District Assembly officials, as well as members from agricultural and mining organisations. Individuals engaged in mining and smallholder farming were also purposefully recruited to respond to the research questions of the study. These enable the reconstruction of knowledge from multiple perspectives and the development of a collaborative understanding. In addition to the necessity to actively select these research subjects, I was required to acquire certain study participants via referral sampling. Referral/snowball sampling is another non-probability sampling strategy in which the researcher contacts a limited number of persons who are relevant to the study issue and then uses these contacts to contact further individuals (Bryman, 2016). As a result of this sampling method, I was able to recruit additional research participants through first contacts with chief farmers, agricultural extension officers, and prominent and leading small-scale miners. Additionally, the technique benefited in the recruitment of certain mining 'financiers' who did not work in the mines or reside in the research areas. It is worth mentioning, however, that the majority of these ‘financiers’ declined to engage in the study, with only a few responding via mobile phone call. As demonstrated in Table 4.3, a total of 85 actors operating at various scales were recruited for this investigation.

**Table 4.3: Total number of study participants at various scales**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Units/Actors</th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>National/Regional</td>
<td>Lands Directorate (MLNR)</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Mines Directorate (MLNR)</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Crop Directorate (MoFA)</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Policy Planning, Monitoring and Evaluation Division (MoFA)</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Forestry Commission</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Minerals Commission</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Sub Total (A)</td>
<td></td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>District</td>
<td>District Planning Office</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>District Agriculture Office</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Ghana Water Company Limited</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Assembly Members</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Sub Total (B)</td>
<td></td>
<td>7</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Local</td>
<td>Farmers</td>
<td>32</td>
<td>7</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Miners</td>
<td>16</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Agric Extension Officers</td>
<td>3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Traditional leaders</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Leadership of farmers/Chief farmers</td>
<td>7</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Sub Total (C)</td>
<td></td>
<td>59</td>
<td>14</td>
<td>73</td>
</tr>
<tr>
<td>Overall Total (Subtotal A+B+C)</td>
<td></td>
<td>85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MLNR- Ministry of Lands and Natural Resources; MoFA- Ministry of Food and Agriculture
Chapter 4: Fieldwork processes

4.5 Fieldwork processes

4.5.1 Feasibility studies

Despite my Ghanaian origins, the precise cases for study were foreign to me. They were rural, with qualities that were diametrically opposed to the metropolitan milieu in which I was born and raised. Regardless, I effectively used my prior experience conducting research in rural areas. I meticulously organised the fieldwork for a variety of reasons. To begin, I was not familiar with the study cases. Second, the informality and illegality of the small-scale mining sector. Third, the existing situation of the small-scale mining industry prior to and during the preparation of the study. Due to the environmental implications of small-scale mining industry, the state utilised punitive measures such as a two-year moratorium on small-scale mining activities, confiscating several excavators from illegal miners, and so on during the designing stage of the study. According to the practicality, sensitivity, and dangers associated with the study, it is required to obtain on-the-ground support to traverse the field and collect useful information to rebuild knowledge about the impacts of mining on food security. Thus, I conducted a feasibility study from September to October 2019 to recruit facilitators and evaluate survey technologies. The District Assembly and persons who negotiated accessibility to the study sites served as facilitators. The district planning office, for example, needed to inform local communities about the study through their respective assembly members and invite them to welcome the study team when it began. In addition, because accessing illicit mining areas by the study team alone was perilous, well-known individual miners in the local communities were needed as facilitators. I started the feasibility study at the national scale with a consultative meeting in Accra with key informants from the Minerals Commission, the Ministry of Food and Agriculture, and the Ministry of Lands and Natural Resources. Additionally, I had a meeting with the convener of the steering committee of the media alliance against illicit mining. These early meetings served to describe the research, obtain permission for fieldwork, and gain a better understanding of some of the important events that occurred in the small-scale mining setting but were not reported in the literature. These sessions gathered contact information and specific procedures for getting appointments with key informants for the main fieldwork. This understanding proved useful during primary fieldwork, particularly considering the covid-19 circumstance, which made scheduling appointments impossible. Even though several visits had to be postponed and rescheduled, the contacts established enabled easy access to key informants. Also, because of these conversations, the selected case was confirmed as a suitable
setting for comprehending my research questions in depth. Additional key informants at the community level were contacted to assist with feasibility and primary fieldwork.

At the local scale, I presented my study objectives to the District Assembly and received their endorsement. The Planning, and Food and Agriculture offices of the District Assembly assisted me in compiling a list of agrarian towns with mining operations from the five local councils for random sampling of study cases. Additionally, because the randomly selected towns were geographically distinct, I visited each to identify them. I used these early field visits to also contact agricultural extension officers and assembly members, advising them of the proposed research and requesting their support for the main fieldwork the following year. Due to the illegality of certain small-scale mining activities, some illicit miners, notably foreigners, are known to have guns to protect their property. Negotiating mining places was consequently regarded as difficult, even more so considering the state-illegal miner dispute at the time. To circumvent this barrier, I choose facilitators to assist in securing safe access to clandestine mining places during the primary fieldwork.

I piloted the survey in Akwasiso, a small mining community in the study district that was not randomly picked for the main research, to see whether possible study participants could comprehend the questions and how long each questionnaire took to complete. Additionally, it was important to evaluate the android software (SurveySolutions) proposed for use in the main survey in terms of usability, time required to complete the questionnaire, and number of participants covered before the handheld tablet battery expired.

The feasibility assessments determined that the main research would be effective if gatekeepers were in place and strict safety criteria were adhered to. By determining which study cases would be used in the main study, the feasibility studies contributed to the improvement of the research methodology. Additionally, it assists in identifying potential hazards and developing solutions for overcoming or minimizing them. For example, armed robbery incidents have been observed in the study district, and the feasibility studies indicate that they often occur late in the day. As a result, I work exceptionally early mornings and close a little later in the evenings during the main fieldwork. Throughout the primary fieldwork, there were approximately three documented armed robbery incidents, one of which culminated in the shooting and murder of the chauffeur of the Chief Executive Officer of the District Assembly. Additionally, the presence of unidentifiable private cars in the region may attract attention to the researchers,
posing an increased risk of violence. This knowledge influenced my option of transportation, since I chose to ride a public motorcycle, which was the principal mode of transportation in the district. Following the feasibility studies, the study protocol was revised and resubmitted to the Human Research Ethics Committee (HREC) of the Open University for clearance. The update includes details on how identified risks will be managed for both researchers and study participants, how identified and agreed-upon gatekeepers will be utilised to negotiate the field, and minor modifications to study instruments, permission forms, and information sheets. After receiving a favourable review from the HREC, I travelled to Ghana on March 3, 2020, to begin the main fieldwork.

4.5.2 Main fieldwork

I trained three interviewers and one supervisor for one week prior to the main fieldwork. These fieldwork assistants were all postgraduate students from Kwame Nkrumah University of Science and Technology who had garnered great experience via their work on a variety of quantitative and qualitative projects. I instructed them on how to complete the questionnaire as well as how to use the SurveySolution app to gather data. The training includes an overview of the major themes of the study, a detailed examination of each question in the questionnaire, probes, quality checks, appropriate translations of the questions into the local dialect, and role playing to familiarize themselves with the questions. The research assistants only assisted with the collection of quantitative data (survey) using the SurveySolution application, allowing me to monitor their data collection at every stage. The decision to employ research assistants was taken due to the large sample size (460), which allowed me to focus on interviews and focus group discussions while the survey was being conducted.

I convened at the Amansie South District Assembly to announce the start of my primary fieldwork and to seek formal authorisation to go to sampled areas at the start of the fieldwork. Additionally, I used the first two days to contact the facilitators in each of the sampled study communities to inform them of the start of the fieldwork. Besides that, I scheduled appointments, devised strategies, and plotted routes to and from each town. Following agreement with facilitators, the data gathering for each day was divided into three portions. The survey and interviews with farmers were conducted in the early mornings (6 am to 9 am) and late evenings (4 pm to 6 pm) during the first phase. This phase was helped by farmers'
early morning departures and late evening returns. Occasionally, some suggested farmers were escorted to their fields for the interviews. Additionally, contacting households in randomly chosen homes for the survey was straightforward.

The second part included field observations and interviews with miners, which occurred largely between 1 and 3 p.m. The miners worked in a variety of hotspots around the settlements, and it was quite easy to identify them at their workplaces with the assistance of a recognised miner from the community who was either recruited directly or recommended by mining gatekeepers from other communities. The final round of interviews, which were often performed only by appointment, comprised solely of key informants being interviewed at mutually agreed-upon times. These interviews took place largely in the morning or evening at the participants' residences or offices.

Upon entering each community, I made an initial call to an Assembly member or an agricultural extension officer. Typically, these important informants are questioned first, followed by additional study participants. It is worth noting that conducting the study without the assembly members' consent was difficult. It was particularly challenging to contact people in areas such as Mem and Odaho, where Assembly members were out of town during the fieldwork. To recruit participants to participate in the research, it required the direct cooperation of head farmers and volunteer gatekeepers. The next section discusses in detail the datasets obtained and how they were obtained.

4.6 Impacts of COVID-19 on fieldwork and overall research
COVID-19 had a tremendous impact on my fieldwork and doctoral dissertation. These effects manifested themselves in three ways: a postponement of fieldwork duties, an increase in research expenses, and a physical and mental burden because of testing positive for COVID-19 upon returning to the UK. Following, I will discuss these three effects in further depth.

To begin, because of COVID-19, the intended five-month (March to July) fieldwork time was prolonged to nine months (March to November). On March 12, 2020, Ghana, the case study, confirmed the first 2 cases of COVID-19 infections, which increased to 152 with five deaths by March 30. The President issued a three-week lockdown in the communities deemed to be infection hotspots (Accra, Kumasi, and its environs) out of concern that the virus could spread
and overwhelm the healthcare system. This first lockdown, which began on March 30, 2020, comprised Kumasi, the capital city of my study region, as well as its surrounding areas. Due to this lockdown, my fieldwork had to abruptly cease three weeks after it had begun. Additionally, agreed-upon appointments with regional and national key informants who resided in Accra and Kumasi had to be cancelled and rescheduled multiple times, while some had to be cancelled outright. On April 19, 2020, the partial lockdown was lifted, despite rising concerns of infection cases, which stood at 1,154 as of April 22, 2020. Due to the lower risk of COVID-19 at my rural study sites, the Open University Human Research Ethics Committee granted permission for the work to resume on the provision that strong COVID-19 prevention procedures were observed. The use of hand sanitizers, the use of face masks, and social isolation were implemented as preventative measures. To mitigate the effects of suspending fieldwork, I began transcribing the data that had been collected during the lockdown. I also took the effort to plan and confirm meetings with national-level key informants. This was possible since contact information for key informants was collected during the pilot study.

Second, the overall cost of my research increased due to COVID-19 travel restrictions and their associated fees. For example, following the conclusion of the fieldwork in November 2020, I had to repeatedly reschedule my return to the United Kingdom. After I returned to the United Kingdom in July 2021, I was required to pay for COVID-19 testing and quarantine. I am grateful to the Strategic Research Areas (SRA) at the Open University for providing funds to cover the COVID-19 travel restriction-related expenses.

Finally, upon returning to the UK, I tested positive for COVID-19. This had an emotional and bodily impact on me. As a symptom of COVID-19, I have conjunctivitis, making it difficult to read and write on my laptop. In addition, I was alone and had no relatives in the United Kingdom, so my health and well-being suffered greatly because of testing positive. Nonetheless, my supervisory team was compassionate and constantly checked in on me throughout this tough time, which provided me the incentive to return to work. During this time, the university campus was closed to students owing to COVID-19, despite warnings for international students to return to the United Kingdom if they were overseas. This meant that even after healing, I had to spend a significant amount of time writing my thesis from home.
Chapter 4: Quantitative datasets and collection procedures

4.7 Datasets and collection methods

I employed multiple datasets and data collection methods to provide a comprehensive solution to the research questions of the study, guided by the pragmatic philosophy and the conceptual framework. I gathered quantitative, qualitative, and geographic data. This section will discuss the quantitative and qualitative datasets, as well as the methods used to gather them. The following sections will discuss the geospatial datasets, which include remotely sensed imagery, as well as the collection procedures.

4.7.1 Quantitative datasets: secondary data and questionnaire

Quantitative datasets are simply those that are constructed using closed-ended questions and are based on predefined response scales or categories (Creswell and Clark, 2018). The most frequently seen type of data in this category is numerical data. I gathered both primary and secondary quantitative datasets.

Food security, as noted in Chapter 2, encompasses four dimensions: access, utilisation, availability, and stability. To construct food security as a functioning, specifically ‘beings’ in accordance with the capability approach and underpinned by the conceptual framework, I gathered essential secondary data on food crop production and global gold prices at multiple scales. To begin, I obtained local-level food crop output data from the Ministry of Food and Agriculture (MoFA) of Ghana, specifically from the Statistics, Research, and Information Directorate of the ministry (SRID). Second, I collected national-level statistics on food crop output using FAOSTAT, a web-based open-source data platform by the FAO. Finally, I acquire global-level statistics on gold prices over time from the archives of the Global Gold Council. Before utilising these datasets, I validated their consistency and completeness and, if necessary, reorganised them into user-friendly formats on Microsoft Excel for analysis. The analysis of these statistics substantiated and/or corroborated statements about local food supply, as well as the effects of different policy initiatives.

I used SurveySolutions application for computer-assisted personal interviewing (CAPI) by World Bank to collect the primary quantitative datasets. Despite the initial investment in Android tablets, communication and networking fees, and extensive interviewer training, this technique provides a dependable mechanism for collecting exceptionally secure and high-quality data. The ability to analyse data immediately after collection simplifies the process of
identifying fieldwork errors and fast implementing corrective steps if necessary (The World Bank 2018). Additionally, because direct data input is used, data is immediately accessible for inspection, cleaning, and analysis following fieldwork (ibid). To implement this strategy, I produced the questionnaire using the Questionnaire Designer, a collaborative tool for developing questionnaires for the CAPI online platform. I assessed the drafted questionnaire online to identify any issues. I then upload the questionnaire to a cloud-based server23 and distribute it to the four well-trained interviewers if no problems are identified. These interviewers were granted randomly generated usernames and passwords and given access to the questionnaire using their Android tablets' Survey Solutions Interviewer programme version 20.07.2.

One interviewer was the field supervisor, and I was the data controller (headquarters). The supervisor was responsible for controlling the interviewers' workloads and ensuring the quality of the gathered interviews. I used a three-tier authority structure to allocate, examine, and approve the obtained data, guaranteeing that the data was of high quality. As the primary researcher, I distributed questionnaires to the supervisor, who then distributed them to the interviewers. Second, at the conclusion of each day of data collection, interviewers synchronized their datasets, which were then cross-checked and approved, or returned for any necessary revisions. After the supervisor approves any data, it is forwarded to me for inspection and approval. This approval system, enabled by the SurveySolutions application, ensured the acquisition of high-quality and secure datasets. Additionally, following data synchronisation at the end of each day, an opportunity was presented to share observations or challenges. Following fieldwork, I exported approved datasets in ready-to-use formats such as SPSS and CSV and stored them on Open University Servers for post-fieldwork data analysis. Quantitative, qualitative, and locational questions were all possible with SurveySolutions. This section describes the quantitative components of the research questions. In the following section, I will focus on the qualitative characteristics.

Chapter 2 establishes that focusing exclusively on one aspect of food security is insufficient to properly comprehend food security and individual well-being. Thus, in addition to collecting data on the food availability dimension stated above, I acquired quantitative datasets on food

23 The World Bank provided independent access to its cloud-based server during the time of the investigation. Later, this offer was limited to studies conducted by the World Bank or affiliated organisations. As a result, it came in handy because I didn’t have to set up my own cloud-based server.
access to corroborate and triangulate qualitative information on food access perception. I quantified Food access using the Food Insecurity Experience Scale (FIES) discussed in Chapter 2. I used the FIES scale because it is simple to administer, rapid, and inexpensive. Furthermore, it is founded on well-established theoretical perspectives that have been proven by extensive research in several settings (Cafiero et al. 2018). The FIES scale is comprised of eight (8) specific questions to which respondents can reply affirmatively or negatively (Table 4.4). It is a reliable indicator of the prevalence of food insecurity since it measures the access dimension of food security (Cafiero et al. 2018). Because the FIES scale has previously been used in Ghana to track SDG Goal 2, Indicator 2.1, it has been translated into various Ghanaian languages and validated as a legitimate representation of the intended metrics. Since most of the study participants were Akan and Twi speakers, I used the Twi translated language scale (See Table 4.4).
### Table 4.4: The Food Insecurity Experience Scale Survey Module by FAO

<table>
<thead>
<tr>
<th>No</th>
<th>Label</th>
<th>Questions in English</th>
<th>Twi Translated Questions</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WORRIED</td>
<td>During the last 12 Months, was there a time when you were worried you would not have enough food to eat because of a lack of money or other resources?</td>
<td>Enam se wonni sika ne akadee bi nti no, na wodwene ho paa se wonnya aduane dodoo a wope nni</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>HEALTHY</td>
<td>Still thinking about the last 12 Months, was there a time when you were unable to eat healthy and nutritious food because of a lack of money or other resources?</td>
<td>Wo koso dwini bosome dumienu yi ntam yi a, mmere bi si ye a woandidi yiye efiri se na sika anaa mmoaye fofo ro bi nni ho?</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>FEWFOODS</td>
<td>Was there a time when you ate only a few kinds of foods because of a lack of money or other resources?</td>
<td>Enam se wonni sika ne akadee bi nti no, na aduane potee, kakra bi ena na wodie</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>SKIPPED</td>
<td>Was there a time when you had to skip a meal because there was not enough money or other resources to get food?</td>
<td>Enam se wonni sika ne akadee bi nti no, na wonntumi nnidi bere ano-bere ano</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>ATELESS</td>
<td>Still thinking about the last 12 Months, was there a time when you ate less than you thought you should because of a lack of money or other resources?</td>
<td>Wo koso dwini bosome dumienu yi ntam yi a, mmere bi si ye a wodzi ditiwa bi efiri se na sika anaa mmoaye fofo ro bi nni ho?</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>RANOUT</td>
<td>Was there a time when your household ran out of food because of a lack of money or other resources?</td>
<td>Enam se wonni sika ne akadee bi nti no, eto da a aduane a wone wo fiefoo benya adie no tumi sa</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>HUNGRY</td>
<td>Was there a time when you were hungry but did not eat because there was not enough money or other resources for food?</td>
<td>Enam se wonni sika ne akadee bi nti no, eto da a ekom de wo dee, nanse wonnidi</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>WHOLEDAY</td>
<td>During the last 12 months, was there a time when you went without eating for a whole day because of a lack of money or other resources?</td>
<td>Wo bosome ahorow dumienu yi etam yi no, mmere be wo ho a Enam se wonni sika ne akadee bi nti no, eto da a, wobuada?</td>
<td>No</td>
</tr>
</tbody>
</table>
Chapter 4: Quantitative datasets and collection procedures

The FIES scale is based on subjective beliefs, experiences, and objectives of an individual towards food security. As indicated in Chapter 2, the FIES is comparable to other food security measures based on personal experience, such as the Household Food Insecurity Access Scale (HFIAS), which is used in the United States, Brazil, Canada, and Mexico, among other countries. As such, it is consistent with the capability approach, which places a premium on human wellbeing over material resources. After extensive consultation with a range of stakeholders, the FIES was chosen as the basis for measuring the prevalence of moderate or severe food insecurity in the population - the second indicator [2.2.1] of the SDG indicator framework for Target 2.1 of the Sustainable Development Goal (Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs) 2017; Cafiero et al. 2018). As a result, it is one of two indicators used to monitor global food security in relation to the Sustainable Development Goals. Each item specifies the degree of food insecurity as defined by the FIES scale, ranging from mild to severe (questions 1 to 8). Because I collected data at a single point in time, a 12-month reference period, as used in monitoring the SDGs, was appropriate to account for seasonal food security swings.

The FIES employs two thresholds to categorize the degree/severity of food insecurity (Figure 4.2). The first barrier is established at the severity level of the FIES item ‘ATELESS’ (i.e., eating “less than you should”), and it distinguishes between the categories of ‘food secure or mildly food insecure’ and ‘moderately food insecure’. The second criterion is set at the severity level of the FIES item ‘WHLDAY’ (“went an entire day without eating”), which distinguishes the ‘moderately food insecure’ from the ‘severely food insecure’ categories (Cafiero et al. 2018; FAO, 2018).

Figure 4.2: Global Standard Threshold
Source: FAO. 2018
Chapter 4: Qualitative datasets and collection procedures

4.7.2 Qualitative datasets: computer-assisted personal interviews, focus groups discussions, and observation

In contrast to the quantitative datasets discussed previously, qualitative datasets are composed of data obtained through open-ended questions without the researcher using pre-defined categories or scales (Creswell and Clark, 2018). These are typically narrative data (Teddlie and Tashakkori 2009), and they might be chosen in advance or uncovered throughout the course of the investigation (Creswell and Clark, 2018). Qualitative datasets can be classified using text data or images. Like the quantitative datasets, I gathered secondary and primary qualitative datasets on variety of topics in accordance with the conceptual framework. I carried out a review of official institutional reports, national policies, laws, and regulations, peer-reviewed published works, and online media outlets in accordance with historical political ecology as discussed in Chapter 3. The aim of this review was to gain better understanding the human-environment relationships in relations to the interconnections between mining and agriculture as well establish the implications of this link on food security. For example, secondary qualitative data were valuable for substantiating and triangulating data on the ecological footprints and driving forces connected with the interaction between mining and agriculture that were produced from primary qualitative data and geospatial data analysis. Additionally, I acquired primary qualitative data from a variety of actors at multiple scales to supplement secondary qualitative, quantitative, and geospatial datasets with the purpose of reconstructing knowledge about the linkages between mining and smallholder farming and its effects on food security. I compiled these datasets using a range of methodologies, including computer-assisted personal interviewing, in-depth and key informant interviews, focus group discussions, and observation. The following paragraphs cover these different qualitative datasets and their acquisition.

To further explore food security as an important functioning and a state of being in accordance with the capability approach, I evaluate the utilisation dimension of food security using dietary diversity (DD). Dietary diversity is a qualitative measure of food intake and a proxy for the nutritional adequacy of individual diets (Kennedy et al. 2010). I used DD because studies have shown that there is a correlation between dietary diversity and micronutrient adequacy, a key component of diet quality (Kennedy et al. 2007, 2010; Arimond et al. 2010a; Mallard et al. 2016; Zhao et al. 2017). I used the qualitative open 24-hour recall technique, in which I asked a series of typical probing questions to elicit recall of all food and beverages consumed the previous day and night, as well as probes for key ingredients in mixed dishes (FAO and FHI
Chapter 4: Qualitative datasets and collection procedures

I considered food prepared both at home and away from home. I chose the open recall method because it is intuitive for both the enumerator and respondents; it allows for structured probing; it can result in increased food categorisation because the enumerator, not the respondents, is tasked with matching food groups; and it can result in a more comprehensive recall of dishes (FAO and FHI 2016). Additionally, the 24-hour recall period was consistent with previous research on dietary diversity research (Arimond et al. 2010b; Koppmair et al. 2017; Caswell et al. 2018), making it easier for participants to recall and minimizing the likelihood of errors (FAO 2010). I incorporated the DD question and other qualitative questions into the computer-assisted personal interviewing technique described in the prior section, which utilised the World Bank SurveySolution application. During data collection, responses to the DD probing questions were placed into a tabulated grid table and used to create a table of predefined food categories by checking or unchecking the consumption of each food group (See Table 4.5).

Table 4.5: Food Groups, examples, and response options

<table>
<thead>
<tr>
<th>No.</th>
<th>Food Categories</th>
<th>Description/Examples</th>
<th>Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Food made from grains</td>
<td>Porridge, bread, rice, pasta/noodles, or other foods made from grains. Eg. Banku,</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>2</td>
<td>White roots, tubers, and plantains</td>
<td>White potatoes, white yam, white cassava, or cocoyam, other foods made from roots, tubers, or plantain</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>3</td>
<td>Pulses (beans, peas, and lentils)</td>
<td>Mature beans or peas (fresh or dried seed), lentils or bean/pea products, including hummus, tofu, and tempeh</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>4</td>
<td>Nuts and seeds</td>
<td>Any tree nut, groundnut/peanut or certain seeds, or nut/seed “butters” or pastes</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>5</td>
<td>Milk and milk products</td>
<td>Milk, cheese, yoghurt, or other milk products but NOT including butter, ice cream, cream, or sour cream</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>6</td>
<td>Organ meat</td>
<td>Liver, kidney, heart or other organ meats or blood-based foods</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>7</td>
<td>Meat and Poultry</td>
<td>Beef, pork, lamb, goat, rabbit, game, chicken, duck, or other birds</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>8</td>
<td>Fish and seafood</td>
<td>Fresh or dried fish, shellfish, or seafood</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>9</td>
<td>Eggs</td>
<td>Eggs from poultry e.g., chicken, duck, guinea fowl or any other egg</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>10</td>
<td>Dark green leafy vegetables</td>
<td>Dark green leafy vegetables, including kontomire, Alefu, gboma, bitter leaf, cassava leaf, Ayoyo etc</td>
<td>No...0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes...1</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Example</td>
<td>Yes/No</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------</td>
<td>----------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>11</td>
<td>Vitamin A rich vegetables, roots, and tubers</td>
<td>Carrots, sweet potatoes</td>
<td>Yes...1</td>
</tr>
<tr>
<td>12</td>
<td>Vitamin A rich fruits</td>
<td>Ripe mango, ripe papaya, dried peach</td>
<td>Yes...1</td>
</tr>
<tr>
<td>13</td>
<td>Other vegetables</td>
<td>Other vegetables e.g., tomato, onion, eggplant</td>
<td>Yes...1</td>
</tr>
<tr>
<td>14</td>
<td>Other fruits</td>
<td>Other fruits</td>
<td>Yes...1</td>
</tr>
<tr>
<td>15</td>
<td>Oils and fats</td>
<td>Oil, fats, or butter added to food or used for cooking</td>
<td>Yes...1</td>
</tr>
<tr>
<td>16</td>
<td>Sweets</td>
<td>Sugar, honey, sweetened juice drinks, sugary foods such as chocolates, candies, cookies, and cakes</td>
<td>Yes...1</td>
</tr>
<tr>
<td>17</td>
<td>Spices, condiments, beverages</td>
<td>Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages</td>
<td>Yes...1</td>
</tr>
<tr>
<td></td>
<td>Did you eat anything (meal or snack) OUTSIDE the home yesterday?</td>
<td>No...0</td>
<td></td>
</tr>
</tbody>
</table>

### 4.5.2.1 In-depth interviews, oral history, and key informant interviews

Along with the computer-assisted personal interviews with randomly selected individuals using the questionnaire stated above, I conducted in-depth interviews, oral histories, and key informant interviews with different actors and from a multi-scalar perspective. The primary objectives of this data collection methodologies were to collect first-hand data on the power dynamics in line with power analysis of the political ecology between key actors in the mining and smallholder farming sectors, as well as the implications for food security. Additionally, these methodologies were used to elicit perceptions of food access and observed ecological footprints linked with mining with the goal of triangulating quantitative and geographic datasets. These objectives were bolstered by the power analysis and multi-scale ideologies of political ecology, which complement the explanations of the capability approach for the causes (conversion factors) influencing prospects in small-scale mining and smallholder farming (doings). It is essential to note that the in-depth interviews consisted of semi-structured interviews with farmers and miners and oral histories with elders from the study communities. In contrast, the key informant interviews included interviews with officials of national and regional government agencies as well as local leaders of agricultural or mining organisations.

In-depth interviewing comprises conducting thorough individual interviews with a small number of respondents to ascertain their perspectives on a certain issue (Boyce and Neale 2006). To gain a deeper understanding of the relationship between mining and smallholder...
farming, as well as the consequences for societal food security, I conducted in-depth interviews with individual farmers and miners at the local scale (Refer to Appendix 1 for the codes and details of the interviews). This type of interview provided detailed information regarding the power dynamics that exist between mining and agriculture, as well as among the numerous actors operating within these two subsectors. Additionally, it featured an oral history of how critical natural resource access was negotiated in relation to the current situation. Oral history is the process of acquiring first-hand knowledge or an inside perspective from someone who lived during a particular period of history (Given, 2008). I conducted oral histories with elderly residents of the study communities who had lived there since birth or for more than three decades. This was done to comprehend the ecological and socioeconomic changes over time and since the base year (1986) for the assessment of dynamic land use and land cover changes in this study. Participants in the oral histories included traditional leaders, appointed and non-appointed assembly members, and community elders (See Appendix 2 for the codes and details of the oral histories). The oral histories respondents expressed their perceptions of environmental challenges over time during these interviews. The in-depth interviews revealed community perspectives of food security. These facts were necessary for correlating, explaining, and developing a thorough comprehension of the subject topics. I used an interview guide to keep the interviews on topic and to guarantee that all necessary research questions were addressed, as well as any necessary probing. Regardless, respondents were free to express their perspectives on the topics raised as well as any additional concerns that surfaced throughout the interviews. The purpose of the study, the conceptual framework, and the literature all influenced the questions posed. Farmers have taken to politics in a few instances, expressing strong feelings about the need for the government to assist them.

A key informant is an expert source of information (Marshall 1996, p. 92). To augment the in-depth interviews, I conducted key informant interviews at the national/regional and local levels (See Appendix 3 for codes and details of key informant interviews). I used key informant interviews due to the high quality of information that may be gathered in a short period of time (Marshall 1996). I recruited the key informants according to five ideal criteria: community involvement, subject competence, a desire to impart knowledge, the capacity to impart knowledge intelligently, and objectivity and unbiasedness (Tremblay 1957). Apart from impartiality, which was challenging to preserve, particularly when selecting key informants at state institutions, all other criteria were met in the selection of key informants to be questioned at the local and national levels.
At the community level, most in-depth interviews with farmers occurred in their homes, whereas those with miners occurred at their workplaces. I interviewed key informants in their offices or homes. At the national level, all interviews took place at the workplaces of key informants. Occasionally, interviews were scheduled for late afternoons around 5 p.m., when most workplaces were closed and relatively calm. Apart from a few cases among miners who refused to be recorded, I audio recorded all interviews with participants with their cooperation. One miner made the following surprising statements: “Do you want to know the truth about what is happening on the ground, or do you want me to tell you what you want to hear? Please put the recorder away and let us have a conversation if you want me to tell you the truth on the ground; however, if you want me to tell you what you need to hear, let us proceed with the recording”. Since these small-scale miners were operating illegally, many of them, notably the 'financiers,' were averse to being documented. Despite this, a sizable number of miners decided to engage in the study based on anonymity, trust in the gatekeepers who introduced the researcher, and the fact that the study was for academic purposes.

4.5.2.2 Focus Group Discussions

A focus group is a type of group that is distinct from others in terms of purpose, size, composition, and procedure (Krueger and Casey 2015, p. 4). It consists of small groups of people brought together by a 'moderator' (the researcher) to discuss their attitudes and perceptions, feelings, and ideas about a particular subject (Denscombe 2017, p. 205). In other words, it is a carefully planned series of discussions aimed at eliciting perceptions on a specific subject in a permissive, non-threatening environment (Krueger and Casey 2015, p. 4). A focus group of between five and ten people is optimal, and participants should be homogeneous. The conversation should be informal in nature for participants to feel comfortable expressing their thoughts and opinions. Additionally, the moderator of the discussion must be knowledgeable (Ibid). These criteria were met in this study. To begin, none of the focus groups exceeded ten participants, and each participant was a farmer of cash, food, or mixed crops. Second, the discussions were held in private, without interruption by other participants. In Odaho, for example, the focus group discussion took place in a remote public classroom, whereas in Watreso, it took place in the public centre of the town. Finally, as the primary researcher and moderator of the focus group discussion, I drew on my prior experience moderating focus groups to guide participants through discussions about historical changes in access to critical natural resources, food security perceptions, and other study topics. I held five focus group discussions in total in four of the six localities studied, with participants including leaders of
farmer groups and various types of farmers (See Appendix 4 for codes and details of the focus group discussions). All attempts to hold a focus group discussion with miners were unsuccessful for two reasons. To begin, their work schedules precluded them from devoting more than an hour to a conversation unless I agreed to compensate them for the hours they would miss if they chose to participate. Second, despite persuasive remarks from facilitators, the fear of imprisonment by miners prevented them from agreeing to a conversation outside of their workplaces, which would have been inconvenient for a focus group discussion. The first focus group discussion included ten leaders of farmer groups from eight distinct agricultural areas with small-scale mining activities. The discussion took place at the District Assembly, following a district-wide meeting organised by the District Food and Agriculture Office. Additionally, four focus group discussions were held in Datano, Watreso, and Odaho, with one in Datano, one in Watreso, and two in Odaho. In Odaho, two focus group sessions were held due to the existence of an organised group of vegetable producers. Thus, one of the focus groups was limited to vegetable growers to clarify and expand on past perceptions and notions concerning the degree of destruction caused by small scale mining activities on vegetable producing. Except for the initial focus group discussion held in the Adubia District Assembly, where the leadership expressed dissatisfaction with the recording, each of these focus group discussions lasted more than an hour and were all audio recorded. Regardless, one of the study assistants acted as a note-taker and took meticulous notes.

The first focus group discussion held at the District Assembly consisted of ten participants aged between 35 and 59, six men and four women. The focus group discussions in Datano and Odaho included eight cash crop farmers ranging in age from 42 to 60 years. In Datano, there were no women in the focus group, whereas in Watreso there were eight men and one woman. The male dominance of the focus group discussions corresponded directly with the male dominance of cash crop farming in Ghana. The second focus group with vegetable farmers in Odaho consisted of seven participants ranging in age from 36 to 50 years. Consistent with the predominance of females within the food crop farming subsector, five of the seven participants were female and two were male. The interaction with these vegetable farmers, the majority of whom were women, allowed me to gain both male and female insights and perspectives. Similar to the focus group in Datano, the last focus group in Watreso consisted of eight men ranging in age from 41 to 60.
4.5.2.3 Observation

The approach of gathering observational data is to record units of interaction in a particular social setting based on visual study or inspection of that circumstance (Teddlie and Tashakkori 2009, p. 218). Observational evidence is critical for supporting interviews with individuals or small groups of members, as well as focus group discussions, by providing additional information on the subject under investigation (Yin, 2018). I used observational data gathering methodologies to gain an understanding of the power dynamics between various actors and the ecological footprints associated with these power dynamics. For example, to acquire a better understanding of the power and labour dynamics among diverse miners, I participated in small-scale mining activities at certain sites (see Figure 4.3), while observing and taking notes at others.

![Figure 4.3: Researcher participating in digging and loading of extracted mineralised material into gold extraction machine.](image)

I also followed farmers to their fields to see first-hand the devastation caused to agriculture by small-scale mining. Additionally, I went on a field trip to observe natural water resources in person to validate several of the concepts and perspectives voiced by research participants during in-depth interviews and focus group discussions. There were plans to visit forest reserves to observe some of the ecological footprints of mining, but due to the tense situation created by a clash between official military men assigned to raid the forest for illegal miners and unassigned military men guiding illegal mining operations in some of the forest reserves during the study period, the gate keepers were unable to negotiate access. Along with taking
notes, I captured most observations on camera with the consent of the research participants. In
the following section, I will describe how the data acquired, were analysed, and presented.

**4.8 Data analytic strategies and presentation**

The pluralistic data collection methodologies used in the study, which were based on the
pragmatist paradigm, necessitated the use of several data analysis. This section discusses the
various data analysis techniques used.

**4.8.1 Quantitative data analysis and presentation.**

To begin, all secondary quantitative datasets were visualised using linear graphs created in
Microsoft Excel following consistency and completeness checks. The trends in the datasets
were then identified and analysed in conjunction with secondary and primary data sources.
Second, I used descriptive\(^{24}\) and inferential\(^{25}\) statistics to analyse the quantitative datasets. To
summarise and analyse demographic and socioeconomic data, for example, I used descriptive
statistics such as frequencies, means, and cross-tabulations. I used inferential approaches such
as multiple linear regressions to illustrate relationships between food security and
socioeconomic characteristics. Two linear regression models were utilised in total. Model 1
investigated the association between each socioeconomic indicator and food security at a
fundamental level. Model 2 considered all the parameters that have been found to be
meaningfully associated with food security. Additionally, I conducted a sensitivity analysis
using binary logit regression. These analyses were conducted using IBM SPSS Statistics
version 27. Thirdly, I evaluated food accessibility using the FIES-SM analytical approach. The
Item Response Theory (IRT), a branch of statistics that enables the assessment of unobservable
qualities via the study of survey and test responses, serves as the analytical framework for this
approach. To quantify the prevalence of food insecurity, I used the Rasch model, a one-
parameter logistic measurement model (Engelhard 2013). This model “assumes that the
position of a respondent and that of the items can be located on the same one-dimensional scale
and postulates that the log-odds of respondent \(r\) saying ‘yes’ to item \(i\) is a linear function of the
difference between the severity of the food insecurity condition experienced by \(r\) and the
severity of item \(i\) ” (Cafiero et al. 2018, p. 147).

\(^{24}\) Descriptive methods are procedures for summarising data, with the intention of discovering trends and patterns,
and summarising results for the ease of understanding and communication.

\(^{25}\) Inferential methods are typically generated after descriptive results have been examined and are normally used
for testing hypotheses or confirming or disconfirming the results from the descriptive results.
I used FAO (2017) recommended three processes for data analysis: parameter estimation, statistical validation, and estimation of food insecurity prevalence estimates. I carried out the parameter estimation and statistical validation using RStudio\textsuperscript{26} version 1.4.1. I specifically used the RM.weights package, which was developed by the Voices of the Hungry project to facilitate Rasch analysis of FIES data.

To quantify the severity of food insecurity associated with each question and respondent, I first calculated the item (FIES questions) and respondent (study participants) parameters. The item parameter is generated by analysing the overall pattern of responses from all respondents. A question with a lower parameter value indicates a less severe experience, whereas a question with a higher parameter value indicates a more severe experience. The relative severity of the items is determined based on the premise that the more severe an item is, the less likely it is to be reported by respondents. Figure 4.4 illustrates the severity of each item, with 'worried' being the least severe and 'Whlday' being the most severe. This is the normal order of the FIES scale. Additionally, the estimated standard errors associated with each item were small, demonstrating a pattern consistent with the assumptions of the Rasch model (See Appendix 5).

\textsuperscript{26} RStudio is an integrated development environment for R, an open-source programming language for statistical computing and graphics
Figure 4.4: Item parameters and statistics for the 8 FIES items

The respondent parameter is generated using the raw score of the respondents. The raw score is an integer value between 0 and 8 that indicates how many affirmative responses were given to the eight FIES questions (See Table 4.6).

Table 4.6: Raw score parameters and statistics

<table>
<thead>
<tr>
<th>Raw score</th>
<th>Respondent Severity</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-4.75</td>
<td>1.67</td>
</tr>
<tr>
<td>1</td>
<td>-3.66</td>
<td>1.35</td>
</tr>
<tr>
<td>2</td>
<td>-2.22</td>
<td>1.06</td>
</tr>
<tr>
<td>3</td>
<td>-1.08</td>
<td>0.98</td>
</tr>
<tr>
<td>4</td>
<td>-0.27</td>
<td>1.01</td>
</tr>
<tr>
<td>5</td>
<td>0.85</td>
<td>1.10</td>
</tr>
<tr>
<td>6</td>
<td>2.15</td>
<td>1.21</td>
</tr>
<tr>
<td>7</td>
<td>3.99</td>
<td>1.51</td>
</tr>
<tr>
<td>8</td>
<td>5.31</td>
<td>1.67</td>
</tr>
</tbody>
</table>

While the raw scores and respondent characteristics are dependent on the quantity of ‘yes’ replies, exceptional quality data must follow a specified pattern to be consistent with the Rasch model assumptions that underpin the FIES (FAO, 2018). When ordered in order of increasing

---

27 The Rasch model is based upon four key assumptions:

- Only one dimension is represented by the response data. For the FIES, this is the access dimension of food security.
severity, the proposed pattern is those that begin with ‘yes’ replies and terminate with ‘no’ responses, without alternating. The precision of the respondent parameter is better certain for patterns that are closer to the theoretically expected ones. The second phase, statistical validation, was employed to determine this.

The Rasch model contains four outcomes that may be used to assess the quality of data. They are. 1. Infit: This metric assesses items that did not perform well in a certain population. 2. Outfit: Like infit, but more sensitive to aberrant answer patterns, even among a small number of responders. 3. Residual Correlation Matrix: analyses potentially redundant items, i.e., they represent the same or substantially identical problems generated by food insecurity. 4. Rasch Reliability: the percentage of the overall variation in the population that the measurement model can account for. This gives information about the entire discriminating power of the scale. The infit and outfit values of 0.7–1.3 for each item indicate an acceptable fit to the Rasch model, which is achieved if all items are related to the latent trait and discriminate equally well amongst respondents. A residual correlation of >|0.4| between two items and an outfit of >2 is considered ‘high’. Additionally, a Rasch reliability score of 0.7 or greater is considered sufficient for an eight-item FIES scale (FAO, 2018). The results of the validation procedure are summarised in Table 4.7.

Table 4.7: Item Severity

<table>
<thead>
<tr>
<th>Item</th>
<th>Infit</th>
<th>Standard Error</th>
<th>Outfit</th>
<th>Rasch Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worried</td>
<td>0.997</td>
<td>0.534</td>
<td>0.271</td>
<td></td>
</tr>
<tr>
<td>Healthy</td>
<td>0.682</td>
<td>0.349</td>
<td>0.038</td>
<td></td>
</tr>
<tr>
<td>Fewfoods</td>
<td>0.249*</td>
<td>0.332</td>
<td>0.027</td>
<td>84.30%</td>
</tr>
<tr>
<td>Skipped</td>
<td>0.653</td>
<td>0.328</td>
<td>1.211</td>
<td></td>
</tr>
<tr>
<td>Ateless</td>
<td>0.847</td>
<td>0.351</td>
<td>0.406</td>
<td></td>
</tr>
<tr>
<td>Ranout</td>
<td>0.694</td>
<td>0.426</td>
<td>0.121</td>
<td></td>
</tr>
<tr>
<td>Hungry</td>
<td>0.908</td>
<td>0.428</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>Whlday</td>
<td>1.015</td>
<td>0.591</td>
<td>1.331</td>
<td></td>
</tr>
</tbody>
</table>

* Low infit

(2) An individual’s responses to the eight FIES items are correlated with each other only because they are all conditioned by the severity of food insecurity of that individual
(3) The greater the severity of food insecurity experienced by a respondent, the higher the likelihood that he or she will respond affirmatively to each item.
(4) All items are equally strongly related to the latent trait of food insecurity and differ only in severity.
Except for the item 'Fewfoods,' the infit and outfit values in Table 4.7 are all within the acceptable range of 0.7 to 1.3, showing that the Rasch model fits adequately. Except for the Fewfoods and 'Healthy' items, the residual correlation between each paired item was within the acceptable >0.4 margins, which may be attributed to a lack of grasp of the item Fewfoods (See Appendix 6). However, there is no effect on the overall quality of the data used in the Rasch model. This means that the Fewfoods item contributes no useful information to the measure and that its formulation in future research must be carefully scrutinised to ensure that it is distinguished from other items. The overall Rasch reliability, which measures the amount of data variability explained by the Rasch model, was 84%, which is acceptable for estimating the prevalence of food insecurity.

Finally, I used the FAO (2018) Excel Template to calculate estimates of moderate (FI\textsubscript{mod+sev}) and severe (FI\textsubscript{sev}) food insecurity, which represent the proportions of the study population experiencing moderate to severe food insecurity (SDG Indicator 2.1.2) and severe food insecurity, respectively.

4.8.2 Qualitative data analysis and presentation

Women of reproductive age (WRA) require dietary diversity assessments since their nutritional requirements are higher and they are more nutritionally sensitive. As a result, I utilised the Minimum Dietary Diversity (MDD) for women of reproductive age (MDD-W) to assess the dietary diversity (DD) of women (Martin-Prevel et al. 2015). The MDD-W is a food group diversity indicator that suggests micronutrient adequacy (Martin-Prevel et al. 2015). The MDD-W is a binary indicator that indicates whether or not women aged 15–49 consumed at least five of ten food categories the previous day or night (FAO and FHI 2016). According to MDD-W criteria, I aggregated the tabulated food categories acquired via computer-assisted personal interviews into ten food groups (See Table 4.8). I calculated the mean dietary diversity score using a theoretical dietary diversity score range of 0 to 10. I then calculated the dichotomised indicator of adequate and inadequate dietary diversity, with the lowest threshold for inadequate dietary diversity being less than five food groups consumed the previous day.
### Table 4.8: Aggregation of food groups from the questionnaire to create MDD-W Indicator

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Aggregated 10 food groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foods made from grains + White roots and tubers and plantains</td>
<td>Grains, Roots, and Tubers</td>
</tr>
<tr>
<td>Pulses (beans, peas, and lentils)</td>
<td>Pulses</td>
</tr>
<tr>
<td>Nuts and seeds</td>
<td>Nuts and Seeds</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>Diary</td>
</tr>
<tr>
<td>Organ meat + Meat and poultry + Fish and seafood</td>
<td>Meat, Poultry and Fish</td>
</tr>
<tr>
<td>Eggs</td>
<td>Eggs</td>
</tr>
<tr>
<td>Dark green leafy vegetables</td>
<td>Dark green leafy vegetables</td>
</tr>
<tr>
<td>Vitamin A-rich vegetables, roots, and tubers + Vitamin A-rich fruits</td>
<td>Other Vitamin A-rich fruits and vegetables</td>
</tr>
<tr>
<td>Other Vegetables</td>
<td>Other Vegetables</td>
</tr>
<tr>
<td>Other Fruits</td>
<td>Other Fruits</td>
</tr>
</tbody>
</table>

*Source: Adapted from FAO and FHI (2016)*

I catalogued and indexed the audiotapes from the focus group discussions, in-depth interviews, and key informant interviews. For ease of reference, I assigned each raw data set a unique serial number. Throughout the data analysis stage, this reference system enabled me to return to particularly interesting locations within the data (Denscombe 2017). I transcribed the audiotape recordings after cataloguing and indexing them. For two reasons, the transcriptions began while I was still in the field. To begin, data gaps needed to be discovered and filled while fieldwork continued. Second, due to COVID-19, appointments for several key informant interviews were delayed. Through the transcription of the datasets, I identified and marked initial themes and patterns in the data for further evaluation in relation to the study questions. I first collected and read the dataset iteratively. At the conclusion of the fieldwork, I evaluated and cross-checked the transcripts against the field notes to ensure data consistency and dependability. Following that, I saved them as Microsoft Word documents and loaded them into NVivo Plus 12 for coding, categorisation, and analysis. To facilitate reference, coding, and data retrieval, I saved all transcripts in NVivo Plus in labelled folders.

I used thematic analysis to analyse the qualitative datasets. Thematic analysis is a technique for finding, evaluating, organising, characterising, and reporting themes in a data collection.
Chapter 4: Qualitative data analysis and presentation

(Braun and Clarke 2006). Unlike other qualitative data analysis methodologies, thematic analysis can be used within a variety of theoretical frameworks, making it perfect for this study's pragmatist paradigm. Thus, I followed the six-stage thematic analysis process of Braun and Clarke (2006). To begin, I read the transcripts multiple times to familiarise myself with the datasets and to obtain a better understanding of the dataset and patterns observed throughout the data collection phase. Second, I used the transcripts to construct initial codes, which I subsequently colour coded in NVivo Plus. Each transcript was meticulously highlighted and categorised according to the emergent themes. After that, I coded the data using as many codes as feasible that corresponded to the research questions of this study. Next, I sorted and studied the emergent codes for potential themes before classifying them inside selected themes. Fourth, in connection to the coded themes and the complete dataset, I reviewed and refined the primary sub-themes discovered in the previous step. This was done to maintain consistency between the themes and datasets. After achieving an appropriate degree of improved code and themes, I identify and label them. Finally, the analysis and writing of the final report began. I present the data analysis narrative as empirical chapters alongside data from the quantitative data analysis and Geospatial analysis.
4.9 Ethical considerations

This study entailed the collection of data from human subjects. As a result, it raised a variety of ethical concerns. To begin, there was the possibility for injury to study participants and the researcher, including emotional and physical harm. For instance, reporting experiences of smallholder farmers losing land to small-scale mining activities may result in emotional anguish. Additionally, because certain small-scale mining activities were illegal and miners used guns to protect their property, there was a danger of violence to both the researcher and study participants during data collection. Second, personal, and sensitive data such as age, gender, income level, and illicit mining operations were obtained for this study. Thus, it was necessary to safeguard these datasets and to ensure that they were used for their original purpose—academic research. To avoid these ethical issues, I placed a premium on research ethical principles such as confidentiality, anonymity, honesty, integrity, and respect. I received a favourable opinion from the Human Research Ethics Committee (HREC) of the Open University pertaining to the research protocol that adheres to these principles, with the reference number HREC/3390/Obodai (See Appendix 7).

In accordance with the authorised protocol, I distributed a research information sheet to prospective study participants, which was read to them in the presence of a witness for those who could not read (See Appendices 8 to 11 for information sheets). Additionally, participants voluntarily decided to participate in the study by verbally or in writing signing a standardised consent form (See Appendices 12 to 14 for consent forms). To avoid causing harm to research participants, I constantly monitored them throughout interviews or focus group discussions to ensure they remained healthy and composed. As a result of this move, neither the discussants nor the interviewers withdrew from the focus group discussions or interviews during the sessions. Additionally, I protected participants from undue intrusion, discomfort, personal embarrassment, or psychological harm. To protect the confidentiality of individual research participants, I anonymise all acquired datasets. The Android Tablets used to collect data were password-protected, limiting access to only authorised persons. The tablets' synchronised data was automatically sent to a secure cloud-based server that was accessible only to me, the researcher. Furthermore, with the consent of research participants, I encrypt and save all audio recordings on password-protected laptop and encrypted external devices. Thus, data security and protection were ensured.
While the quantitative and qualitative datasets discussed above were robust and complete, they lacked important datasets for spatio-temporal analysis. Thus, I employed geospatial data and analytical tools to fill in gaps and to corroborate some of the findings from the oral history and key informant interviews regarding the ecological footprints of mining. The next section discusses the various geospatial tools and analytical frameworks I employed.

4.10 Geospatial tools and methods

To address the first study question, I employed remote sensing and GIS technologies and techniques to better understand and forecast changes in land use and land cover across time. This is critical for a variety of reasons. To begin, it serves as a historical record of landscape changes and sheds light on the spatial ecological footprints left by mining activities. Typically, such historical records are not readily accessible. Second, it provides useful information for triangulating the historical records of perceived and actual changes gained through qualitative interviews and focus group discussions with research participants. Additionally, these methods can assist in forecasting the future to influence policies and programmes, particularly in the event of controversies about the implications of small-scale mining. The overall methodological flow involving remote sensing and GIS is summarised in Figure 4.5, followed by a description and discussion of the individual steps and processes.
As illustrated in Figure 4.5, I used Google Earth Engine to retrieve United States Geological Survey Landsat images spanning the study area. I extracted the images from the pre-processed Tier 1 calibrated top-of-atmosphere (TOA) reflectance image collection using dates and bounds. In all, I downloaded for use six multispectral images with no cloud cover for the years 1986, 2002, 2008, 2015, and 2020 (See Table 4.9). I used the GDAL fill nodata utility in the QGIS Desktop version 3. software to remedy the Scan Line Corrector off data issue in the ETM+. 

Figure 4.5: Methodological Flowchart for this chapter

Key: AHP: Analytical Hierarchy Process, WLC: Weighted linear combination LULC: land use and land cover

4.10.1 Digital data acquisition, pre-processing, and analysis
### Table 4.9: The available Landsat satellite images

<table>
<thead>
<tr>
<th>Image ID</th>
<th>Satellite ID</th>
<th>Sensor ID</th>
<th>Resolution (m)</th>
<th>Acquisition Date</th>
<th>Path/Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>LANDSAT/LC08/C01/TI_LC08_194056_20200109</td>
<td>Landsat 8</td>
<td>OLO_TIERS</td>
<td>30</td>
<td>09-01-2020</td>
<td>194/056</td>
</tr>
<tr>
<td>LANDSAT/LC08/T1_TOA/LC08_194056_20151229</td>
<td>Landsat 8</td>
<td>OLO_TIERS</td>
<td>30</td>
<td>29-12-2015</td>
<td>194/056</td>
</tr>
<tr>
<td>LANDSAT/LE07/C01/TI_TOA/LE07_194056_20080201</td>
<td>Landsat 7</td>
<td>ETM</td>
<td>30</td>
<td>01-02-2008</td>
<td>194/056</td>
</tr>
<tr>
<td>LANDSAT/LE07/C01/TI_TOA/LE07_194056_20020115</td>
<td>Landsat 7</td>
<td>ETM</td>
<td>30</td>
<td>15-01-2002</td>
<td>194/056</td>
</tr>
<tr>
<td>LANDSAT/LT05/C01/TI_TOA/LT05_194056_19861229</td>
<td>Landsat 5</td>
<td>TM</td>
<td>30</td>
<td>29-12-1986</td>
<td>194/056</td>
</tr>
</tbody>
</table>

### 4.10.2 Land use land cover classification

I employed a hybrid image classification model that incorporated both supervised and unsupervised approaches. This allowed me to profit from the advantages of unsupervised classification while avoiding the drawbacks of supervised classification. To begin, I applied unsupervised classification to all images using the ISO Cluster algorithm in ArcGIS Pro version 2.7.1 to automatically group pixels with comparable spectral features into discrete spectral clusters (classes) for preliminary interpretation (Lillesand et al. 2015). Additionally, I used supervised image classification with a greater accuracy than unsupervised image classification (Tso and Mather 2009) to generate the land use and land cover (LULC) maps using the random forest classifier (Breiman 2001). I trained sufficient and valid reference data as samples for characterising the spectral features of each of the established classes of interest, using data obtained from field surveys and the utilisation of visual interpretation from RGB compositions. According to the USGS classification system (Anderson et al. 1976), I chose six macro classes to represent the land use and land cover. (Table 4.10). Using Landsat imagery with a medium spatial resolution spanning three satellites, misclassifications were anticipated (Hassan et al., 2016; Pei et al., 2017). The most frequently detected misclassifications were between open forest and croplands, mining, and settlements/bare lands. However, the presence of pockets of water helped distinguish mining sites from settlements/bare lands. Consequently, I utilised the...

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\(^{28}\) Random Forest is a “classifier consisting of a collection of tree-structured classifiers \(\{h(x,?k), k = 1,...\}\) where the \(\{?k\}\) are independent identically distributed random vectors and each tree casts a unit vote for the most popular class at input \(x\)” (Breiman 2001, p. 6). The RF is advantageous in generating large sets of independent classification trees, with each tree trained from randomly selected samples of original training samples and produces higher classification accuracies (Gislason et al. 2006, Gislason et al. 2006; Tsai et al. 2019; Wang et al. 2019a, b).

\(^{29}\) The word “barelands” in this context refers to land with no plants, unpaved roads, and land that has been cleared for farming.
post-classification algorithm (Pixel editor tool) in ArcGIS Pro to rectify some of the most blatant misclassifications.

Table 4.10: Description of land use and land cover (LULC) types

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Pictorial view of LULC classes in practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Forest</td>
<td>Densely forested areas mostly located in forest reserves</td>
<td><img src="image1" alt="Closed Forest" /></td>
</tr>
<tr>
<td>Open Forest</td>
<td>Sparse forest, trees, shrubs, bushes, grasses</td>
<td><img src="image2" alt="Open Forest" /></td>
</tr>
<tr>
<td>Cropland</td>
<td>Arable land, plantation land, and heterogeneous agricultural areas</td>
<td><img src="image3" alt="Cropland" /></td>
</tr>
<tr>
<td>Water</td>
<td>Rivers, water in mine pits, ponds, wetlands</td>
<td><img src="image4" alt="Water" /></td>
</tr>
<tr>
<td>Mining</td>
<td>Areas where both large and small-scale surface mining has taken place</td>
<td><img src="image5" alt="Mining" /></td>
</tr>
<tr>
<td>Settlement/Bare lands</td>
<td>Areas including villages, towns, cities, roads, bare areas</td>
<td><img src="image6" alt="Settlement/Bare lands" /></td>
</tr>
</tbody>
</table>
4.10.3 Accuracy assessment

I used a quantitative accuracy assessment procedure to identify, measure, and rectify map errors to maximize their decision-making utility (Congalton and Green 2009). To determine the accuracy of the classified map, I employed confusion matrices, which included omission and commission errors, and the kappa statistic. To validate the classified maps, I computed the error matrix using Landsat, ESRI High Resolution (3m) imagery, GPS ground truth data from a field survey, and Google Earth imagery as reference data. Using a method of stratified random sampling, I selected 500 random sampling points to validate each of the classified maps. These sampling points were distinct from those used to train the classification algorithm for land use and land cover. Overall, the accuracies of the classified maps of 2008, 2015 and 2020 exceeded or was equal to 90%, resulting in kappa\textsuperscript{30} indices better than 0.90 (See Appendices 11 to 13).

4.10.4 Change detection

Change detection is the process of identifying and characterising changes across time (Lillesand et al. 2015). I employed the Post Classification Comparison (PCC) technique for the change analysis due to its remarkable utility in quantitatively extracting conversions between distinct LULC classes and calculating LULC change rates (Hassan et al. 2016). Additionally, the PCC is acknowledged as the most precise method, with the added benefit of showing the nature of the changes (Mas 1999). In analysing the rate of change for each period of the LULC change analysis, I utilised a spatial analysis model of land use dynamic change based on the dynamic degree suggested by Shenghe and Jin (2002) and adopted by Liping et al. (2018). The following formula is used to calculate the spatial-based land use dynamic degree (rate of change):

\[ CCL = TRL_i + IRL_i \]  
\[ TRL_i = \frac{LA_{(i,t_1)} - ULA_i}{LA_{(i,t_1)}} \times \frac{1}{t_2-t_1} \times 100\% \]  
\[ IRL_i = \frac{LA_{(i,t_2)} - ULA_i}{LA_{(i,t_1)}} \times \frac{1}{t_2-t_1} \times 100\% \]

\[ 30 \text{ Kappa index is used to measure the agreement between two sets of categorisations of a dataset while correcting for chance agreements between the categories. It can be used to estimate the accuracy of predictive model by measuring the agreement between the predictive model and a set of field-surveyed sample points (Jenness and Wynne, 2005).} \]
where \( LA_{(i, t1)} \) is the area of a certain type of and use at an earlier date, while \( LA_{(i, t2)} \) is the area of a certain type of land use at a later date. \( ULA_i \) is the part that is not changed. \( t_1 \) and \( t_2 \) represent the year before and after the change, respectively. \( TRL_i \) is the transfer-out rate, \( IRL_i \) is the transfer-in rate, and \( CCL_i \) is the sum of \( TRL_i \) and \( IRL_i \).

4.10.5 Land use land cover change scenarios

Land use land cover scenario modelling enables decision makers to comprehend the uncertainties associated with land processes under a range of plausible futures, potential impacts, and interactions in a number of varied situations (Höjer et al. 2008; Moss et al. 2010; Armenteras et al. 2019). I developed two LULC scenarios, ‘business as usual’ (BAU) and ‘remedial’, to predict future LULC modifications. To begin, the BAU scenario is constructed using the rates and transition trends of change in LULC from 2008 to 2015. This is the period when mining activity peaked, resulting in huge LULC changes. Second, the 'remedial' scenario is modelled using the present rates of change in LULC from 2015 to 2020. It is assumed in this section that the remedial actions\(^{31}\) implemented by the Ghanaian government since 2016 have resulted in some modest reductions in land degradation and deforestation (Forkuor et al. 2020). Thus, the model prediction procedure makes use of the transition area matrix between 2015 and 2020, with 2020 serving as the base year.

4.10.6 Change prediction

To simulate and predict LULC changes, I used the CA-Markov model, a powerful and widely used (Mas et al. 2014; Gidey et al. 2017; Awotwi et al. 2018; Hamad et al. 2018; Karimi et al. 2018; Liping et al. 2018; Singh et al. 2018; Mondal et al. 2020; Tariq and Shu 2020) tool for the simulation and prediction of LULC. To maximize the effectiveness of both methodologies, the CA-Markov model combines the advantages of Markov chain analysis with Cellular Automata models.

4.9.6.1 Markov chain analysis

I used the Markov chain analysis model to evaluate the transition trends across dynamic land use situations by assessing the transition probabilities between the initial and final states. The

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\(^{31}\)In 2018, as part of the remedial steps, a nearly two-year moratorium on small-scale mining was implemented. This prohibition was enforced by a police-military task team tasked with confiscating excavators used in small-scale mining operations. Additionally, an import prohibition on excavators was enacted. Mining exploration and the issuance of mining licenses are now permanently prohibited in forest reserves.
Markov chain is a stochastic process that is discrete in time and state and may be represented as a sequence of states, $S = \{S_0, S_1, S_2, \ldots, S_n\}$. Because the model postulates that the current state ($S_t$) transitions to the next state ($S_j$) with a probability denoted by the transition probabilities ($p_{ij}$), state $S_{t+1}$ in the system can be computed using the formula (ibid):

$$P_{ij} = \begin{bmatrix} p_{i1} & \cdots & p_{in} \\ \vdots & \ddots & \vdots \\ p_{1} & \cdots & p_{nn} \end{bmatrix}$$

Equation (4.5)

$$\sum_{j=1}^{n} p_{ij} = 1, \text{i, j = 1, 2, \cdots, n}$$

where $P_{ij}$ is the state transition probability matrix and $n$ are the land use type number; $S$ is land use status, $t$; $t+1$ is the time point.

To forecast land use change patterns, the Markov model generates a transition probability matrix, a transition area matrix, and a collection of conditional probability images (Eastman 2020). The transition probability matrix and the transition area matrix are stored in text files. The former indicates the possibility that each land cover category will transition to the next, whereas the latter indicates the expected number of pixels that will transition from one land cover type to another over a certain time (Eastman 2020).

### 4.9.6.2 Cellular automata

Cellular automata are bottom-up dynamic model with spatiotemporal computation that may be used to simulate complex time-space scenarios (Liping et. al. 2018). The cellular automata model is composed largely of a cell, cell space, neighbour, rule, and time, with the neighbours determined by the cellular automata -filter model. For instance, in state $S_{t+1}$, the data for each cell are determined by the cell and its neighbouring cells in state $S_t$, suggesting that the change of cell is defined by the following mathematical rules (Ibid):

$$S_{(t+1)} = f(S_t, N)$$

Equation (4.6),

where $S$ denotes the set of finite cell states. $t$ and $t+1$ are distinct moments; $N$ is the neighbourhood of cells; and $f$ is the local space transformation rule.
4.9.6.3 CA-Markov model

A Markov chain analysis alone cannot capture the spatial dimensions of LULC. Thus, when paired with the potential of the cellular automata for dynamic spatial modelling, the CA-Markov model provides an efficient tool for simulating and forecasting LULC changes (Mas et al. 2014; Gidey et al. 2017; Awotwi et al. 2018; Hamad et al. 2018; Karimi et al. 2018; Liping et al. 2018; Singh et al. 2018). When applied to GIS applications, the CA-Markov model has been enhanced, increasing its appeal. A data-driven CA-Markov model that incorporates expert knowledge (Mas et al. 20) was used to forecast future changes. I followed three fundamental standard steps while forecasting LULC using the CA-Markov model. These include a) the generation of the transition matrix and probabilities using the Markov Model, (b) the building of the suitability atlas using Multi-Criteria Evaluation (MCE), and (c) the prediction of the future LULC using the CA-Model.

To begin, I generated the transition area matrix and transition probability matrix for the years 1986 to 2002, 2002 to 2008, 2008 to 2015, and 2015 to 2020 using Markov chain analysis. I used the Markov transition area matrix files from 2008 to 2015 to simulate the 2020 LULC map and to forecast the 2030 LULC under the BAU scenario, whereas those from 2015 to 2020 were used to forecast the 2030 LULC under the remedial scenario. Second, I used the multi-criteria evaluation (MCE) tool to generate a collection of suitability maps for each of the LULC classes. MCE integrates a series of criteria to generate a single index for evaluation based on a specified purpose (Liping et al. 2018; Eastman 2020). MCE is divided into two parts: constraints and factor criteria. Based on the literature (Lambin et al., 2001; Geist and Lambin, 2002; Lambin and Geist, 2006; Gidey et al., 2017; Awotwi et al., 2018; Liping, Yujun, and Saeed, 2018; Singh et al., 2018; Mondal et al., 2020; Tariq and Shu, 2020), and expert knowledge from key informants, I identified and included in this model physical parameters (slope, elevation), and socio-economic factors (proximity to rivers, secondary roads, tertiary roads, major settlements, population density) that are highly associated with LULC changes. These datasets were compiled from a variety of sources and subjected to conventional quality control methods before being used. The research area was covered by a NASA Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) of 30m x 30m acquired from Earth Explorer. Additionally, this was used to compute the slope map. I downloaded the road and river datasets from OpenStreetMap and verified them against 'the image data for each year. I extracted major settlements from the settlement data provided by the Land Use and Spatial Planning Authority (LUSPA) of Ghana. I also obtained population densities for various years.
from WorldPop, a service of the University of Southampton in the United Kingdom. I initially prepared the images in ArcGIS Pro (version 2.7.1) and then imported them into the TerrSet 2020 Geospatial Monitoring and Modelling Systems for processing. I utilised the Multi-Criteria Evaluation Module (MCE) in TerrSet2020 to combine the factors and construct the suitability maps for each of the LULC maps using the Weighted linear combination (WLC) option. Prior to developing the suitability maps for each class, I standardised the factors using the Fuzzy Module of TerrSet 2020, and the output ranged from 0 to 255 using a variety of fuzzy functions and control points. There were no constraints developed. I allocated weights to the standardised factors using the pairwise comparison approach established by Saaty (1977) and implemented in TerrSet 2020. Weights assigned to each LULC class resulted in an acceptable consistency ratio of between 0.03 and 0.8. The suitability maps for each class (Map 4.2) were collected into a single collection in TerrSet 2020 using the Collection Editor. Utilising a conventional 5x5 contiguity filter and five iterations of cellular automata in the TerrSet 2020 software, I generated a simulated LULC map for the year 2020 using this, the 2008 to 2015 Markov transition area, and the 2015 categorised LULC map as a basis map.

4.9.6.4 Model validation and future land use land cover change prediction
Prediction models must be valid to be useful in decision-making. As a result, model calibration and validation are crucial steps in any model prediction process. To validate the model, I compared the simulated land use and land cover map for 2020 to the actual classified map for 2020 using the Validate Module of TerrSet 2020. A standard kappa index of 72% was determined based on the validation results. Thus, the simulated land use and land cover map can be used to forecast the future land use and land cover map. Consequently, the model prediction for 2030 was conducted using the 2020 simulated land use and land cover maps under ‘business as usual’ and ‘remedial’ scenarios.
Map 4.2: Suitability maps for each land use and land cover class and the input datasets used in its generation. (a) Water (b) cropland (c) mining (d) Closed Forest (e) Settlements/ bare lands (f) open forest are suitability maps. (g) slope (h) DEM (i) Population Density (j) River (k) secondary roads (l) tertiary roads (m) major settlements are input maps.
4.11 Chapter summary

Figure 4.6 offers a diagrammatical summary of the key research approaches used in this study.

In this chapter, I have explained the different research approaches that I employed to generate responses to the research questions. I have discussed how several data collection and analytical frameworks were used throughout the study to gain a better understanding of the research issues, which were guided by the pragmatist paradigm. I have continued by describing how combining geospatial technologies with quantitative and qualitative approaches might help paint a more nuanced and complicated picture of nature-society interactions. I have demonstrated the value of merging social research methodologies with geospatial tools and techniques in this chapter, which, if adopted, would promote inter- and multi-disciplinary research in the social and natural sciences, as well as a better understanding of nature-society relationships.
CHAPTER FIVE
HISTORICAL POLITICAL ECOLOGY OF GHANA’S MINING AND AGRICULTURAL SUBSECTORS

5.1 Introduction
To fully comprehend the connections between small-scale mining and smallholder farming, as well as the consequences for food security, it is necessary to have a wide understanding of the mining and agricultural subsectors and to place the connections in context. As a result, this chapter presents a historical political ecology of mining and agriculture, which is supported by the political ecology approach described in Chapter 3.

Agriculture, industry, and services are the three principal economic sectors in Ghana. Crop farming, livestock, forestry, and fisheries are all subsectors of the agriculture sector. Mining and quarrying, manufacturing, electricity, water and sewerage, and construction are all subsectors of the industry sector. Trade, hotels, and restaurants are all part of the services sector, as are financial and insurance services, real estate, education, health, and social work. The farming and mining subsectors of the economy of Ghana play a crucial part in the economy of the country. They contribute to employment generation, foreign exchange revenues and gross domestic product (GDP). For instance, in the year 2019, the agriculture and mining subsectors contributed 14 per cent and 17.9 per cent respectively to GDP at the current market prices (Ghana Ministry of Finance 2020). These two subsectors have evolved by going through a succession of economic and structural policy reforms. This chapter offers insights into the shifting structural and regulatory regimes driving these two subsectors over time and provides the context for the empirical chapters of the thesis. Furthermore, flashpoints of conflicts between the two subsectors shaped by altering structural and economic developments were shown. Researchers have periodised the mining and agricultural sectors of Ghana from pre-colonial to post-independence and this chapter expands on their work. For example, Bebbington et al. (2018) periodised the mining sector from pre-colonial times to 2016, concentrating on the important policy frameworks, dominating actors, and industrial inclusivity measures. This chapter updates the timeline to the year 2021, considering new regulations and measures relating to small-scale mining as well as ecological footprints linked with the mining industry over time. Teye and Torvikey (2018) did a review of the political economy of agriculture in Ghana, but it was only up to 2018 and focussed on commercialisation of agriculture.
Chapter 5: Historical political ecology of mining and agriculture in Ghana

This chapter extends the scope to the year 2021, with a concentration on smallholder farming. The chapter will focus mostly on a review of peer-reviewed journals, books, policy documents, reports, national development frameworks, and other archival documents. These sources of information are augmented with primary data gathered through key informants’ interviews and secondary data obtained from the Food and Agriculture Organisation (FAO).

Three major conclusions are drawn from the historical accounts on the mining and agriculture subsectors of Ghana in this chapter. To begin, mining sector of Ghana, like others in Sub-Saharan Africa, has had a significant impact on the environment since the early 1980s, owing to its adherence to neoliberal and capitalist ideas. However, these ecological footprints received little or no attention until they reached alarming proportions, forcing extreme steps that may not be able to reverse some of the damage. These ecological footprints have a variety of consequences for the well-being of individuals and communities living near and far from gold mining sites, but they are all connected by nature (rivers, food systems, climate, and so on).

Second, the agricultural modernisation thesis, which is inextricably linked to the promotion of cash crops and commercial agriculture in general and has been championed by international funding organisations and adopted by successive governments, has a sizable impact on peasant farmers, who account for most of the agricultural workforce. Income and livelihoods of peasant farmers, particularly those engaged in food crop production, are harmed, adding to the fact that peasant farmers continue to be the poorest segment of the population in Ghana and contribute the most to the poverty of the country.

Third, populations living along the agroecological zone boundaries, where mining areas meet agricultural lands, are disproportionately harmed by the double-edged sword of mining and agriculture reforms. This is because of the flashpoints of conflict between mining and smallholder farming, which have been exacerbated by the concurrent economic and structural changes experienced by both sectors.

This chapter is divided into five sections. Section 5.1 serves as an introduction. Section 5.2 and its subsections detail the history of the mining sector in Ghana. Section 5.3, together with its subsections, covers the shifting agricultural landscapes in Ghana, with a particular emphasis on crop production. I discuss the flashpoints of conflict between mining and crop cultivation in Section 4.4, as well as how those conflicts may have played out over time. Section 5.5 contains a summary of the chapter as well as the conclusions drawn.
5.2 Overview of the mining sector in Ghana

For decades, mining has been a vital aspect of the economy of Ghana. The history of gold mining in Ghana extends all the way back to the fifteenth century (Government of Ghana 2014), giving the country its former name, Gold Coast. Between 1493 and 1600, Ghana produced 36% (8,153,426 fine ounces) of the gold in the world (ibid; p. 4). Ghana is currently 'the largest gold producer in Africa and sixth in the world (Ghana Chamber of Mines 2021; World Gold Council 2021). Apart from gold, Ghana is endowed with a variety of natural resources, including diamonds, manganese, bauxite, limestone, salt, and, more recently, oil. The focus of this study is on gold mining.

Historically, 'the gold mining sector of Ghana has undergone a succession of economic and policy changes, culminating in the current state of the sector. These shifts include periods of stagnation and abundance, as well as the socioeconomic benefits and environmental decadence that accompany them. The modifications may be traced back to pre-colonial, colonial, and post-independence periods. Drawing on and expanding on the historical timelines of Bebbington et al. (2018), this subsection delves into the many stages of mining in Ghana, the prominent actors involved at each stage, the levels of ecological footprints, and important governmental measures (Summarised in Table 5.1).
Table 5.1: Periodisation of the mining sector of Ghana: actors; ecological footprints and reforms/actions

<table>
<thead>
<tr>
<th>Period</th>
<th>Dominant actors</th>
<th>Ecological Footprints&lt;sup&gt;32&lt;/sup&gt;</th>
<th>Key Policy Reforms and actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-colonial period</td>
<td>Chiefs, clans, and families</td>
<td>None to negligible ecological footprints.</td>
<td></td>
</tr>
<tr>
<td>1874–1956: Colonial capitalism</td>
<td>British mining companies, chiefs</td>
<td>Emerging ecological footprints.</td>
<td>• 1897 Land Bill</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Mercury Ordinance Law of 1933</td>
</tr>
<tr>
<td>1957–85: State dominance and the</td>
<td>State-owned enterprises</td>
<td>Gradual increase in ecological</td>
<td>• Minerals Act (Act 123) of 1962</td>
</tr>
<tr>
<td>nationalisation of mines</td>
<td></td>
<td>footprints</td>
<td></td>
</tr>
<tr>
<td>mines</td>
<td>Bank, Chiefs</td>
<td>ecological footprints</td>
<td>• Mercury Act (PNDC Law 217 of 1989)</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>• Small-Scale Mining Law (PNDC Law 218 of 1989)</td>
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<td></td>
<td></td>
<td></td>
<td>• Precious Minerals Marketing Corporation ACT (PNDC Law 219 of 1989)</td>
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<td></td>
<td></td>
<td></td>
<td>• Environmental Protection Agency Act, 1994 (Act 490)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Minerals and Mining Act, 2006 (Act 703).</td>
</tr>
<tr>
<td>2009–15: Return to resource</td>
<td>Multinational corporations, IMF and World</td>
<td>Sharp increase in ecological</td>
<td></td>
</tr>
<tr>
<td>nationalism</td>
<td>Bank, Chiefs, Small-Scale miners</td>
<td>footprints driven by illegal small-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>scale mining</td>
<td></td>
</tr>
<tr>
<td>2016-2021</td>
<td>Multinational corporations, IMF and World</td>
<td>Gradual decrease in ecological</td>
<td>• Inter-Ministerial Committee on Illegal Mining</td>
</tr>
<tr>
<td></td>
<td>Bank, Chiefs, Small-Scale miners</td>
<td>footprints driven by radical</td>
<td>o Operation Vanguard</td>
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<tr>
<td></td>
<td></td>
<td>government actions</td>
<td>o Operation Halt</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>o Operation Quick Response</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Community Mining</td>
</tr>
</tbody>
</table>

<sup>32</sup> Ecological Footprint (EFP) measures how much nature we have and how much nature we use (Global Footprint Network 2021). This helps countries to improve sustainability and well-being, local leaders to optimize public project investments and individuals to understand their impact on the planet (ibid). In this study, EFP of mining and farming are defined in terms of the activities associated with mining and farming that harms nature. They include forest and land clearing, land and water pollutions and water diversions. These activities trigger three main EFP: deforestation, land degradation, and pollution with varied ramification for nature and humans.
5.2.1 Pre-colonial period: traditional governance and none/negligible ecological footprints

Prior to colonial authority, the gold mining industry in Ghana was governed by traditional rulers. Kings and chiefs held mineralised lands in trust for their subjects and were accountable for their allocation and management (Dumett 1998). These chiefs exercised power in three fundamental ways, depending on the office they occupied (ibid, p.71). The earliest and most common approach was the ‘abusa share system’, in which miners retained one-third of their profits and distributed another third to the local chief or stool, leaving the remaining third to the king or paramount ruler. Ofosu-Mensah (2016) confirms this system. The second was the direct power of political authorities to tax, which stemmed from both the customary territorial control of the chiefs and the familial responsibilities of his people to him. Thirdly, through obligatory community labour, special days were set out for all citizens to mine exclusively for the benefit of the paramount chief (Dumett, 1998, p. 71). The chiefs wielded such power that with complete disregard for the abusa share and legitimate taxation procedures, they may at any moment forcibly collect any gold dust and gold jewellery possessed by miners and their families (Dumett, 1998, p. 75-76). Although this time demonstrated some degree of inclusivity, the allocation of material profits favoured the elites at the expense of the masses (Bebbington et al. 2018). Mining in Ghana was entirely an African activity during this period, utilising traditional and appropriate methods, and was mostly carried out by farmer-miners and their families on a seasonal basis to augment revenue from farming (Ofosu-Mensah 2011, 2016). Dumett (1998) classifies typical gold mining during this age into three distinct categories: alluvial, shallow pit, and deep shaft. Alluvial gold mining was the most common type of gold mining, which occurred along the banks of large rivers such as the Ankobra, Tano, Birim, and Offin. Mining activities during this era had none to negligible ecological impacts due to the use of primitive tools and hence did not require government intervention.

5.2.2 1874–1956: colonial capitalism, the decline in traditional powers and the emergence of ecological footprints

This is the era when colonialism and expatriate-led capitalism begin (Bebbington et al. 2018). It coincides with the commercialisation of mineralised land, the gradual erosion of traditional authority over mineralised land, and a general fall in indigenous gold mining (Ofosu-Mensah

33 Farmers who mine on part time basis
34 The term ‘emergence’ refers to the beginning of an increase in mining’s environmental footprint. The gold rushes during this era, for example, resulted in increased land clearing, which had severe implications such as deforestation and land degradation. Furthermore, the use of mercury in small-scale mining signals the beginning of potential and real water pollution due to spills and direct use in water resources.
Slave emancipation\textsuperscript{35}, the demonetisation of gold dust\textsuperscript{36} in 1889, and European imperialism are all blamed for the general decline in indigenous gold mining (Ofosu-Mensah 2011). Europeans were very interested in securing mining concessions on the then-Gold Coast in the 1870s. This culminated in large-scale gold rushes in the 1880s, forcing the drafting of the 1897 Land Bill to bring the situation under control (Ofosu-Mensah 2011). Europeans expanded their capital investment in the country. A grant of a 25,000 ha land mineral concession in Obuasi in 1890 (Ashanti Goldfields, 2002 cited in Hilson 2002) and the establishment of a rail link between Takoradi/Sekondi and Kumasi in 1901 resulted in approximately 4000 applications for mine concessions between 1901 and 1902 (Hilson 2002). This is the first gold rush, which (Kesse 1985, p. 175 cited in Hilson 2002) refers to as the first “Jungle Boom”. Between 1892 and 1901, it is estimated that over 400 newly founded firms invested £40 million in developing gold mining sites (Hilson 2002; Bebbington et al. 2018). Gold production in the Gold Coast soared 400\% in a single year (1901–1902), as investors began withdrawing their investments from South Africa during the Boer War of 1899–1902 (Hilson, 2002, p. 21). Following the First World War, a second “Jungle Boom” followed, with as many as 7000 inquiries for land concessions (ibid). The commercialisation of stool lands, which resulted in intervillage boundary disputes, was associated with the gold rushes (Ofosu-Mensah 2016, p. 32). Mineralised land was given monetary value by paramount chiefs, subchiefs, and village herdsmen. However, the power and authority wielded by these leaders deteriorated with time. According to Terray (1974 cited in Ofosu-Mensah 2010, p. 18), the colonialists' presence on the Gold Coast signalled the start of the struggle for control of their mineral-rich territories. To achieve this control, it was necessary to first erode the authority of chiefs and other indigenous systems that reflected the power of African society at the time. Dumett (1998, p. 175) identifies three factors that contributed to the deterioration of these traditional authority structures: (i) a long-term decline in respect for coastal chiefs as a result of colonial rule and westernisation; (ii) further fragmentation of chiefly power in the interior as a result of the lure of payoffs by European prospectors and African middlemen as consequence of concession leasing; and (iii) arbitrary actions by the colonial government, such as the occasional destoolment of ‘recalcitrant’ chiefs. It is worth noting here that while some chiefs benefited from the enormous leverage provided by the lease of mineral assets to Europeans (Dumett, 1998, p. 75), others experienced a loss of authority and control.

\textsuperscript{35} Native mines lost slave labour
\textsuperscript{36} Gold dusts were used for centuries as the main medium of exchange
Paramount chiefs in Akan traditional territories complained that their traditional and decision-making authority had been eroded or ignored (Dumett, 1998, p. 273). These chiefs share this sentiment because they reaped little profit from leasing concessions to Europeans.

Throughout this era, the European mining firms were the major actors and significant beneficiaries of gold mining in Ghana. They wielded considerable influence, to the extent that they were able to influence prevailing mining policies. According to Tsikata (1997, p. 9), British mining interests exerted considerable influence over the Colonial Office in London and its territorial agents, influencing their development and implementation of mineral policy. Tsikata (1997) argues that mining policies during this era were aimed at four objectives: (i) establishing a legal and administrative framework conducive to mineral operations; (ii) ensuring security of tenure for grantees of mineral rights; (iii) assisting in the resolution of conflicts between mining companies and representatives and members of local communities; and (iv) generating revenue for the government through the imposition of duties or income taxes. As previously stated, purposeful steps were taken to weaken traditional authorities, and as a result, the powers and authority of local traditional chiefs decreased dramatically in comparison to the pre-colonial age. The average Ghanaian was forced to work as casual labourers in European mining, earning pitiful wages and assigned “arduous, dirty, and dangerous” activities (Ofosu-Mensah 2010, p. 14).

The evolution and experience with ecological footprints associated with mining, in my opinion, began during this age. According to Ofosu-Mensah (2010, p. 15), many “ambitious indigenous miners” left their jobs with European mining companies to create their own operations. They merged local expertise with knowledge acquired from European mining firms, such as the use of mercury and cyanide in gold recovery methods. According to Ofosu-Mensah (2010), this hybrid system evolved into what became known locally as ‘galamsey’ - small-scale mining. However, there remain unresolved issues in the literature. Were these aspirational miners knowledgeable about the proper handling of these chemicals? Are they capable of preventing or managing contamination caused by these chemicals? Mercury is used extensively throughout the system because of growing activity by European mining firms and defected indigenous miners who combine traditional and scientific mining methods. The effects of mercury use, as well as the direct effects of mining, such as land clearing, began to pose hazards to the ecosystem. However, these hazards received scant attention, as environmental issues received inadequate attention (Addy 1998; Ofosu-Mensah 2011).
For example, Ofosu-Mensah (2011) highlighted that in the absence of stringent regulation or environmental concerns about procurement, usage, and disposal, mercury was the most appropriate alternative for many of the gold-mining enterprises in the country. Although these environmental risks were contained to mining areas and were not widespread, they were pushed under the rug only to resurface in the future. However, a significant measure during this era was the enforcement of the 1933 Mercury Ordinance Law. Indigenous miners were barred from utilising mercury in their mining activities under this law. In other words, using mercury for local mining was unlawful. According to certain scholars (Akabzaa and Darimani 2001; Ofosu-Mensah 2011), this law initiated the criminalisation of small-scale gold mining and marginalisation of indigenous gold producers. Additionally, the rule was described to have damaged chiefs’ authority by removing their influence and control over their subordinates in terms of employing them as labour (Tsuma, 2009). It is worth mentioning, however, that mercury use persisted underground notwithstanding the passage of this law (Ofosu-Mensah 2011). This could have increased its exposure to individuals and the environment, as people were forced to conceal them after obtaining them on the underground market. Political elites and prominent individuals were identified as pushing this illegal mercury trade and aiding the selling of gold produced via such activities (Ofosu-Mensah 2011). These compromised conditions were to persist and worsen over time, culminating in the indictment of the political elite and other very powerful members of society as accomplices to the developing small-small mining sector.

5.2.3 1957 to 85: post-independence reforms, nationalisation of mines and gradual increase in ecological footprints

Ghana became ‘the first independent country in Africa in March 1957. In 1958, immediately following independence, the government appointed a Commission to ascertain the terms of mineral rights, the profitability of the mining industry, and the status of unexplored concessions (Tsikata 1997). The Commission suggested, among other things, that:

1. the government takes over mineral rights from the landowning communities on whose behalf grants had hitherto been made by their chiefs and other local leaders.
2. royalties to be paid by mining companies be calculated as a percentage of net profit (rather than be fixed amounts whose value diminished with time).

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37 Because of inadequacies in governmental control of mineral resources, the emerging ecological footprints from small scale mining activities as well as those from the accelerated gold rush in Ghana continued, albeit slowly.
3. landowners be entitled to a percentage of mining royalties determined by law.
4. more stringent rules be developed to restrict the area over which a mineral right could be held and its duration.
5. power be given to a government body to terminate a mineral right held for an undue length of time without adequate activity by the grantee.
6. government investigates the advisability of acquiring 51 per cent of the shares in mining companies and
7. consideration be given to the advisability of establishing a state monopoly for the export of minerals (Boateng et al, 1961, paragraph 85 cited in Tsikata 1997).

In 1961, the State Gold Mining Corporation (SGMC) was founded in response to these proposals. By 1966, the SGMC had taken control of all gold mines previously under British control and those owned by different companies, except for the Obuasi site in the Ashanti region (Hilson 2002a). Thus, this age saw the nationalisation of mining activities and the strong involvement of the state in the mining industry. The state invests enormous powers on itself through the enactment of several law. For instance, in 1962, the Minerals Act (Act 123) and the Concessions Act (Act 124) were enacted. Act 123 established the basis for governmental control of mineral resources in Ghana, which has persisted to the present day. All minerals are vested in “the President on behalf of the Republic and in trust for the People of Ghana” under this Act. Additionally, Act 123 requires that all minerals produced in Ghana be sold at a negotiated price to a state agency. The Minerals Act, in conjunction with the Administration of Lands Act 1962 (Act 123) conferred significant power on the government in allocating and managing ‘stool land' previously possessed by chiefs on behalf of their communities. Rather than paying chiefs directly for stool lands used for mining in their communities, the Administration of Lands Act requires that such payments be made to the designated Minister. The Minister would then use a portion of these payments to maintain the traditional authority, for projects that benefit residents of the area and local government entities in the area (Tsikata 1997, p.10). These arrangements have remained largely unchanged over time.

Despite these enormous advances in mining operations, gold production decreased significantly throughout this era. By 1970, gold production had decreased by 20%, from 956,947 oz in 1960 to 766,258 oz in 1970 (Hilson 2002). Throughout the 1970s, output continued to decrease quickly, hitting a 50-year low of 232,000 oz in 1982 (ibid). Among other factors, these dramatic drops in gold production have been attributed to heavy state control.
According to Addy (1998, p. 230), during the 1960s and 1970s, “Ghana developed one of the most centrally planned economies outside of Eastern Europe”, and the economy deteriorated in terms of economic indicators such as gross capital formation, public saving, government revenue and expenditure, trade, inflation, real wages, and per capita gross domestic product. By the early 1980s, the economic situation in Ghana had deteriorated significantly, owing to the adoption and implementation of “bad economic policies”, as well as the transition from a “market-based economy” to one based on “centralised planning” (Addy, 1998, p. 230). The importance of the mining subsector to the broader economy worsened, as its percentage of GDP fell to 0.3% in 1982, down from 2.5% in 1968 (Addy, 1998, p. 234). The economic woes of the country, which were not entirely due to mining, necessitated significant reforms. Thus, beginning in 1983, the government began the Economic Recovery Programme (ERP) with the assistance of the World Bank and the International Monetary Fund (IMF). Implementation of this strategy initiated the acquisition of dominating interests and positions in mining sector of Ghana by the Bretton Woods institutions. These hegemonic roles were not unique to Ghana but were reproduced in several other African mining countries. Although the state nationalised mining activities and served as the dominant actor during this period, the growing number of small-scale underground mining activities indicates that the ecological imprints that had evolved during the prior century persisted, albeit slowly. This is inferred from previous incidents, as there is no documentation of such ecological footprints due to their lack of attention. The following paragraph discusses the major policy prescriptions that have a direct impact on the mining industry.

5.2.4 1986–2008: liberalisation of mines and acceleration\(^{38}\) of increases in ecological footprints

In 1986, Ghana introduced the Structural Adjustment Programme (SAP) as part of the ERP. Structural Adjustments are “a set of programmes that seek to restructure the economies of countries in the developing world or transition, literally ‘adjusting’ the ‘structure’ of national economic life” (Mohan and Chiyemura 2020, p. 61). One distinguishing aspect of SAPs is the imposition of policy requirements on loans to indebted and impoverished countries (ibid). The SAP implementation in Ghana did undoubtedly alter the structure of the mining sector in

\(^{38}\) The term ‘acceleration of increases’ in ecological footprints refers to the ongoing increase in ecological footprints that leads to the creation of Environmental Protection Agency to address the problem. Both small-scale and large-scale mining activities increased their ecological footprints, which included water resources contamination, forest, and land clearance for mining.
Chapter 5: Historical political ecology of agriculture in Ghana

accordance with neoliberal objectives. According to Akabzaa and Darimani (2001, p. 18), there are five major SAP policy reforms in the mining sector.

1. Changes in mining sector legislation to make the sector attractive to foreign investment.
2. Increasing fiscal liberation of the mining sector.
3. Strengthening and reorientation of government support institutions for the mining sector.
4. Privatisation of state mining assets.
5. Enactment of environmental laws and other mining sector legislative changes

Several legal reforms occurred during this period. Mining Law (PNDCL 153 of 1986), the Small-Scale Mining Law (PNDCL 218 of 1989), the Mercury Act (PNDCL 217 of 1989), Precious Minerals Marketing Corporation Act (PNDCL 219 of 1989), the Environmental Protection Agent Act, 1994 (Act 490) and the Minerals and Mining Act, 2006 (Act 703) are significant among these legislations.

To begin, the 1986 Minerals and Mining Law established the Minerals Commission to govern the mining sector, liberalised the mining regime, and provide considerable additional benefits to private investors. This new law provided significant tax breaks and capital allowances to foreign mining businesses. For example, eligible mining businesses were entitled to get 75% depreciation or capital allowances and 5% investment allowances in the first year of investment, and 50% of capital allowances in future years. Additionally, losses in each fiscal year may be carried forward up to the value of capital allowances for the year. Furthermore, mining rights holders were exempted from paying customs import charges on plant, machinery, equipment, and accessories imported particularly and exclusively for the purpose of initiating mineral activities, as well as from paying income tax on furnished housing on the mine site. Moreover, mining companies could keep negotiated percentages of their total minerals sales in offshore accounts. These reforms resulted in an increase in private capital investment in the mining sector of Ghana (Aryee 2001; Government of Ghana 2014). Between 1983 and 1998, the Minerals Commission of Ghana documented a total investment of nearly US$4 billion in mineral exploration, new mine sites, and mine rehabilitation (Aryee, 2001). International investment increased significantly in the mining sector, resulting in a considerable shift away from underground to surface mining. This transition led to the emergence of conflicts between large-scale mining businesses and small-scale mining enterprises and individuals, among other consequences (Yankson and Gough 2019). These conflicts arose because of large-scale mining corporations' desire for and acquisition of huge tracts of land for surface mining, which frequently prevent small-scale miners access to such mineralised lands, thereby infringing on
such concessions. The 1986 Mineral and Mining Law remained the substantive law for two decades, until it was deemed insufficiently competitive internationally in comparison to other African countries such as Tanzania and Mali (Akabzaa, 2009). It was thus repealed and replaced with the Minerals and Mining Act, 2006 (Act 703), which was deemed "more investment-friendly" consistent with industry best practices (The World Bank, 2008, p. 32 cited in Bebbington et al. 2018). Act 703 provided multinational corporations with a variety of tax benefits, including a 10% drop in the corporate income tax rate (from 35% to 25%), and the elimination of the additional 35% profit tax (Bebbington et al. 2018). From the mid-2000s forward, these tax breaks combined with rising commodity prices resulted in mining corporations earning supernormal profits. The attempt of the government to gain from this profit by enacting a new windfall tax was unsuccessful (ibid).

Second, in acknowledgment of the expanding operations of the small-scale mining industry, the Small-Scale Mining Law was enacted to regulate and simplify small-scale gold mining activities (Government of Ghana 2014). The law legalised small-scale mining and allowed Ghanaian citizens to acquire mining concessions as individuals, groups of individuals, or cooperative societies. Individuals or groups of individuals (up to four) are permitted to up to 1.2 ha of land with a mining license valid for three years and renewable thereafter. Individuals (5 to 9) are entitled to own up to 2 ha of land for the same length as a single person, whereas cooperative societies (10 or more individuals) are permitted to own up to 10.1 ha of land for a period not to exceed 5 years. In comparison to countries such as Sierra Leone, Zambia, Mali, Niger, Burkina Faso, Peru, Ecuador, and Tanzania, where a clear distinction between small-scale and artisanal mining is made, necessitating the designation of separate areas for each activity and clearly defined procedures for land acquisition by small-scale miners, small-scale mining laws in Ghana does not make such a distinction. The absence of a clear demarcation between small-scale and artisanal mining is cited as one of the problems of the sector (UNEP 2012; UNDP Ghana 2017). According to a Minerals Commission official, the Mineral and Mining Law is now being reviewed (KII_013_M_NS). Hopefully, such differences will be established in an amended law to reflect the status of the small-scale mining sector today. There should also be a recognised medium scale mining class, as some small-scale mining businesses and/or small-scale miners' existing operations exceed the definition of ‘small’ in terms of mechanical sophistication, coverage area, and accompanying ecological imprint. As demonstrated in Chapter 3 and further in the next subsection, the small-scale industry has grown and evolved fast since 2008, in response to the global surge in gold prices.
Third, the Mercury Act lawfully\textsuperscript{39} repealed the colonial-era prohibition on mercury usage in small-scale mining activities and tries to control mercury use by small-scale gold miners. Mercury regulation in mining activities has been largely unsuccessful to date. Mercury is still being used indiscriminately by small-scale miners. Their use of mercury poses serious risks to themselves, the environment, and the broader population when mercury contaminates water bodies and/or the food value chain. Ghana is a signatory to the Minamata Convention, which aims to safeguard human health and the environment against anthropogenic mercury and mercury compounds emissions and releases (UNEP 2013). According to a recent study on the initial assessment of the Minamata Convention on Mercury in Ghana, gold mining remains the primary source of mercury intake into the environment (Ministry of Environment Science Technology and Innovation 2018). Mercury amalgamation extraction of gold from concentrate accounts for 56\% of the estimated 81,060 Kg Hg/y\textsuperscript{40} mercury input into the environment (ibid). Annually, 48,100 kg of mercury was emitted into the air, 8,870 kg into water bodies, and 27,340 kg into the land, with gold extraction with mercury amalgamation from concentrate being a major contributor to these emissions (ibid). These emissions are major environmental concerns because mercury should not be found in water, and the limit of mercury compounds in the air is set to be 0.000005 kg/m\textsuperscript{3} or lower, while soil contamination with mercury in farmland is suggested to be 4mg/kg (Ye et al. 2016). Diverse research conducted in various mining regions have also discovered an increase in mercury exposure in humans and the environment (Amonoo-Neizer et al. 1996; Golow and Adzei 2002; Golow and Mingle 2003; Clifford 2017; Gyamfi et al. 2021). These investigations demonstrate that, despite the existence of mercury legislation for three decades, the small-scale gold mining sector contributes significantly to mercury emissions into the environment. The prospect of periods without regulation is far more frightening.

Fourth, the Precious Minerals Marketing Corporation Act established a formal market for small-scale gold miners (Government of Ghana 2014). This act at the very least addresses the issue of middlemen (mostly the political elite and influential society) in the selling and purchase of gold from small-scale miners, as well as the exploitation that occurs as a result. By appointing licensed gold buying agents to purchase precious minerals generated by small-scale

\textsuperscript{39} Officially because as explained by Tsuma, (2009) powerful actors in government kept the market chain for mercury open despite the ban of 1933, which prohibits the trade and use of mercury in any mining operations. Also, Nyame (2010) noted that attempts by various governments to enforce the law banning mercury were unsuccessful because of the growing activities of small-scale mining.

\textsuperscript{40} Hg/y is mercury per year
miners, many small-scale miners have a choice of agents, as such agents are plentiful in mining areas.

Finally, and somewhat belatedly in my opinion, environmental concerns were addressed in the early 1990s with the founding of the Environmental Protection Agency (EPA) in 1994. This focus, I believe, among others, was a direct response to the ever-increasing ecological footprint of mining. The functions of the EPA include protecting and improving the quality of the environment through policy formation, coordination, and collaboration with other relevant organisations. Since the founding of the EPA and the adoption of different environmental rules and regulations over the last two decades, environmental concerns related with mining have persisted (Akabzaa and Darimani 2001; Hilson 2004; Akabzaa et al. 2009; Akabzaa 2011). The fast expansion of both legal and illicit small-scale mining activity after the end of this era has exacerbated environmental risks. Significant natural rivers and streams have been contaminated, forest reserves have been encroached upon and deforested, open forests have been destroyed, and farms/arable lands have been degraded; these ecological footprints have been examined and addressed in the following chapter.

Environmental issues in the mining sector are linked to a variety of factors, including inefficient environmental policy implementation (Hilson 2004). A recent report by Ghana Audit Service (2021) confirms the inefficient implementation and enforcement of environmental rules in the mining sector. According to the report, both the Mineral Commission - the regulator of the mining sector - and the EPA - the environmental custodian of the state- failed to adequately enforce certain laws/regulations pertaining to small-scale mining. To begin, the EPA neglected to manage the posting of reclamation bonds and the collection of funds for such bonds. This was in violation of Regulation 23 of the Environmental Assessment Regulations, 1999, which requires the EPA to require potential small-scale miners to deposit reclamation bonds in the form of cash into an escrow account based on an authorised reclamation plan prior to issuance of permits. Second, the Inspectorate Division of the Mineral Commission (MC) failed to enforce the filing of operational plans that detail, among other things, how a miner intends to recover mined areas and the method to be used. Third, the EPA paid scant attention to monitoring reclaimed lands, and neither it nor the MC took any action to assure compliance with land reclamation criteria agreed upon before to issuing mining licenses and permits. Finally, both the EPA and the MC failed to create mechanisms to verify that small-scale miners' restoration efforts were validated and certified. These premeditated violations of
institutionalised environmental rules and regulations, abetted by those tasked with enforcing compliance, are merely the tip of the iceberg, spanning the whole extractive industry. Stapenhurst et al. (2016) detailed the multi-tiered institutional corruption that exists within the extractive industry in Ghana, which involves mining firms and state regulatory agencies. For example, the authors cited a case in which the EPA, rather than exercising its regulatory function, defended a Canadian mining corporation that had failed to restore mining grounds and had also failed to post reclamation bonds. If such non-compliance is permitted within the legalised SSM system, it implies and demonstrates the complete breakdown of the illegal SSM system, in which miners violate all applicable laws and regulations. Lack of community participation, insufficient coordination among government institutions, insufficient people and logistics, and a lack of political will have all been cited as contributing to the weak environmental policy implementation in the mining sector (Tuokuu et al. 2018).

5.2.5 2009–2015: a return to resource nationalism and sharp increases in ecological footprints

The era from 2009 to 2015 can be seen as a return to the early post-independence reforms’ resource nationalism (Bebbington et al. 2018). This time, however, the government implemented a series of fiscal measures that aimed to increase revenue from natural resource extraction by encouraging private ownership of mines. In 2009, the National Fiscal Stabilisation Levy was implemented, imposing an additional 5% levy on the profits (before tax) of businesses in specific industries, including mining. Mineral and Mining Act, 2006 (Act 703) was revised in 2010 and renamed The Mineral and Mining (Amendment) Act, 2010 (Act 794). The Amended Act established a uniform 5% royalty charge across the board, repealing the sliding scale of 3% to 6% of Act 703. Additionally, beginning in 2012, a 10% rise in the corporate tax rate from 25% to 35% was enacted effectively (Bebbington et al. 2018). The successful implementation of the higher corporate tax rate and the 5% royalty rate resulted in an increase in government mining revenue. By 2020, the mining and quarrying sector was the largest source of direct domestic revenue in Ghana, contributing GH 4.172 billion to the national fiscal purse (Ghana Chamber of Mines 2021). Mineral royalties climbed by 38.20% in 2020, from GH 1.007 billion in 2019 to GH 1.391 billion in 2020, as gold prices increased significantly (ibid). It is worth emphasizing that, despite this growth in mineral royalties, only

41 The term ‘sharp increases’ in ecological footprints refers to the unprecedented ecological footprints driven largely by small-scale mining activities. Massive land degradation, forest reserve encroachment and water resource pollution are among these ecological footprints.
about 13% is retained for development in mining communities. Approximately 5% of the overall royalty amount is distributed to the District Assemblies, while 4% is distributed to the Mining Community Development Scheme (MCDS) established under the Minerals Development Fund Act\textsuperscript{42}, 2016 (Act 912). The remainder is distributed to traditional authorities and stools/skins\textsuperscript{43} in the host mining communities (ibid). However, there is clear evidence that payments to traditional councils and stools are frequently used to subsidise expenditures unrelated to the interest of the local communities" (ICMM, 2007, p. 77 cited in Bebbington et al. 2018). On this basis, it might be argued that increases in mining revenue primarily benefit the state and, to a lesser extent, traditional authorities, with little benefit to host communities. This obstacle explains the lack of infrastructure in most mining settlements and the engagement of some subchiefs and young people in illegal small-scale mining, as detailed in subsequent chapters of this thesis.

Act 703 was amended again five years after it was enacted as The Mineral and Mining (Amendment) Act, 2015 (Act 900). The new modifications prescribe the method in which royalties are to be paid; the confiscation of equipment used in illicit small-scale mining; and other topics (Republic of Ghana 2015, p. 2). Additionally, the amended act, among other things, prescribed penalties for violations in the small-scale mining sector, including a fine of up to 3000 penalty units or a term of imprisonment of up to five years, or both, for individuals who engage in the illegal sale or purchase of minerals or small-scale mining operations. Foreigners convicted of engaging in small-scale mining operations faced a fine of not less than 30,000 penalty units and not more than 30,000 penalty units, or a sentence of imprisonment of not more than twenty years, whichever was greater. Ghanaians who employ foreigners in unlawful mining activities face further penalties. These amendments to the Act reflect the rapid growth and diversification of the small-scale mining sector.

\textsuperscript{35}The Minerals Development Fund was created to foster socio-economic development in mining communities. The fund provides financial resources for the implementation of development plans in mining host communities. 

\textsuperscript{43}Chiefs’ authority is symbolised by a stool and a skin in the southern and northern regions of Ghana, respectively.
Following the financial crisis of 2008, gold prices on the world market began to rise (Figure 5.1). This exceptional increase in gold prices sparked widespread small-scale gold mining in several nations worldwide (Bryceson et al. 2014; Alvarez-Berrios et al. 2016; Bose-O’Reilly et al. 2016; Krätz et al. 2017; Hausermann and Ferring 2018; Hausermann et al. 2018; Barenblitt et al. 2021). In Ghana, there has been an inflow of people, primarily Chinese, into the small-scale mining business. During this time, the methods of operation for small-scale mining evolved from the use of simple instruments such as pickaxes and shovels to the use of sophisticated machinery such as excavators and suction equipment (Crawford et al. 2016). This adjustment was made to increase production and profit margins in light of the increased gold price. The engagement of foreign nationals, primarily Chinese, has significantly mechanised and intensified the small-scale mining sector in Ghana (Crawford et al. 2016; Crawford and Botchwey 2017). These foreign nationals expanded gold output by introducing new technology, machinery, and considerable quantities of financial capital into the small-scale sector. Indeed, small-scale mining accounted for 43% of total gold production in Ghana in 2018 (Minerals Commission 2019 cited in Adu-Baffour et al. 2021). However, these advances in output come at the expense of the terrestrial biosphere, leaving it with significant and radical ecological footprints (See Map 5.1). According to a recent study by Barenblitt et al. (2021),

*Figure 5.1: World gold price (US$/troy ounce), 2000 to 2020.*

*Source: Author’s Construct with data from World Gold Council, 2021*
the cumulative footprints of small-scale mining can be greater than those of industrial mining on a big scale.

Map 5.1: Satellite image showing the dramatic footprints of mining in southwestern parts of Ghana as of March 2020

Source: NASA Earth Observatory, 2020

5.2.6 2016 to 2021: persistence of resource nationalism and gradual decrease in ecological footprints

In response to appeals from individuals, civil society groups, mining communities, media organisations etc for government to address the rising ecological footprints from small-scale mining, the government since 2016 has embarked on multiple interventions. Among these interventions, the Inter-Ministerial Committee on Illegal Mining\(^4^4\) (IMCIM) was established. The IMCIM had duty inter alia to monitor the enforcement of the ban on all small-scale mining.

\(^4^4\) The committee was made up of Ministers of the following ministries: Environment, Science, Technology, and Innovation (MESTI), Lands and Natural Resources, Local Government and Rural Development, Chieftaincy and Religious Affairs, Regional Re-Organisation and Development, Monitoring and Evaluation, Water and Sanitation, Interior, Defense, and Information.
A task group referred to as ‘Operation Vanguard’ formed from the military and the police were tasked to ensure compliance with this restriction. This resulted in the arrest of many miners who disobeyed the order. Additionally, numerous excavators and other heavy-duty equipment used in small-scale mining operations were seized. A temporary prohibition on the importation of excavators into Ghana also came into effect on the 1st of May 2019.

Several corruption allegations have been levelled against some IMCIM leaders, and excavators seized from illegal small-scale miners have gone missing. In the study district, members of the Operation Vanguard task force were accused of receiving payments and permitting small-small miners to work (ORH_02_DT). These allegations and assertions tarnished the reputation of the IMCIM. It must also be mentioned that, despite these claims which were believed to have harmed the performance of the IMCIM, their actions chalked some accomplishments. For instance, it was reported that the turbidity of several rivers, including the Ankobra, had decreased. That notwithstanding, the ecological footprints were still large requiring the President of Ghana to urge for a “open and honest conversation” on small scale mining during his 2020 final State of the Nation’s speech to Parliament. In January 2021, the President dissolves the IMCIM and in April 2021, the first-ever National Consultative Dialogue on Small Scale Mining was conducted in Accra. Following this national dialogue, Regional Dialogues were held in various parts of the country. The final statement of the national discussion underlined, among other things, that galamsey poses a significant threat to the future of water resources in general and the environment in particular and urged for immediate and coordinated actions to address it as a national emergency (Ministry of Lands and Natural Resources 2021a).

As a result of the dialogue, renewed action and dedication to ‘combat’ unlawful small-scale mining have occurred. A new task force comprised of military personnel, dubbed ‘Operation Halt’, has been launched to combat unlawful mining activity. The activities of Operation Halt have been acrimonious, involving the outright burning of excavators. Operation Halt is estimated to have destroyed 49 excavators, 228 changfans, and 87 water pumping machines, among other mining equipment, as of May 2021 (Graphic Online 2021). Although these dramatic acts, particularly the burning of excavators, have drawn widespread condemnation, they have been justified by the President, who has dared those who disagree to sue the government in court.

Additionally, the Acting Chief Executive Officer of the Minerals Commission stated that wetlands, forest reserves, and bodies of water have been designated as ‘red zones’ where no
Chapter 5: Historical political ecology of agriculture in Ghana

mining activities are permitted. The government has asked the Ministry of Lands and Natural Resources to suspend all mining reconnaissance and prospecting activities in national forest reserves until further notice. The Minerals Commission has also been directed to halt the processing, distribution, and renewal of reconnaissance and prospecting licenses for forest reserves in accordance with this prohibition. The order was issued pursuant to Section 4 of the Minerals and Mining Act, 2006 (Act 703), which provides that the Minister for Lands and Natural Resources has the power to reserve land from mining (N Dowuona & Company 2021). These directions are long overdue, given that spectacular small-scale mining operations in water bodies and forest areas have been occurring for over a decade. Permits for large-scale mining operations, including reconnaissance studies, in forest reserves are insufficient considering the importance of forest reserves to the ecosystems of the country and the world at large. This authorisation implies a focus on economic advantages at the expense of the environment. It is important to emphasize that, despite some criticism from industry participants and academics, the cumulative effect of efforts to clean the small-scale mining sector has resulted in some gains in terms of ecological footprint reduction. For instance, some bodies of water were less muddy during the guidelines' peak implementation. Regardless, reports and observations from several mining sites indicate that a significant number of illegal small-scale miners have resumed operations, wreaking havoc on the natural ecosystems that the country wanted to protect.

The government to curb the illegal mining activities and the harmful repercussions has initiated the community mining programme (CMP). At the time of the study, there is no blueprint describing the nuances of this programme. However, the programme was announced in several localities including Adomanu in the Adansi North District, Mfante in the Ahafo Ano North Municipality etc. Over 20,000 miners were recorded to have enrolled with the scheme and a total of 328 concessions in 16 mining districts had been delineated and mapped for the programme (MESTI 2020). According to Professor Kwabena Frimpong-Boateng, the former Minister of Environment, Science, Technology, and Innovation, the community mining programme is “a major step towards reducing illegal small-scale mining, formalising mining activities as well as give all miners training and official cover” (MESTI 2020). Professor Frimpong-Boateng goes further to explain that “unlike the old practice where small-scale mining was done haphazardly, the CMP will be inclusive, well-regulated with a dedicated central processing site sufficiently equipped. It [CMP] would cease the ancient practice of mining in water bodies and the earnings would be well apportioned to all relevant bodies”.

116
The community mining programme is supposed to equip small-scale miners with sustainable mining skills and offer them special concession to mine. This aside, it is difficult to differentiate which small-scale mining activities are illegal and those that are not because of the CMP as many miners involved in illegal mining hide behind the CMP to maintain their illegality by pretending, they have obtained training to engage in sustainable mining (KII_09_M_LS). The following section provides an overview of the agricultural subsector.

5.3 Overview of the agricultural sector of Ghana

In comparison to the industry and service sectors of the economy of Ghana, agriculture contributes the least to gross domestic product. Despite this, the sector is the second largest employer in Ghana, amid the falling employment contribution of the sector during the last two decades (See Figure 5.2)

![Percentage Share of Total Employment](image)

**Figure 5.2: Percentage share of total employment in the economy**

*Source: Author’s Construct with data from the International Labour Organisation, ILOSTAT database.*

Crops (including cocoa), livestock, forestry and logging, and fishing compose the agriculture sector. The crop subsector (which includes cocoa) is the major component of the sector,
accounting for approximately 85% of the overall value of the sector. Crop cultivation is prevalent in Ghana, as it is in other parts of Sub-Saharan Africa. Like the mining sector, smallholder farming and agriculture in general have seen several economic and structural changes over the last few decades. The following subsections will examine the evolution to the current state of the agricultural sector, as summarised in Table 5.2.
### Table 5.2: Periodisation of the agricultural sector of Ghana: actors; key policies/reforms

<table>
<thead>
<tr>
<th>Period</th>
<th>Dominant actors</th>
<th>Ecological Footprints</th>
<th>Key Policies/Reforms</th>
</tr>
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<tbody>
<tr>
<td>Pre-colonial</td>
<td>Chief, families</td>
<td>Limited ecological footprints</td>
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| 1874 – 1956: Colonial Era and attempts at commercialising agriculture | Colonial authorities, chiefs, | Emergence of increasing ecological footprints | • Plantation Farms  
• Agricultural Marketing Boards |
| 1957 – 1970s: Early Post-Independence Reforms | State farms, chief, international funders, peasant farmers | Increasing ecological footprints | • Socialist approach to agricultural modernisation  
• Establishment of state farms and formation of workers and farmers’ Brigades  
• Operation Feed Yourself Programme  
• Operation Feed Your Industries |
| 1980s-2000: Liberalisation of agricultural system and continued promotion of export crops | International funders (IMF and World Bank), Foreign capitalists and national capitalists, chief | Increasing ecological footprints | • Structural Adjustments |
| 2000s-2021: Agricultural modernisation, rural development, and poverty alleviations | International funders (IMF, World Bank, USAID, GIZ, FAO etc), Foreign capitalists and national capitalists; chief | Sharp ecological footprints | • FASDEP I & II  
• METASIP I & II  
• Investing for Food and Jobs |
5.3.1 Pre-colonial: subsistence agriculture and limited ecological footprints

During the pre-colonial era, agriculture, particularly crop farming, was conducted using extensive agricultural methods due to the abundance of lands and relatively low population densities. In other words, farmers engaged in shifting cultivation to either increase crop yields or expand their farms by cultivating new and well-endowed lands. During this period, labour access was significant to the agricultural sector. In comparison to the availability of land, labour was scarce. Labour was primarily obtained from family sources, which explains why family sizes were so large during those times. The critical role of labour in agriculture necessitated the establishment of institutions regulating labour, such as the family, kinship systems, and slavery. Crop farming was primarily subsistence agriculture during this era. Prior to colonisation, there is a dearth of historical data on the ecological footprints of agriculture in Ghana. However, the primitive methods of agriculture used during this period (such as shifting cultivation and bush fallow) and the resulting utilisation of multiple fields at various locations provide insight into land use and ecological implications. Even though primitive agricultural traditions necessitated the use of large areas, limitations in labour access and a relatively small population precluded the establishment of very large farms. Thus, one could argue that, while land and forest clearance for agricultural purposes left ecological footprints, these footprints were relatively small.

5.3.2 1874-1957: Colonial era and attempts at commercialising agriculture with its associated emergence of increasing ecological footprints

During this period, two agricultural systems were defined by their scope of operation and variety of crops farmed. These were two distinct agricultural systems: European and indigenous peasant agriculture (Dickson 1969). European agriculture was characterised by ‘kitchen gardens’ that were the property of European castles and plantation estates. The kitchen gardens provided food for the castles and served as testing grounds for new food crops. Such successful new crops were eventually disseminated to the general farming community with the assistance of slaves employed at such food stations. On the other hand, plantation farms were established by the Dutch and were primarily used to cultivate export crops. Along with coffee, cotton, and tobacco, oil palm was the most important export product farmed by plantations. These plantations represented the first attempt in Ghana at commercial agriculture. This endeavour is a subset of wider colonial capitalism, like what occurred in the mining sector, as detailed above. It is worth noting, however, that despite these efforts, which lasted from the early 1800s to
around 1850, the plantation farms were not particularly successful, due in part to inter-ethnic conflicts, inter-colonial disputes over territorial expansion and acquisition, and the British colonial rulers' negative attitude toward the plantation system, who believed that traditional farming systems were more economically resilient than large plantations (Huddleston and Tonts 2007, p. 268). The colonists believed that obtaining enormous expanses of land for plantations would alienate peasants, jeopardise their export production system, and incite local opposition and conflict (Gyasi 1996). On the other hand, indigenous peoples practiced peasant agriculture on a small scale, mostly for subsistence. In contrast to the mining industry, where chiefs' authority and ownership of mineralised land has dwindled, most colonial chiefs retained significant control over agricultural lands. Without the approval of the chief, peasant farmers were unable to clear and sow land. Farmers were also forced to work communally on the farms of chiefs before being allowed to work independently, and a portion of the proceeds from the sale of produce from individual farms was needed to be paid to the chief as farm rent (Dickson 1969). This means that when minerals are discovered on agricultural land, chiefs lose both revenue and labour. From 1900 to 1950, the Department of Agriculture was responsible for training farmers and assisting them in producing large amounts of high-quality export crops. This indicates that peasants were realigned to produce for the capitalist system rather than for domestic needs. This trend has persisted to the present, with non-export agriculture receiving significantly less state investment than export agriculture. Apart from cocoa, agriculture is harmed by its inability to establish value chains for non-traditional export crops (Hazell et al. 2019; Lambert 2019). Cocoa became the primary export product of Ghana in the 1920s, eventually displacing oil palm. The swollen shoot disease, which threatened cocoa production in the 1940s, exemplifies the overdependence of the agricultural sector on cocoa and its neglect of food and other cash crops. Among other things, a 1948 Commission of Inquiry confirmed this disrespect for alternative crops, prompting the founding of the Agricultural Produce Marketing Board in 1949 to encourage farmers to diversify their cash crops (Lambert 2019).

During the colonial era, agriculture, like mining, developed an increasing ecological footprint. The establishment of plantation farms devoted to monoculture farming of cash crops such as cocoa, oil palm, and rubber signalled the beginning of expanding ecological footprints. The most significant ecological footprint during this era was the destruction of forest ecosystems, as production of these cash crops thrives in the forest agroecological zones\textsuperscript{45} of Ghana.

\textsuperscript{45} The different agroecological zones of Ghana are discussed in subsequent subsection.
Additionally, further ecological footprints may result from improper agrochemicals usage, which was an essential element of plantation farming, in addition to its highly mechanised nature and extensive use of hired labour. Despite this, plantation farming had a negligible impact on the environment during this era (Gyasi 1996), as the Dutch-introduced system was not well received by the British colonial authorities. Following independence, the agricultural sector of Ghana, like the mining sector, saw significant reforms. The subsections that follow detail these reforms.

5.3.3 1957 - 1970s: Early post-independence reforms and its associated increasing ecological footprints

Following the independence of Ghana in 1957, the ruling Convention People Party government, led by Dr Kwame Nkrumah, embraced a radical socialist development model that included industrialisation. Modernisation of agriculture was deemed crucial to this new vision of an industrialised Ghana. As a result, the Agricultural Development Corporation (ADC) was founded with the mission of modernising agriculture and promoting agricultural development. The ADC was entrusted with promoting mechanised and diversified agriculture (Amanor 1999; Lambert 2019) with a beginning budget of £100,000 (Lambert 2019). The ADC was liquidated in 1962 due to serious financial difficulties, and the State Farms Corporation (SFC) was founded the same year. The SFC enabled the establishment of new large-scale state farms. The state farms were established to provide jobs in rural areas, to feed the growing population in the country, to modernise the agricultural sector, and to expedite the industrialisation of the country (Lambert 2019).

Despite this goal, state farms concentrated on the production of raw materials for agribusinesses such as rubber, cotton, sugar, and oil palm. Only 40% of the entire land area of state farms was set aside for food crops, chiefly maize (*Zea mays*) and rice (*Oryza sativa*) (Hansen, 1989 cited in Amanor 1999). This demonstrates a profound contempt for food crops and a reliance on peasant farmers to provide the food requirements of the country. Regrettably, peasant farmers are unable to meet the demands of an expanding population, necessitating food importation. Current trends follow a similar pattern, with an increased reliance on imported foods. Expropriation of existing agricultural areas and secondary forest readily accessible by road, rather than virgin forests, was also associated with state farms. As a result, the state and farmers who have lost their farms and livelihoods have become outraged. Lambert (2019, p. 39) quotes a desperate coconut farmer who lost his farm to SFC as saying, “It was by force.
[Whether] you like it or not, you have to obey.’…They [SFC] scattered everything. … It reduced the town’s progress. All of a sudden, everything [was] destroyed”. It is conceivable to extrapolate from this quote the impunity with which the state exploits its power over land resources. This resulted in opposition to the SFC from stool chiefs, community leaders, and farmer proprietors.

During this period, the Workers and Farmers Brigades were formed. Although the initial objective was to handle rising unemployment rates and accompanying demonstrations by school dropouts, ex-servicemen, and other community members, brigaders were changed into an “autonomous agricultural army” focused on food production in 1960 (Hodge 1964).

Following President ’the overthrow of Kwame Nkrumah in 1966, his socialist approach to agricultural modernisation in favour of private capitalist agriculture was abandoned. Several previously existing state farms were abolished or privatised. Subsidies on imported machinery and farm inputs were offered by the government to private large-scale farmers, which included military officers, urban bureaucrats, civil servants, and entrepreneurs.

In response to escalating food import costs\textsuperscript{46}, the 1970s saw the establishment of the ‘Operation Feed Yourself Programme (OFYP)’ as a new agricultural trajectory. The stated objective of the programme was to increase domestic food production. With the assistance of donor organisations, integrated development programmes such as the Upper Regional Integrated Agricultural Development Programme and the Northern Regional Integrated Agricultural Development Programme were launched. These programmes aimed to increase food production, rural incomes, and social services. However, Amanor (1999) asserts that additional funds designated for these programmes ended up in the hands of affluent farmers. The poor peasant farmers intended for such programmes were disregarded in their conception and implementation, and despite the provision of incentives on machinery and inputs, the affluent capitalist farmers reaped the greatest benefits (Hansen, 1989 cited in Amanor 1999). Closely following the OFYP was the ‘Operation Feed Your Industries’ project, which was undertaken between 1972 and 1974 with the goal of producing raw materials for Ghanaian industries.

\textsuperscript{46} Ghana spent over £26, 000,000 on food imports in 1961(Lambert 2019)
In the 1970s, Ghana created a successful collaboration between large-scale and small-scale peasant agriculture to achieve a single national goal of providing export crops and raw materials for industry (Yaro et al. 2016; Teye and Torvikey 2018). Three agricultural approaches were in use: plantation farming, outgrower farming, and clusters of medium and large commercial farms. The plantation model involved enormous tracts of land dedicated to a single crop that were all owned and operated by the same organisation. Numerous farmers worked under contract with a mother entity, utilising personal land and, in some cases, corporate land, under the supervision and control of the mother business.

Due to the suitability of contiguous land tracts for high-demand commercial goods, clusters of commercial farms developed, culminating in mass land leases/sales to wealthier farmers (Yaro et al. 2016). Using a collaboration with the World Bank, the National Redemption Council (NLC), a military administration led by Ignatius Kutu Acheampong, was able to graft peasant farmers into the capitalist system as contract farmers who produce for commercial firms. This alliance set the stage for the complete liberalisation of agriculture in the 1980s, as well as the promotion of export crops through structural reforms, as discussed in the next subsection.

It is important to highlight at this point that the renewed focus and concentration on plantation planting as part of the agricultural modernisation push resulted in increased ecological footprints during this era. Among the most significant ecological footprints identified were deforestation caused by the removal of natural vegetation to make way for monoculture plantations; pollution caused by agrochemicals used to increase crop yields and control pests and weeds; and environmental pollution caused by palm fruit and oil palm effluents (Gyasi, 1990, 1996). Gyasi (1996, p. 352) asserts that “the resilient, diversified indigenous agriculture, modelled on the forest ecosystem and based on eco-farming principles borne out of the peasants' intimate knowledge of the natural environment, is being replaced by the risk-prone monocultural system, with devastating results for the forest ecosystem”.

5.3.4 1980s - 2000: Liberalisation of agricultural system, continued promotion of export crops and its associated increasing ecological footprints

As indicated previously in this chapter, Ghana initiated the Structural Adjustment Programme (SAP) in 1988 as part of its Economic Recovery Programme (ERP). It is worth noting that the World Bank and International Monetary Fund (IMF) championed neoliberal agriculture and trade agendas, which resulted in the implementation of the SAP. Numerous groups in Ghana,
including civil society organisations, university professors, farmers, and city dwellers, articulated contradictory narratives about the detrimental effects of SAP on livelihoods (Teye and Torvikey 2018). Despite this, the government of Ghana was forced to embrace the recommended reforms of the SAP to qualify for IMF and World Bank loans and grants to assist the struggling economy of the country (ibid). The economy of Ghana was transformed by the SAP, and agriculture was no exception. Promoting cash crops at the expense of food crops for local consumption, as well as eliminating and/or reducing agricultural input subsidies, are all characteristics of SAP in agriculture (Mohan and Chiyemura 2020). In Ghana, particular SAP reforms in the agricultural sector included the elimination of subsidies, the disbandment of marketing boards, the promotion of export crop production, the administration of land tenure to facilitate foreign direct investment, and trade liberalisation (Amanor 1999; Yaro et al. 2016; Benin 2019).

The SAP reforms had a wide range of repercussions on agricultural investments, with implications for crop output and peasant farmers' overall well-being. For instance, the Ghana Cocoa Board\footnote{The Ghana Cocoa Board (GCB), formerly Ghana Cocoa Marketing Board (GCMB) was founded by ordinance in 1947, with an initial working capital of €27 million (Ghana's share of the net profit of the West African Produce Control Board) (Ghana Cocoa Board 2021). In 1984, an act of parliament (GHANA COCOA BOARD ACT, 1984 P.N.D.C.L. 81) was passed to constitutionalise the board and to change its name from GCMB to GCB. The mission of the board is to encourage and facilitate the production, processing and marketing of good quality cocoa, coffee and sheanut in all forms in the most efficient and cost effective manner) (Ghana Cocoa Board 2021).}, the organisation responsible for the cocoa subsector, spent substantially more than the government on the non-cocoa subsector, which included food staples. For a decade, agriculture expenditure on the cocoa subsector was 5.9% in absolute terms and 70% in terms of production value (1982-1992). During the same period, just 1.1% and 2.5% of total expenditures were made in the non-cocoa subsector, respectively (Benin 2019). While government financing for the non-cocoa subsector remains minimal, it climbed from 1.1% in the preceding decade to 4.9% between 1993 and 2000 (ibid).

Increased government spending on the cocoa subsector reflects the prominence of cocoa as an export crop in comparison to other cash and food crops, as seen by the increase in production outputs since the SAP began in 1983. (See Figure 5.3). Additionally, it demonstrates adherence to the Bretton Woods institutions' policy guidelines to promote export crops. To aid in diversification away from cocoa, the World Bank-financed Oil Palm Development Project...
(OPDP) - Phase II (1984–1988) was also launched, as was the World Bank-financed Agricultural Diversification Project (ADP) from 1991 to 1999 (Teye and Torvikey 2018).

![Graph](image)

**Figure 5.3:** (a) Production output for cocoa and oil palm fruit (b) Production output for other cash crops

*Source: Author’s Construct with data from FAOSTAT (2021)*
As illustrated in Figure 5.3, cocoa production had recovered its negative percentage decline by 1985 (18% and 17% in 1982 and 1983, respectively). Except for the years 1987, 1991, 1993, and 1998, when production fell significantly, cocoa output has been consistently increasing. In the 1980s, oil palm production continued to drop, with more oscillations in the 1990s. Additionally, the value of cashew as a cash crop may be seen. Cashew production, which remained nearly constant between 1987 and 1993, more than doubled in 1994. Other cash crops have not increased significantly during the last two decades and have varied. Except for cotton seed, which climbed to an average of 20,214 tonnes in the 1990s, and rubber, which produced an average of 6940 tonnes over the same period, all other cash crops produced less than 2500 tonnes. These numbers illustrate the benefits accrued because of the 'increased investment in cash crops. In the 1980s, production output for most major food crops fluctuated but began to increase in the 1990s (See Figure 5.4). Cassava (*Manihot esculenta*) and yam (*Dioscorea*) produce the highest yields, whereas roots and tubers produce the lowest. Peasant farmers generated a greater proportion of these food crops as outgrowers for privately owned medium-scale farms. Privatisation of state-owned farms boosted private sector participation in 'the agricultural sector of Ghana.

![Production Output for Major Food Crops (1980 to 2000)](image)

*Figure 5.4: Production output for major food crops from 1980 to 2000*

*Source: Author’s Construct with data from FAOSTAT (2021)*
Additionally, the government lavished emphasis on the 'non-traditional' export industry during this era as part of trade liberalisation and efforts to diversify the economy. Agriculture, processed/semi-processed goods, and industrial art and craft (handicrafts) are three key subsectors of the non-traditional export sector (NTES) (GEPA 2019). Agriculture includes agricultural products such as pineapple, mango, and chilies. The processed and semi-processed subsectors include furniture components, veneer, plywood, canned fruits and vegetables, and chocolate, while the handicraft subsectors comprise decorative ceramics, carvings, floor tiles, textile ('kente') carvings, and other goods. Ghana Export Promotion Authority (GEPA) was established in 1969 by Act of Parliament (ACT 396) with the mission of developing and promoting the non-traditional sector of Ghana. The mandate of this institution was strengthened with the introduction of the SAP reforms, which intended to diversify the Ghanaian economy. According to Addo and Marshall (2000), the political commitment to the NTES in 1983 as part of the ERP marked a sea change in the focus, emphasis, and structure of national economic development policy. The authors noted that the commitment of the government to promote diversification necessitated the implementation of new policies and programmes to address the NTES' major constraints, which included a deficient manufacturing base, high domestic production costs that resulted in uncompetitive global prices, a lack of funding, inadequate marketing infrastructure, insufficient export incentives, and a lack of capital.

Export-free zones (EFZs) were created to incentivize food processing enterprises to add value to agricultural products, diversifying the economy. Businesses operating within the EFZ are entitled for a variety of incentives, including duty and tax exemptions. These initiatives were designed to attract international investors. Additionally, many of the state-owned farms and manufacturing enterprises that existed during the early post-colonial eras were sold. For example, in 1995 and 1996, foreign investors acquired Ghana Oil Palm Development Corporation (GOPDC) and National Oil Palms Limited, respectively (Teye and Torvikey 2018). These ownership changes benefited the private sector and foreign investors, but they also affected individual workers who were laid off because of state-owned firm divestitures. Moreover, landowners benefited significantly from increased rents, increased employment, lower wages, and improved producer prices for export commodities (Sawyerr 1988). Further, the emphasis on cash crops rather than food crops aggravates the plight of peasant farmers. Not only were peasant circumstances aggravated, but also the ecosystems. The cropland of Ghana has increased steadily since 1980, peaked in 2004, and then begun to drop, albeit mildly and above pre-1980s levels (See Figure 5.5). These expansions will have a significant impact on
forests and biodiversity. Benhin and Barbier (2001, 2004) discovered that cocoa crop expansion and timber extraction are significant proximate causes of forest land loss in Ghana during a theoretical and empirical examination of the effects of structural adjustment programmes on forest loss from 1965 to 1995. These effects were found to be diminished following SAP because of increased investment in existing cocoa farms due to increasing cocoa producer prices, the availability of necessary inputs, and other initiatives aimed at rehabilitating existing cocoa farms (ibid).

These findings shed light on the ecological footprints of nineteenth-century agriculture. Due to increased croplands and outputs during this era, as indicated previously, and the findings of Benhin and Barbier (2001, 2004), it is reasonable to deduce that the ecological footprint of agriculture expanded as well. To mitigate some of the effects of SAP, particularly among peasant farmers in rural areas, agricultural policies in the 2000s emphasized rural and agricultural development. The next subsection discusses the policies that have been developed and their implications.
Chapter 5: Historical political ecology of agriculture in Ghana

5.3.5 2000-Date: Agricultural modernisation, rural development, and poverty alleviation

The objective of the agricultural sector for this time period is to establish “a modernised agriculture culminating in a structurally transformed economy and manifested in food security, employment opportunities, and reduced poverty” (MoFA 2010, 2018a). This perspective is based on the narratives of international funders that agriculture policies should be tied to rural development initiatives and agricultural modernisation programmes. This narrative was marketed against the backdrop of the various economic issues in Ghana at the time, notably high poverty rates (31.9 %) countrywide and significantly higher rates (43.7%) in rural areas in 2005/2006. (Ghana Statistical Service 2014b, 2018). Thus, agricultural policies and programmes were carefully developed to align with the aims of international development donors (Teye and Torvikey 2018), with a focus on input provision, agricultural marketing, value addition, and rural infrastructure. Various agricultural policies and investment plans had the purpose of modernising agriculture, alleviating poverty, promoting rural development, and ensuring food security. Specifically, and in accordance with regional policies, the policies/investment plans are aimed at transforming the agricultural sector by investing at least 10% of the national budget in agriculture and achieving an annual sector growth rate of at least 6% during the plan term (MoFA 2007, 2010, 2018a).

The Food and Agriculture Sector Development Policy (FASDEP I) was developed in 2002 in accordance with the Accelerated Agricultural Growth and Development Strategy. The primary objective of the policy was to modernise the agricultural economy of Ghana, with a particular emphasis on enhancing private sector as a growth engine (MoFA 2007). This demonstrates that, notwithstanding ‘the reorientation of agriculture toward poverty alleviation, capitalist mechanisms continued to drive these activities. “… [FASDEP II] was developed with all sector stakeholders playing a role when it was recognised that the farming population was not homogeneous and that there was a need to take care of all the different groups and stakeholders (KII_005_F_NS)”, a Director at the Ministry of Food and Agriculture (MoFA) explained. Although the policy does not include specific provisions for smallholder farmers or other types of farmers, the FASDEP II was created to solve the flaws of FASDEP I, which were labelled a “one-size-fits-all” policy (KII_005_F_NS).

FASDEP I was implemented in accordance with the then-current Medium Term National Development Framework (MTNDF) of the country— the Ghana Poverty Reduction Strategy (GPRS I, 2003–2005), which included a focus on rural poverty reduction. FASDEP II was
implemented in accordance with the MTNDFs for the Growth and Poverty Reduction Strategy II (GPRS II, 2006–2009) and the Ghana Shared Growth and Development Agenda (GSGDA, 2010–2013 and 2014–2017). At the time of this research (Mid 2020), planning was underway to review FASDEP II considering the evolving development framework and new declarations such as the Malabo Declaration on Accelerated Agricultural Growth (KII_005_F_NS).

A Medium-Term Agriculture Sector Investment Plan (METASIP) is designed to guide agricultural sector investments and to operationalise the objective of the MTNDF through the national FASDEP, global, and regional development strategies. It is essential to understand that, while the FASDEP contains long-term agricultural policy directives, the METASIPs are investment plans that carry out those goals. Thus, in anticipation of the new FASDEP, the current METASIP III (2018-2021) has already been renamed “Investing for Food and Jobs”48, (KII_005_F_NS) to align with the ‘the flagship programme of government dubbed planting for food and job, and to align with the current Medium-Term Development Framework dubbed “Agenda for Jobs: Creating Prosperity and Equal Opportunity for All” (KII_005_F_NS). The Investing for Food and Jobs plan is based on development frameworks such as the Sustainable Development Goals (SDGs), the CAADP/Malabo Declaration49, and the ECOWAS Agricultural Policy (ECOWAP)50. The ideas of the Investing for Food and Jobs plan are comparable to past METASIPs aimed at modernising agriculture and easing rural poverty. The primary investment areas of the Investing for Food and Jobs plan include improving farmers’ access to fertilizer and agrochemicals; promoting agricultural mechanisation, irrigation, and water management; value chain management; and climate change mitigation and resilience initiatives.

48 Planting for food and jobs is one of the central campaign promises of Ghana’s current government led by President Akufo Addo. Additionally, the campaign pledged a ‘Free Senior High School (SHS)’ and a ‘One District, One Factory’.

49 CAADP is an African-led agenda that aims to guide Africa’s agricultural transformation to ensure food security and socioeconomic progress in the long run. The 2014 Malabo Declaration is a reaffirmation of the CAADP principles adopted by AU Heads of State and Government to provide effective leadership for the achievement of specific goals by 2025, including ending hunger, tripling intra-African trade in agricultural goods and services, enhancing livelihoods and production systems’ resilience, and ensuring agriculture contributes significantly to poverty reduction.

50 The Economic Community of West Africa’s Agricultural Policy (ECOWAP) was adopted in 2005 to define the principles and objectives of the agricultural sector, the direction of agricultural development, and the intervention axes through which the sub-region can maximize its potential for ensuring sustainable food security in Member States.
It is worth noting that aligning these agricultural modernisation programmes with Medium-Term National Development Frameworks has produced some encouraging results. Poverty rates decreased from 31.9 to 23.4% in 2005/06 to 2016/17, while rural poverty rates decreased from 43.7 to 39.5% during the same period (Ghana Statistical Service 2014b, 2018). Additionally, FAOSTATS (2021) data indicate that food crops increased steadily from 2000 to 2019 (Refer to Figure 5.6). Cassava (Manihot esculenta) output climbed by 177%, while plantain (Musa paradisiaca) and yam (Dioscorea) production increased by 152% and 146%, respectively. Maize (Zea mays), millet (Pennisetum glaucum), and sorghum (Sorghum bicolor) production also grew by 172%, 12%, and 23%, respectively. Rice (paddy) cultivation increased by a large percentage (271%).

![Figure 5.6: Production output for major food crops from 2000 to 2019](image)

*Source: Author’s Construct with data from FAOSTAT (2021)*

These increases can be attributed to the Planting for Food and Jobs programme by the National Patriotic Party, which has resulted in massive investment in food crop production since 2016.
through the reinstatement of fertiliser subsidies and the provision of better seedlings. The long-term viability of the programme has been called into doubt, particularly in light of recent claims of fertiliser shortages in Ghana, which were recognised by the Ministry of Food and Agriculture (Lartey 2021a). While one of the primary causes of the fertiliser shortfall has been linked to the large debt to fertiliser suppliers by the country, the Ministry has placed the blame squarely on COVID-19 (ibid). Farmers' reliance on subsidised fertiliser, particularly peasant farmers, is in tatters, with some farmer organisations predicting a food crisis in 2022 unless the situation is resolved (Lartey 2021b).

Despite these increases in output, the modernisation thesis that is currently propelling the agriculture sector in Ghana and is championed by international funding institutions, with a greater emphasis on cash crop production and commercial agriculture, poses some challenges for peasant farmers and creates issues surrounding land ownership and management. For example, some peasant farmers have lost their livelihood and source of income because of land dispossession for commercial agriculture. This may explain why farmers continue to constitute the poorest segment of the Ghanaian population, accounting for most of the poverty in the country (Ghana Statistical Service 2014b, 2018).

While the ecological imprint of farming was not equal to that of mining throughout this era, it did expand, albeit at a higher rate than in the 1990s. This conclusion is drawn from the renewed emphasis on achieving a new green revolution for Africa (Diao et al. 2008; Toenniessen et al. 2008; Sanchez et al. 2009), which has resulted in a surge in interest and investment in large-scale farms, as well as the Ghanaian government prioritizing the adoption of contemporary agricultural technologies (Diao et al. 2014; Houssou et al. 2016; Kansanga et al. 2018a, b). The reinstatement of subsidies on agrochemicals and improved seeds, as well as the provision of subsidised and timely ploughing services to smallholder farmers, have resulted in increased farm sizes. For example, Kansanga et al. (2018b) discovered that with the advent of tractor-based mechanisation, some smallholder farmers in Northern Ghana have transitioned to the use

51 Beginning in 2007, the Ghanaian government supported the creation of private mechanisation centres, known as Agricultural Mechanisation Service Enterprise Centres (AMSEC), to supply tractor services to smallholder farmers using concessional loans (Diao et al. 2014; Houssou et al. 2016). The government imports and distributes tractors to AMSECs located in designated farming communities across the country to serve farmers in neighbouring areas with subsidised and timely ploughing services. In addition, in 2008, the National Fertiliser Subsidy Initiative was launched, facilitating local access to subsidised chemical fertilizers (Banful 2009; Yawson et al. 2010).
of tractors in land preparation, as well as substituted weeding and manure application for the use of weedicides and fertilisers, resulting in increased farm sizes. The likelihood of similar increases in farm sizes in other parts of Ghana is very high, as the agricultural modernisation projects of the government are countrywide, suggesting the expanding areas that may be deforested to make way for agricultural activity.

5.4 The flashpoints of conflict between the mining and farming subsectors, as well as how they may have played out

Ghana is divided into multiple agroclimatic zones (FAO 2005), each of which has its own individual agricultural production patterns. Three distinct agroecological zones are recognised based on climate, natural flora, and soils: the forest zone (which includes both rain and deciduous forests), the savanna zone (which includes coastal and northern savannas), and the transitional zone (Diao et al. 2019) (Refer to Map 2.1). The forest zone, which accounts for 57% of overall food crop production (Diao et al. 2019), also accounts for 61% of gold-bearing landscapes (See Map 2.1). To put it another way, the same geography that facilitates the development of food crops also facilitates gold mining. This is where tensions between the two subsectors erupt. Cash crops such as cocoa and palm plantations can only be grown in the forest zone, which includes most of the gold-bearing environment. Thus, any changes in the environment affecting gold mining or agricultural productivity have an impact on the other. Additionally, these two subsectors are very labour-intensive and require substantial amounts of water, resulting in acrimonious rivalry over access to and use of these resources. Thus, in this chapter, I will discuss some of the significant disagreements that have arisen because of past political, social, and economic structure and policy changes in these two subsectors, as well as how this has shown itself in the current heightened tensions. I must note that, to my knowledge, such historical disputes between the two subsectors have not been documented in the literature because the two subsectors have been studied independently in terms of their historical, political, social, and economic development.

Two key points of conflict and their associated ecological footprints may be discovered by a historical examination of the mining and agriculture subsectors. To begin, analogous policies implemented in the two subsectors had comparable outcomes. In this regard, the social, political, and economic conditions that facilitated gold rushes during the colonial era, with their associated ecological footprints, alienation of land by expatriates, and demotion of traditional
authority and local actors within the mining sectors, were analogous to the initial promotion of plantation agriculture, the beginning and gradual marginalisation of peasant farmers. Since these events occurred in a coincidental agroecological zone for mining and agriculture, the seeds of conflict were sown gradually, though this was not apparent at the time due to the abundance of mineral-rich lands and large tracts of fertile agricultural land in comparison to the relatively low population. The low population density, paired with the low urbanisation pressure, just lays the groundwork for future competition between the two subsectors. The post-independence era, which saw the nationalisation of mines and the implementation of the socialist beliefs of President Kwame Nkrumah aimed at modernising agriculture in Ghana, intensified the growing hostility between mining and agriculture. This is because the nationalisation of mines and the transfer of mineral rights from communities to the state resulted in the state acquiring agricultural lands rich in mineral reserves and holding them in trust for the people. This marked the start of the transition from agricultural to mining land use, which was later exploited on a local level by both political elites and illegal miners, as discussed in Chapter 7.

Second, identical political, social, and economic policies used in the mining and agriculture subsectors had antagonistic impacts, most notably during the implementation of the Economic Recovery Programme and its associated structural changes. Consider the currency devaluations, increased cocoa producer prices, and trade liberalisation policies enacted as part of SAP as illustrations of this. Due to currency devaluation in Ghana, imports were prohibitively expensive; as a result, agricultural inputs such as fertilisers and other chemicals became prohibitively expensive, particularly for the typical peasant farmer (Cheru 1992). This was exacerbated when all agricultural input subsidies were eliminated. Rising cocoa producer prices encouraged its production at the expense of food crops within agriculture. Furthermore, as part of the industrialisation drive of Kwame Nkrumah, the push for cash crops to feed agribusiness and export at the expense of food crop cultivation set the precedent for future non-recognition and undervaluation of the food crop sector, which was exacerbated by the mining sector during the height of land use competition. Additionally, trade liberalisation lowered the cost of imports and facilitated the establishment of mining organisations and operations. For example, under the SAP, trade liberalisation resulted in a massive influx of imported rice into Ghana, which is partly attributable to the failure of large rice mills in Ghana (Kranjac-Berisavljevic et al. 2003).
Simultaneously, this policy of trade liberalisation fostered small-scale and large-scale mining (Hilson 2004; Banchirigah 2006). For example, unemployment caused by industry privatisation in both large-scale mining and other economic activities is cited as a factor stimulating small-scale mining, whereas the continued expansion of large-scale mining and mining exploration activities is cited as displacing peasants and destroying natural resources (Hilson 2004). These dynamics and flashpoints of antagonistic outcomes of social, economic, and political policies affecting mining and smallholder farming have remained relatively constant over time, except for the dynamic and ecological imprints revealed in Chapters 6 and 7, as well as the implications for food security discussed in Chapter 8.

5.5 Chapter summary and conclusions
To contextualise the empirical chapters that follow, I have offered an overview of the mining and agriculture subsectors in this chapter (with an emphasis on crop farming). From pre-colonial periods to the present day, I have traced the growth of mining and agriculture in Ghana.

I have explained how mining activities in Ghana, which are like those in other African mining countries, have progressed from traditional to commercial mining over time, as well as the ecological consequences of this evolution. Prior to colonial control in Ghana, I have illustrated how farmer-miners, or farmers who grow but also mine, used mining as an alternative livelihood activity, particularly during off-farming seasons, by utilizing indigenous and appropriate technology with no or minimal ecological effect. Additionally, I have highlighted how colonialism transformed the face of mining by introducing commercial mining and its attendant seizure of chiefs' traditional rights. Further, I have discussed how the quest for gold in Ghana by European capitalists culminated in at least two gold rushes in the early 1900s, with growing consequences for the environment, land ownership, and management. Also, I have discussed how commercialisation of mined lands resulted in boundary disputes and a decline in the power of chiefs. I have then examined the substantial influence that European mining capitalist institutions wield on mining policies. Besides that, the historical review hinted at how the hybrid mining system, which combined commercial and traditional mining techniques, may have resulted in increased ecological footprints, but these were swept under the rug until their full manifestation in the 2000s due to a lack of attention paid to environmental issues.
Chapter 5: Summary and conclusions

Additionally, I have highlighted how, following independence, the state gained much power through mineral nationalism. I have detailed the enactment of legislation vesting the state with all mineral rights, as well as the dramatic engagement of the state in mining activities through the founding of State Gold Mining Corporations. These vast state powers over mining resources were intended to lay the groundwork for future confrontations between mining and agriculture, with mining taking precedence over agriculture, as will be discussed in Chapter 6.

Moreover, I have explored the direct involvement of international financing partners such as the International Monetary Fund and the World Bank in the mining sector of Ghana in the early 1980s as part of the Economic Recovery Programme in Ghana. I have shown how neoliberal policies that prioritised private sector investment in mining have resulted in increased mining investment because of the favourable environment provided for foreign mining businesses to prosper. These expanded investments were accompanied by a shift from underground to surface mining, resulting in vast ecological footprints and protracted confrontations between large-scale and small-scale mining companies and individuals. I have also detailed how small-scale mining, which had been prohibited during the colonial and early post-colonial centuries due to a mercury prohibition, was recognised by law, and a market for their outputs was formed.

I have proved in this chapter that the ecological impact of mining expanded significantly in response to rising gold prices and the evolution of small-scale mining from a low-tech to a highly sophisticated technological industry through the involvement of foreign nationals, particularly Chinese. Additionally, I have demonstrated that, while dramatic ecological footprints such as land degradation, water resource pollution, and forest depletion were recognised and institutional arrangements – including the establishment of the Environmental Protection Agency – were made to mitigate them, they were out of proportion, necessitating the adoption of radical approaches such as the use of military and police enforcement, the seizure and burning of excavators, and a nearly two-year ban on small-scale mining.

Also, I have chronicled the evolution of agricultural landscape from pre-colonial times to the present. I have explained how agriculture, which was historically centred on subsistence agriculture, has developed through time to become more export-oriented through various governmental reforms. In this chapter, I have showed how European colonists introduced plantation cultivation, which laid the groundwork for the future marketing of export crops.
I have highlighted how, shortly after independence; substantial agricultural changes based on socialist principles were enacted. These strategies aimed to modernise agriculture and accelerate agricultural industrialisation. As a result, state farms, workers’, and farmers’ brigades, and so on were established. These socialist goals did not last long, as the President was ousted, and capitalism models were pursued. Capitalist methods enabled the coexistence of large-scale and small-scale peasant agriculture. This was the start of contract farming, in which peasant farmers worked as outgrowers for huge commercial institutions that specialised in export commodities.

Further, I have demonstrated in this chapter how the neoliberal conditional reforms of the IMF and World Bank under structural adjustment consolidated the capitalist values adopted following the overthrow of Kwame Nkrumah in 1966. With a significant agricultural sector presence, the IMF and World Bank advocated for the development of cash crops, the elimination of agricultural input subsidies, and broader agricultural sector deregulation. Peasant farmers were disproportionately affected by the changes, as they were reliant on government assistance and hence unable to compete in a liberalised economy. Therefore, poverty grew worse, particularly in rural areas dominated by peasant farming. To address this, the chapter have explained that, beginning in 2000, agricultural policy reforms have been tied to rural development and poverty reduction initiatives, even though they continue to pursue modernisation.

Three important conclusions may be drawn from the historical accounts on Ghana's mining and agriculture subsectors in this chapter. To begin, the mining sector of Ghana, like others in Sub-Saharan Africa, has been linked to serious environmental consequences since the early 1980s, because of its reliance on neoliberal and capitalist ideals. However, the analyses reveal that little or no attention was paid to these ecological footprints until they reached hazardous levels, demanding dramatic interventions that may not be sufficient to reverse some of the damage. These ecological footprints have a variety of consequences for the well-being of individuals and communities living near and far from gold mining areas, but they are all connected by nature (rivers, food systems, and climate, for example), as will be demonstrated in subsequent chapters of this thesis. Second, the agricultural modernisation thesis, which is inextricably linked to the promotion of cash crops and commercial agriculture in general and has been championed by international funding organisations and adopted by successive governments,
has a sizable impact on peasant farmers, who account for much of the agricultural workforce. Income and livelihoods of peasant farmers, particularly those engaged in food crop production, are harmed, adding to the fact that peasant farmers continue to be the poorest segment of the population in Ghana and contribute the most to the poverty of the country. Third, populations living along the agroecological zone boundaries, where mining areas meet agricultural lands, are disproportionately harmed by the double-edged sword of mining and agriculture reforms. This is because of the flashpoints of conflict between mining and smallholder farming, which have been exacerbated by the concurrent economic and structural changes experienced by both sectors.
CHAPTER SIX
GOLD MINING’S ECOLOGICAL FOOTPRINTS, DRIVERS, AND FUTURE PREDICTIONS

6.1 Introduction
Numerous human-induced activities have altered terrestrial landscapes (Lambin et al. 2001). Land use and land cover (LULC) changes refer to such changes in terrestrial landscapes. Changes in LULC are a significant contributor to global environmental change (Turner, 2002, 2006) and are influenced by a variety of factors (Lambin et al. 2001; Turner 2002; Lambin et al. 2003; Steffen et al. 2004; Gutman et al. 2004; Moran and Ostrom 2005). Changes in LULC pose a significant threat to both the natural environment and human health. Among the significant impacts of LULC changes recognised in the literature are significant changes in local to global weather and climate conditions (Mahmood et al. 2010; Salazar et al. 2015; Sleeter et al. 2018), biodiversity loss (Sala et al. 2000), declines in ecosystem services (Vitousek et al. 1997; Millennium Ecosystem Assessment 2003; Costanza et al. 2014; Hasan et al. 2020), soil degradation (Trimble and Crosson 2000; Mariye et al. 2020), and impacts on water resources (Awotwi et al. 2018; Obodai et al. 2019; Tadese et al. 2020) etc.

Gold mining activities, particularly small-scale mining (SSM), have increased dramatically worldwide over the last two decades, as discussed in Chapters 2 and 5. This increase is attributed to a variety of factors, including increased global demand for gold and rising gold prices (Bryceson et al. 2014; Alvarez-Berrios et al. 2016; Bose-O’Reilly et al. 2016; Krätz et al. 2017; Hausermann and Ferring 2018; Hausermann et al. 2018; Barenblitt et al. 2021). Despite its smaller area coverage than other LULC classes, mining is inextricably linked to and significantly influences the LULC changes experienced in mining communities. Thus, assessments of historical and projected LULC changes in mining landscapes shed light on the ecological footprint of mining. Such analyses are important for the long-term planning and management of natural resources. As a result, some researchers have examined the dynamics of LULC in mining enclaves and their ecological implications (Aduah et al. 2015; Basommi et al. 2015; Abass et al. 2018; Awotwi et al. 2018; Hausermann et al. 2018; Obodai et al. 2019; Boakye et al. 2020; Forkuor et al. 2020). For example, Awotwi et al. (2018), Obodai et al. (2019), and Boakye et al. (2020) highlight the ecological consequences of gold mining in the Pra and Ankobra river basins of Ghana. Another study by Espejo et al. (2018) in the Peruvian Amazon region of south-eastern Peru demonstrates the ecological impact of gold mining on
deforestation and forest degradation. Many of these studies drew heavily on recent advances in earth observation and geospatial technologies to assess and to explain these changes. However, when advanced geospatial technologies are combined with social research techniques, elaborate, robust, and nuanced insights into dynamic LULC changes and their associated ecological footprints in mining landscapes can be gained. Furthermore, except for Awotwi et al. (2018), future LULC forecasts for mining landscapes in Ghana are uncommon. Thus, in this chapter, and in accordance with the conceptual framework outlined in Chapter 3, I evaluated the LULC dynamics and driving forces in the case study by integrating geospatial and social research techniques. Additionally, I used the CA-Markov model to forecast the future dynamics of the LULC over the next decade under ‘business as usual’ (BAU) and ‘remedial’ scenarios. The CA-Markov model is an integration of the Markov chain analysis and Cellular Automata models that is used for the simulation and prediction of land use and land cover changes (Refer to Section 4.9.6). The chapter make use of historical Landsat images, key informant interviews, documentary analysis, and observations.

I identify four distinct epochs of LULC dynamics for mining footprints based on the analysis presented in this chapter: periods of none to limited increase, gradual to accelerated increase, sharp increases, and gradual decrease in mining footprints. These LULC dynamics were found to be associated with three major ecological footprints associated with mining, both directly and indirectly: land degradation, deforestation, and water pollution and diversions. Large areas have been degraded, and the quality and quantity of natural water resources have been compromised, with numerous consequences for individuals and communities at large (as discussed in Chapters 6 and 7). Additionally, forest resources declined over the 34-year period, with a total of 27,333 ha representing 36% of forest cover being lost at an annual average deforestation rate of 1.07%. Further, forest resources declined over the 34 years period, with a total of 27,333 ha representing 36% of forest cover at an average annual deforestation rate of 1.07% being lost. Furthermore, using the CA-Markov model, the study project increases in mining and water use at the expense of forest ecosystems and their associated negative externalities under the BAU scenario. Under the remedial scenario, the study forecasts the opposite of the prediction under the BAU scenario, with forest ecosystems and livelihoods preserved. I conclude that, despite its smaller area coverage than other LULC classes, mining is inextricably linked to all of them and significantly contributes to observed LULC changes. Moreover, I argue that combining RS/GIS and social sciences methods to understand LULC
changes provides more detailed, robust, and nuanced insights into LULC dynamics than using only RS/GIS or social sciences methods.

The chapter comprises six broad sections. Section 6.1 examines observed changes in LULC in the study districts. Section 6.2 examines the trends and patterns of LULC change, while Section 6.3 examines change rates. Section 6.4 discusses the factors that contributed to the observed changes, while Section 6.5 analyses the predicted future LULC under ‘business as usual’ and ‘remedial’ scenarios for the next decade. Section 6.5 concludes the chapter by discussing the overall findings of the chapter and the conclusions that can be drawn from them.

6.2 Changes in land use and land cover in case study

As illustrated in Map 6.1, five land use and land cover maps covering the case study were generated for the study years (1986, 2002, 2008, 2015 and 2020), with six macro classes including closed forest, open forest, cropland, water, mining, and settlement/bare lands. Table 6.1 contains the corresponding statistics for the five years of various LULC and their proportions. Four distinct phases of LULC dynamics can be observed and explained in conjunction with LULC trends and driving forces of change using Map 6.1 and Table 6.1.
Map 6.1: Land use and land cover classification maps of the case study area
### Table 6.1: Area of land use and land cover (LULC) classes of the classification and the percentage area change results

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (ha)</td>
<td>% Area</td>
<td>Area (ha)</td>
<td>% Area</td>
<td>Area (ha)</td>
</tr>
<tr>
<td>Water</td>
<td>4,798</td>
<td>3.90</td>
<td>1,800</td>
<td>1.46</td>
<td>963</td>
</tr>
<tr>
<td>Cropland</td>
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<td>33.52</td>
<td>47,390</td>
<td>38.50</td>
<td>40,201</td>
</tr>
<tr>
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<td>0.00</td>
<td>480</td>
<td>0.39</td>
<td>98</td>
</tr>
<tr>
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<td>28.64</td>
<td>17,710</td>
<td>14.39</td>
<td>16,603</td>
</tr>
<tr>
<td>Settlement/bare lands</td>
<td>1,843</td>
<td>1.50</td>
<td>4,320</td>
<td>3.51</td>
<td>15,154</td>
</tr>
<tr>
<td>Open Forest</td>
<td>39,926</td>
<td>32.44</td>
<td>51,370</td>
<td>41.74</td>
<td>50,050</td>
</tr>
<tr>
<td>Total</td>
<td>123,070</td>
<td>100.0</td>
<td>123,070</td>
<td>100.0</td>
<td>123,070</td>
</tr>
</tbody>
</table>
Chapter 6: Changes in land use and land cover

6.2.1 None to limited mining footprints

The first phase (1980s), as indicated by the 1986 base map (Map 6a), is the period during which no 'visible' physical footprints of mining activities were observed on the landscape. Despite this, key informant interviews (KII) indicate that artisanal mining occurred in the study districts. However, because these artisanal mining practices occurred on small parcels of land and required the use of rudimentary tools such as pickaxes, shovels, and pans, their physical footprints were minimal and 'invisible'. Confirming the limited ecological footprints associated with mining in the past, an Assembly Member of the Amansie South District in Manso Adubia stated:

“Historically, this community was not well known for mining activities, though our forefathers did engage in some artisanal ‘galamsey’ activities. There were gold nuggets referred to as ‘nkomra’. They dug deep holes on their farms to extract these golds nuggets. It was nothing like what is currently being done, where standing here [in front of a settlement shop] you can see a vast area degraded due to gold mining using mechanics” (ORH_04_AD).

During this phase, the primary LULC were open forest and cropland. Their area coverage was nearly identical, accounting for 41,259 ha (32 % of the total land area) and 39,926 ha (34 % of the total land area, respectively (See Table 6.1). Closed forest, primarily in district forest reserve areas, followed closely behind these two LULC, accounting for approximately 35,244 ha or 29 % of the total land area. This was followed by water, which covered an area of 4,798 ha and included natural rivers, streams, ponds, and wetlands. During this period, the Offin and Oda rivers52, as well as their tributaries, were the primary water sources. In forested areas, pockets of small droplets of water can also be observed. The district portion of the Offin River is approximately 40 kilometres long, with an average depth of 12–15 meters, and flows downstream in the southwestern portion of the district. It has a catchment area of 4,400 kilometres square at the Oda River confluence (MESTI and TCPD 2013). The Oda River

52 The Oda and Offin rivers are two major tributaries of the Pra River in Ghana. Together with the main Pra river, rivers Anum and Birim, and their tributaries, they form the largest river basin of the three principal south-western basin systems of Ghana (i.e., Ankobra, Tano and Pra). The Pra River basin has a total basin area of approximately 23,200 km² with an area of 1174km² in the Amansie West and South Districts.
flows through the districts' north-western corner, eventually joining the Offin River in the south. It has a catchment area of approximately 2,800-kilometer square (MESTI and TCPD 2013) and flows downward for approximately 50 kilometres at a depth of approximately 10 to 15 meters. These two rivers serve as the dividing line between adjacent districts. Additionally, key informant and semi-structured interviews revealed that several pockets of perennial streams existed during this phase, primarily in the districts' forest areas. The built-up areas of the district were sparsely developed, and there were only a few bare lands, most likely from lands prepared for farming and feeder roads. As a result, settlement/bare lands comprised only 1.5% of total land area.

6.2.2 Gradual to accelerated increase in mining footprints
The second phase (late 1980s to early 1990s), as depicted on the 2002 classified map (Map 6b), marks the onset of active mining activities and their associated social and environmental consequences. It is worth noting that the Environmental Protection Agency was established in 1994 in response to the growing ecological footprints of mining and other subsectors. This epoch was dominated by licensed mining companies because of the economy of Ghana being restructured to provide a strong incentive for the private sector to participate in the mining industry of the country, as discussed in Chapter 4. Prior to 1986, the mining industry in Ghana was largely state-owned. The State Gold Mining Corporation (SGMC), founded in 1961, was in charge of almost all mining operations in Ghana. However, under the auspices of the World Bank and International Monetary Fund some policy reforms were undertaken beginning in 1983 with the implementation of the Economic Recovery Programme (Refer to Chapter 4 for details of the policy reforms and their implications). Among the key policy prescriptions of the economic recovery programme affecting the mining industry directly was the complete divestiture of state-owned mines to the private sector in 1986, with the government maintaining a statutory 10% free equity stake in all new mines. In addition to the Minerals and Mining Law (PNDC Law 153) enacted in 1986 to promote and regulate the consistent development of the mining sector, the economic recovery programme policies resulted in an increase in private investment capital within the mining industry of Ghana (Aryee 2001; Government of Ghana 2014). Between 1983 and 1998, the Minerals Commission of Ghana recorded a total investment of approximately US$4 billion in mineral exploration, new mine establishments, and mine rehabilitation (Aryee, 2001).
The Bonte Gold Mines was granted a license in 1991 to conduct alluvial mining along the Bonte River in Bonteso. This mine is believed to have been the only one in Ghana at the time that was permitted to mine adjacent to a river. Additionally, Amansie Resources Limited was incorporated in 1994 to conduct business in Manso Nkran (Gbireh et al. 2009). Bonte Gold Mines operated for 13 years (1991–2004), while Amansie Resources Ltd, which was acquired by Resolute Amansie Ltd in 1997, operated for eight years (1994–2002). These years correspond to the second phase of the LULC dynamics in the study area, as indicated by the 'visible' footprint of mining activities on the 2002 LULC map (Figure 1b). Mining took up 480 ha of total land area in the Bonteso and Manso Nkran areas. In comparison to the 1986 reference year, an increase in the area extent of open forest from 32 % to 39 % and croplands from 34% to 42% was observed. Additionally, settlement/bare lands increased in area from 1,843 to 4,320 ha, accounting for 3.5% of the total area extent, as new settlements developed to house farmers and other district residents. Closed forest, on the other hand, decreased significantly in size from 35,244 ha to 17,710 ha in 1986. Water resources were also reduced to nearly half their original extent in 1986. These decreases are primarily the result of the drying of small pockets of water in forested areas. Additionally, in areas closer to Keniago in the western corner of the district, the Offin river is obscured by forest cover. Illegal mining activities, particularly those involving river dredging in the upper reaches of the Offin in adjoining districts, may have also reduced river flow downstream.

6.2.3 Sharp increase in mining footprints

Phase three commences in 2008 and concludes in late 2016. Small-scale gold mining activities (both legal and illegal) increased abruptly across all mining districts in Ghana during this season, in response to increases in gold prices and other factors. This phase saw the introduction of new technology and heavy-duty machinery into the small-scale gold mining sector, including excavators and wash plants, and marks the beginning of the grave ecological footprint of the mining sector in Ghana. The period is characterised by the influx of foreign nationals, primarily Chinese, and the involvement of extremely powerful political elites in the small-scale mining sector. For example, Crawford et al. (2016 p. 4), discovered “extensive collaboration and collusion between Chinese miners and Ghanaian miners, as well as between Ghanaian traditional leaders and government officials who use their positions for private financial gain”. Almost anywhere on the earth's surface with mining deposits was mined during this period. However, riverbanks and valleys, riverbeds, cropland areas, and forest reserves
Chapter 6: Changes in land use and land cover

were among the key landscapes that felt the scorch of this era. Both the 2008 and 2015 classified maps (See Maps 6c and 6d) depict the LULC dynamics during this era.

Prior to this period, Ghana enacted the Small-Scale Gold Mining Law (PNDC Law 218), the Mercury Law (PNDC Law 217), and the Precious Minerals Marketing Corporation Law (PNDC Law 219) in recognition of the burgeoning activities of the small-scale mining sector. These laws were enacted to regulate and streamline small-scale gold mining activities, to regulate small-scale gold miners' use of mercury, and to provide a formal market for small-scale gold miners' produce (Government of Ghana 2014). As a result of these laws, some licensed small-scale mining operations occurred throughout the country, including the case study areas. Nonetheless, a sizable number of individuals and groups of individuals operate illegally and informally as small-scale miners (galamseyers) without licenses or official recognition from regulatory authorities. This has been attributed to a variety of factors, including a lack of capacity to enforce existing laws (Banchirigah 2008; Maconachie and Hilson 2011; UNDP Ghana 2017), law enforcement corruption (Abdulai 2017; Crawford and Botchwey 2017), elections and partisan polarisation (Abdulai, 2017), administrative bureaucracy and the rent-seeking behaviour of government officials (Hentschel et. al, 2002; Bockstael, 2014; UNDP Ghana 2017), and expansion of large-scale mining (Hilson and Potter 2005; Maconachie and Hilson 2011). According to an interview with a District Planning Unit official, small-scale miners account for 70% of all mining activities in the case study, with the majority operating informally and illegally. The remaining 30% are comprised of large-scale mining businesses (KII_009_M_LS). The land use land cover changes seen in the case study thus followed a similar pattern, with small-scale mining activities accounting for more than 70% of the observed changes owing to mining.

Prior to the mining activities escalating in the case study, the early part of 2008, as depicted in Map 6c, demonstrates a decline in mining activities. This decline was primarily caused by the closure of some major licensed mining companies. For instance, in 2004, the Bonte Gold Mines, which operated in the Bonteso area, had its license revoked due to environmental degradation, crop loss, and property loss. The operations of Resolute Amansie also ceased in 2002, which can be attributed to the decline in gold prices on the world market during that time. Additionally, the outbreak of Buruli ulcer in Tontokrom and other communities (Owusu-sekyere 2012), as well as the closure of four small-scale mining companies operating in the Tontokrom community due to conflict (Freiku, 2005), may have all contributed to the decline
Chapter 6: Changes in land use and land cover

in mining activities. As displayed in Table 6.1, mining expanded dramatically from 98 ha in 2008 to 4,276 ha in 2015, accounting for 3.5% of total land area. Settlements/bare lands nearly quadrupled in size from 4,320 ha (3.5%) to 15,525 ha (12.7%) in 2008. Settlement/bare land increased because of the clearing of many forests for farming and mining purposes. Additionally, numerous structures were constructed to accommodate the throngs of miners who arrived in the district to engage in mining activities. This clearly resulted in cropland and open forest losses of 47,390 ha (38.5%) in 2002 to 40,200 ha (32.7%) in 2008, and 51,370 ha (41.7%) in 2002 to 50,050 ha (40.7%) in 2008. Water collected primarily from mine pits, land surfaces, and diverted natural river courses more than tripled in size from 1,800 ha (1.5%) in 2002 to 6,170 ha (5%) in 2015. Confirming the magnitude of the water class increases in mining landscapes, a study by Hausermann et al. (2018) found that mine water increased by 13,000% to cover 200 ha along portions of the Offin River between 2008 and 2013. A greater proportion of the small-scale mining activities occurred along the major rivers' courses (Offin and Oda Rivers). Dredging for alluvial gold widened the drainage basins of these river bodies, thereby increasing the amount of water collected in them. Additionally, these river sources were diverted and piped to other locations far from the rivers to wash gold ores on land. Following that, some of the effluent collects on the land surface, while others end up in abandoned mining pits. Thus, the dramatic increases in the water land cover class can be attributed primarily to the development of several mining pits that collect water, as well as those that collect water on the land surface and those that drain into the study districts' major river systems. These water increases collected in mining pits and on the surface of the land impose significant challenges on farming and act as death traps for the study districts' residents. The following chapter will provide an in-depth discussion of several of the impacts of the growing water land cover class. Throughout this era, closed forest has decreased, reaching 13,600 ha (11.05%) in 2015. It is worth noting that other licensed medium to large-scale mining companies established new operations or acquired pre-existing operations in the study districts during this era. Among the notable companies are Asanko Gold Mines, Goldline Mining Investment Group, and Triple Key Mining Company, all of which are currently operational at the time of the study.

6.2.4 Gradual decrease in mining footprints

The final phase, which spans the years 2016 to the present, has been marked by active public activism demanding an end to illegal small-scale mining operations. This crusade was prompted by the negative ecological consequences of small-scale mining activities, which
Chapter 6: Changes in land use and land cover

include land degradation and water pollution. This era saw a renewed commitment from both
the populace and government institutions, culminating in a March 2017–December 2018 ban
on all small-scale mining activities. A task force called Operation Vanguard comprised of
military and law enforcement personnel was tasked with enforcing this prohibition. This
resulted in the arrest of many miners who disobeyed the regulation. Additionally, numerous
excavators and other heavy-duty machinery were seized from small-scale mining sites. On May
1, 2019, a temporary ban on the importation of excavators into Ghana went into effect, all in
the name of combating illegal mining activities. Despite this renewed commitment to combat
illegal mining, mining activities continue, albeit at a slower pace than during the third era.

Though at a slower pace than between 2008 and 2015, mining activities increased from 4,280
ha (3.5%) in 2015 to 55,90 ha (4.5%) in 2020, as shown in Table 6.1. In 2020, water was nearly
halved in size in reference to 2015. Croplands expanded in area from 50,600 ha (41.1%) in
2015 to 54,850 ha (44.6%) in 2020. Cropland expansion may be because of the new
government policy of planting for food and jobs, which provides farmers with free seedlings
and fertiliser. Additionally, the programme of action by Cocoa Board to reverse the trend of
farmers selling their cocoa farms by aiding with pruning and other logistical issues may have
contributed to the increase in cropland. Both closed forest and open forest land classes
experienced marginal increases. Closed forest area increased from 13,595 ha (11.1%) in 2015
to 14,070 ha (11.4%) in 2020, while open forest area increased from 32,900 ha (26.7%) in 2015
to 33,760 ha (27.4%) in 2020. Additionally, by 2020, settlements/bare lands were reduced.
Specifically, the bare lands were reduced as those created for mining activities were utilised.
Moreover, with the operations of Operation Vanguard, new bare lands were created in a
negligible amount.

6.3 Analysis of the trend and patterns of the land use and land cover changes
The diagrammatic and statistical views of the changing trends in land use and land cover from
1986 to 2002, 2002 to 2008, 2008 to 2015, and 2015 to 2020 are depicted in Figure 6.1 and
Table 6.2, respectively. The increases and decreases in LULC clearly indicate the significant
changes over the four periods, which correspond to the four distinct phases of LULC dynamics
discussed previously. As illustrated in Figure 6.1 and Table 6.2, the most significant changes
in LULC occurred between 2002 and 2008 and 2008 and 2015.
Between 1986 and 2002, closed forest lost approximately half (17,534 ha) of its total area, while water lost over 60% of its total area (See Table 6.2). Settlements/bare lands experienced the greatest change, increasing by approximately 134%, resulting in a net increase of 2,478 ha. Around 43% of the total land area covered by settlement/bare lands was transferred to other LULC classes, while 75% were transferred into settlement/bare lands. Additionally, open forest and cropland gained 11,444 ha and 6,130 ha, respectively, accounting for approximately 29% and 15% of the total changes. Areas transferred from and into open forest are 51% and 62%, respectively. Cropland area was transferred from and into other land classes at a rate of 48% and 55%, respectively.
Table 6.2: Net Area of Change and the percentage changes in the observed Land use and land cover (LULC) classes

<table>
<thead>
<tr>
<th>LULC Classes</th>
<th>1986-2002 Net area of change (ha)</th>
<th>% Change</th>
<th>2002-2008 Net area of change (ha)</th>
<th>% Change</th>
<th>2008 - 2015 Net area of change (ha)</th>
<th>% Change</th>
<th>2015-2020 Net area of change (ha)</th>
<th>% Change</th>
<th>1986-2020 Net area of change (ha)</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Forest</td>
<td>-17,534</td>
<td>-49.75</td>
<td>-1,107</td>
<td>-6.25</td>
<td>-3,008</td>
<td>-18.12</td>
<td>479</td>
<td>3.53</td>
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<tr>
<td>Cropland</td>
<td>6,130</td>
<td>14.86</td>
<td>-7,188</td>
<td>-15.17</td>
<td>10,399</td>
<td>25.87</td>
<td>4,251</td>
<td>8.40</td>
<td>13,593</td>
<td>32.94</td>
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<td>-79.75</td>
<td>4,178</td>
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<td>1,313</td>
<td>30.70</td>
<td>5,589</td>
<td>100.00</td>
</tr>
<tr>
<td>Open Forest</td>
<td>11,444</td>
<td>28.66</td>
<td>-1,320</td>
<td>-2.57</td>
<td>-17,146</td>
<td>-34.26</td>
<td>859</td>
<td>2.61</td>
<td>-6,163</td>
<td>-15.43</td>
</tr>
<tr>
<td>Settlement/bare lands</td>
<td>2,478</td>
<td>134.45</td>
<td>10,834</td>
<td>250.76</td>
<td>371</td>
<td>2.45</td>
<td>-4,217</td>
<td>-27.16</td>
<td>9,466</td>
<td>513.67</td>
</tr>
<tr>
<td>Water</td>
<td>-29,96</td>
<td>-62.45</td>
<td>-839</td>
<td>-46.52</td>
<td>5,207</td>
<td>540.87</td>
<td>-2,685</td>
<td>-43.53</td>
<td>-1,314</td>
<td>-27.38</td>
</tr>
</tbody>
</table>
Chapter 6: Changes in land use and land cover

Except for settlement/bare lands, all LULC classes lost value between 2002 and 2008. The largest change, 251%, is in settlement/bare lands, with a net increase of 10,834 ha. Only 25% of settlements/bare lands were transferred to other classes, whereas 79% of other LULC classes were transferred to settlements/bare lands. Following the greatest change in settlement/bare land, mining and water accounted for 80% and negative 47% of observed changes, respectively, with a marginal net loss of 386 and 839 ha. Closed forest continued to lose area (1,107 ha), albeit at a slower pace (6%) than in the previous period. Cropland lost the most net area (7,188 ha), while open forest lost 1,320 ha. This accounted for approximately 15% of observed changes in cropland and 3% of observed changes in open forest, respectively. Around 58% of cropland area was transferred to other LULC classes, while 51% was gained from other LULC classes.

Similar trends in LULC change observed from 2002 to 2008 were observed from 2008 to 2015. The most significant changes occurred in the mining and water classes, with these two classes recording significant net gains in area when compared to the previous period. Each of the remaining LULC classes suffered a net loss. Mining and water accounted for 4267% and 541% of observed changes, respectively, resulting in net gains of 4,178 ha and 5,207 ha. The percentage of area gained through mining other LULC classes was nearly 100%. Significant net losses in closed forest (3,008 ha) and open forest (17,146 ha) were observed, accounting for 34% and 18% of the observed changes, respectively. Cropland, on the other hand, reversed its previous net losses period to record a net gain of 10,399 ha, accounting for 26% of the observed changes. Settlements/bare lands continue to gain area, but only marginally, at 371 ha, accounting for less than 2% of the changes observed.

Between 2015 and 2020, mining and water continued to be the most dynamic LULC classes. They accounted for approximately 31% and 44% of observed changes, respectively, with a net gain of 1,313 ha and a net loss of 2,685 ha in area. Following that, settlements/bare lands changed by 27%, resulting in a net loss of 4,217 ha. Both open forest and closed forest recorded marginal net gains in area of 859 ha and 479 ha, respectively, accounting for approximately 3% and 4% of observed changes. Cropland continues to gain area (4,251 ha), but at a decreasing rate, accounting for only 8% of observed changes.
Chapter 6: Changes in land use and land cover

The changes in the various land use land cover types from 1986 to 2020 are depicted using the change maps in Map 7 (a-f). The green and red layers indicate areas gained or lost to other land uses and land cover types for each land use and land cover type respectively. The yellow layer denotes areas that have remained constant over time. The gains and losses depicted in Map 7 demonstrate the significant changes over the four periods, which correspond to the four distinct phases of LULC dynamics discussed previously.

Overall, the change maps from 1986 to 2020 (Map 6.2) and their graphical representation in Figure 6.2e indicate that significant deforestation due to the conversion of open forest and closed forest land cover to other land uses. On the other hand, mining, croplands, and settlements/bare lands all increased significantly between 1986 and 2020. Mining along the Oda and Offin rivers increased. The following paragraphs summarise the specific trends and patterns of change that occurred during each period.
Map 6.2: The gains and losses in land use and land cover classes over the period 1986 to 2020.

‘Gains’ represent an increase in a particular land use and land cover type, ‘Losses’ represent a decrease in a particular land use and land cover type and ‘No change’ represent no change in a particular land use and land cover.
6.4 Analysis of the change rates

The tables 6.3 (a, b, c, and d) illustrate the dynamic changes in land use and land cover from 1986 to 2002, 2002 to 2008, 2008 to 2015, and 2015 to 2020. The severity of the land use and land cover changes within each period can be determined from these tables.

According to Table 6.3a, the greatest change rate between 1986 and 2002 was observed in settlement/bare lands, at 1,379 ha.a\(^{-1}\). This land use class recorded transfer and gain rates of 269 ha.a\(^{-1}\) and 1,110 ha.a\(^{-1}\), respectively. Additionally, the rate of change in open forest and water is nearly identical, at 814 ha.a\(^{-1}\) and 822 ha.a\(^{-1}\), respectively. Open forest transfer and gain rates are 318 ha.a\(^{-1}\) and 497 ha.a\(^{-1}\), respectively, while water transfer and gain rates are 606 ha.a\(^{-1}\) and 2.16 ha.a\(^{-1}\), respectively. Open forest changed at a rate of 696 ha.a\(^{-1}\), while transfer and gain occurred at similar rates of 301 ha.a\(^{-1}\) and 394 ha.a\(^{-1}\), respectively. Closed forest had the lowest change rate at 325 ha.a\(^{-1}\), with transfer and gain rates of 318 ha.a\(^{-1}\) and 07 ha.a\(^{-1}\), respectively.

Between 2002 and 2008, settlement/bare land remained the land use with the highest rate of change (1,879 ha.a\(^{-1}\)) with a transfer and gain rates of 156 ha.a\(^{-1}\) and 1723 ha.a\(^{-1}\). The remaining land use and land cover classes experienced similar rates of change, ranging between 773 and 622 ha.a\(^{-1}\), with varying rates of transfer and gain (See Table 6.3b). Closed forest remained the land use with the slowest rate of change, at 132 ha.a\(^{-1}\), even slower than in the previous period.
Chapter 6: Changes in land use and land cover

Table 6.3a: The rate of land use and land cover (LULC) change during the period 1986 to 2002

<table>
<thead>
<tr>
<th>LULC Classes</th>
<th>Unchanged area (ha)</th>
<th>Transfer</th>
<th>Gain</th>
<th>Rate of change/ (ha.a⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Area (ha)</td>
<td>Transfer rate (ha.a⁻¹)</td>
<td>Area (ha)</td>
</tr>
<tr>
<td>Closed Forest</td>
<td>17,312</td>
<td>17,932</td>
<td>318</td>
<td>398</td>
</tr>
<tr>
<td>Cropland</td>
<td>21,364</td>
<td>19,895</td>
<td>301</td>
<td>26,025</td>
</tr>
<tr>
<td>Mining</td>
<td>0.0000</td>
<td>0.0000</td>
<td>000</td>
<td>483</td>
</tr>
<tr>
<td>Open Forest</td>
<td>19,634</td>
<td>20,291</td>
<td>318</td>
<td>31,736</td>
</tr>
<tr>
<td>Settlement/bare lands</td>
<td>1,049</td>
<td>794</td>
<td>269</td>
<td>3,271</td>
</tr>
<tr>
<td>Water</td>
<td>145</td>
<td>4,653</td>
<td>606</td>
<td>1,657</td>
</tr>
<tr>
<td>Total</td>
<td>59,500</td>
<td>635,600</td>
<td>1810</td>
<td>63,570</td>
</tr>
</tbody>
</table>

Table 6.3b: The rate of land use and land cover (LULC) change during the period 2002 to 2008

<table>
<thead>
<tr>
<th>LULC Classes</th>
<th>Unchanged area (ha)</th>
<th>Transfer</th>
<th>Gain</th>
<th>Rate of change/ (ha.a⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Area (ha)</td>
<td>Transfer rate (ha.a⁻¹)</td>
<td>Area (ha)</td>
</tr>
<tr>
<td>Closed Forest</td>
<td>15,287</td>
<td>2,423</td>
<td>086</td>
<td>1,315</td>
</tr>
<tr>
<td>Cropland</td>
<td>19,880</td>
<td>27,509</td>
<td>363</td>
<td>20,321</td>
</tr>
<tr>
<td>Mining</td>
<td>037</td>
<td>446</td>
<td>577</td>
<td>061</td>
</tr>
<tr>
<td>Open Forest</td>
<td>25,153</td>
<td>26,217</td>
<td>319</td>
<td>24,897</td>
</tr>
<tr>
<td>Settlement</td>
<td>3,245</td>
<td>1,076</td>
<td>156</td>
<td>11,910</td>
</tr>
<tr>
<td>Water</td>
<td>267</td>
<td>1,534</td>
<td>532</td>
<td>695</td>
</tr>
<tr>
<td>Total</td>
<td>63,870</td>
<td>59,210</td>
<td>2030</td>
<td>59,200</td>
</tr>
</tbody>
</table>
Between 2008 and 2015, mining achieved the highest change rate of 27,395 ha.a\(^{-1}\), followed by water at 4,270 ha.a\(^{-1}\). Mining recorded a transfer rate of 364 ha per area and a monstrous gain rate of 27,031 ha per area. The rate of change in settlement/bare lands (765 ha.a\(^{-1}\)) was slower than in previous periods and was comparable to the rate of change in open forest (708 ha.a\(^{-1}\)). Except for water and mining, each of the LULC classes had relatively low rates of transfer and gain (Refer to Table 6.3c). Closed forest continued to be the land use class with the slowest rate of change, at 218 ha.a\(^{-1}\).

Between 2015 and 2020, the rate of change was relatively slow in comparison to previous periods. Mining continued to be the land use class with the fastest rate of change, albeit at a slower rate of 822 ha.a\(^{-1}\) than in the previous period. Mining also had relatively low transfer and gain rates, at 315 ha.a\(^{-1}\) and 507 ha.a\(^{-1}\), respectively. Apart from closed forest, which changes at a rate of 214 ha.a\(^{-1}\), the remaining LULC changes at a rate of 478 ha.a\(^{-1}\) to 478 ha.a\(^{-1}\). Their transfer rates ranged from 96 to 370 ha.a\(-1\), while their gain rates ranged from 118 to 265 ha.a\(^{-1}\).

These relatively high rates of change, particularly from 2002 to 2008 and 2008 to 2015, demonstrate the intense LULC changes. It is therefore critical to comprehend the forces that initiate and sustain these changes, as well as to forecast future scenarios under 'business as usual' and 'mediation' scenarios. As a result, the following sections are devoted to this subject.

Chapter 6: Changes in land use and land cover
### Chapter 6: Changes in land use and land cover

**Table 6.3c: The rate of land use and land cover (LULC) change during the period 2008 to 2015**

<table>
<thead>
<tr>
<th>LULC Classes</th>
<th>Unchanged area (ha)</th>
<th>Transfer</th>
<th>Gain</th>
<th>Rate of change/ (ha.a⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Forest</td>
<td>12,199</td>
<td>4,404</td>
<td>166</td>
<td>1,396</td>
</tr>
<tr>
<td>Cropland</td>
<td>22,629</td>
<td>17,572</td>
<td>273</td>
<td>27,971</td>
</tr>
<tr>
<td>Mining</td>
<td>41</td>
<td>57</td>
<td>364</td>
<td>4,235</td>
</tr>
<tr>
<td>Open Forest</td>
<td>19,925</td>
<td>30,125</td>
<td>376</td>
<td>12,979</td>
</tr>
<tr>
<td>Settlement</td>
<td>6,071</td>
<td>9,083</td>
<td>375</td>
<td>9,454</td>
</tr>
<tr>
<td>Water</td>
<td>278</td>
<td>685</td>
<td>445</td>
<td>5,891</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>61,140</strong></td>
<td><strong>61,930</strong></td>
<td><strong>2000</strong></td>
<td><strong>61,930</strong></td>
</tr>
</tbody>
</table>

**Table 6.3d: The rate of land use and land cover (LULC) change during the period 2015 to 2020**

<table>
<thead>
<tr>
<th>LULC Classes</th>
<th>Unchanged area (ha)</th>
<th>Transfer</th>
<th>Gain</th>
<th>Rate of change/ (ha.a⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Forest</td>
<td>11,506</td>
<td>2,089</td>
<td>96</td>
<td>2,568</td>
</tr>
<tr>
<td>Cropland</td>
<td>33,373</td>
<td>17,227</td>
<td>213</td>
<td>21,478</td>
</tr>
<tr>
<td>Mining</td>
<td>2,120</td>
<td>2,156</td>
<td>315</td>
<td>3,469</td>
</tr>
<tr>
<td>Open Forest</td>
<td>19,983</td>
<td>12,921</td>
<td>245</td>
<td>13,780</td>
</tr>
<tr>
<td>Settlement</td>
<td>6,331</td>
<td>9,194</td>
<td>370</td>
<td>4,977</td>
</tr>
<tr>
<td>Water</td>
<td>2,025</td>
<td>4,144</td>
<td>420</td>
<td>1,459</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>75,340</strong></td>
<td><strong>47,730</strong></td>
<td><strong>1660</strong></td>
<td><strong>47,730</strong></td>
</tr>
</tbody>
</table>
6.5 The forces that initiate and sustain the observed land use and land cover changes

The observed trends and patterns of LULC change are triggered and sustained by a plethora of factors. These factors are complex and go beyond the simplistic narrative of poverty and population as the primary determinants (Lambin et al. 2001). Despite this, population and poverty cannot be underestimated, and thus this study took a holistic and critical approach to determining the driving forces of LULC, utilising both primary and secondary data.

The driving factors are discussed in two ways, according to Geist and Lambin (2002): the proximate and underlying driving forces. Proximate driving forces are human activities or immediate actions at the local level that are directly related to the intended land use and influence the land cover. On the other hand, underlying factors are dominant social processes that either reinforce proximate causes and functions at the local level or have an indirect effect at the national or global level (Geist and Lambin, 2002). The analysis of semi-structured interviews, key informant interviews, and focus group discussions reveals the following driving forces, which are summarised in Table 6.4.

Table 6.4: Proximate and underlying causes of land use and land cover changes in the case study

<table>
<thead>
<tr>
<th>Proximate causes</th>
<th>Underlying drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining operations (both legal and illegal)</td>
<td>Government policies regarding mining and agriculture</td>
</tr>
<tr>
<td>Lumbering</td>
<td>Population growth (immigrants included)</td>
</tr>
<tr>
<td>Expansion of existing building structure</td>
<td>Unemployment and poverty</td>
</tr>
<tr>
<td>Agriculture expansion</td>
<td>Challenges of agriculture</td>
</tr>
<tr>
<td></td>
<td>Improved and sophisticated technology</td>
</tr>
<tr>
<td></td>
<td>Weak enforcement of law/Corruption</td>
</tr>
</tbody>
</table>

Mining operations (both legal and illegal) were identified as a significant direct factor influencing observed changes in land use and cover in the study area. This land use activity is responsible for substantial changes in water bodies, open forest, croplands, and, to a lesser extent, closed forest land cover. This corresponds to the observations on the classified LULC maps and confirms the findings of other LULC studies regarding land cover conversions (Kusimi 2008; Aduah et al. 2015; Awotwi et al. 2018; Hausermann et al. 2018; Obodai et al.
Chapter 6: Drivers of changes in land use and land cover

2019; Boakye et al. 2020). For example, the acquisition of croplands for mining has been noted as compelling some farmers to cultivate forest reserves and open forest areas. Additionally, it was established through interviews that involvement in mining, particularly by youth, has financially empowered them to expand built-up areas at the expense of open forest areas. The analysis of the LULC maps, key informant interviews, and focus group discussions reveals that mining has resulted in massive land degradation. In Map 6.3, a collage of satellite imagery of mining (both large and small scale) demonstrates the extent of land degradation caused by mining activities. The imagery demonstrates the extent of land degradation in the communities' once-green landscapes prior to mining activities. In several of the major communities, mine pits filled with water and degraded mined land surfaces can be seen in the images. This is consistent with the other settlements in the case study, as galamsey activities are district-wide in scope. Confirming the prevalence of illegal small-scale mining, an official of the Ministry of Food and Agriculture at the Amansie South District stated.

“There are no communities in the district where galamsey activities do not occur. We share a boundary with Dunkwa, and I was astounded the first time we visited ‘Taabosere’ and discovered ongoing illegal mining. Only the settlement remained in this town; all other land use were abandoned to illegal mining. I am at a loss of words. You must be present to observe. Illegal mining occurs in the most remote town” (KII_001_M_LS).

Additionally, the proximity of small-scale mining activities to settlements can be observed, as is the case in almost every settlement in the district (Map 6.3). This trend was observed in several communities and reflects community members' exposure to health risks associated with mining. The map further demonstrates the haphazard nature of small-scale mining operations in comparison to large-scale mining. Unlike large-scale mining, which occurs within a clearly defined concession area, small-scale mining, particularly illegal mining, occurs anywhere there are proven mineral deposits and water to wash the ore.
Map 6.3: A collage of 2021 satellite images illustrating the extent of land degradation from mining in some communities in the study district
Source: ESRI (2021) High Resolution 30cm Imagery
Mining as a significant proximate driving force is shaped by a variety of underlying factors revealed during interviews and focus group discussions. Advanced technology and various revised and new mining policies were significant underlying factors that had an indirect effect on the observed LULC changes in mining. The Chinese are well-known for their introduction of improved small-scale mining technology and their subsequent access to it in Ghana’s mining sector (Hilson and McQuilken 2014; Crawford et al. 2016; Owusu-Nimo et al. 2018).

Remarking on the advanced and sophisticated technology used primarily by Chinese individuals and companies and their impact on LULC changes, a small-scale miner explained as follows:

“Had the Chinese continued to operate, all our forest cover would have been destroyed by now. A track of land that a local miner will clear in months, the Chinese will clear in days with improved technology” (SSI_003_M).

This sentiment encapsulates the devastation caused by land cover change because of the underlying driver of improved technology and reflects the concerns of a large proportion of study participants.

Additionally, the various mining and agricultural policies discussed in detail in Chapter 4 highlight the underlying impact of institutional policies. For example, the mining sector of Ghana, like most mining sectors in Sub-Saharan Africa, is based on capitalist ideologies and is most compatible with global capitalist systems. It is the exclusive domain of a few international investors and has been partially blamed for increasing activity of small-scale mining (Hilson 2002b; Yankson and Gough 2019). Despite the passage of the small-scale mining law, which allows Ghanaians to participate in the mining sector, the average person is unable to obtain a concession due to the bureaucratic nature of the process and corruption (Hilson et al. 2017). The sector is criticised for concentrating power in the hands of influential members of society and foreign investors (Crawford et al. 2016), at the expense of the common man, thereby perpetuating inequalities (Hilson et al. 2017; Yankson and Gough 2019).

These consequences may be either positive or negative. For instance, policies aimed at increasing foreign direct investment and private domestic investment in the mining sector resulted in changes to the vegetative cover and cropland because of the establishment and operation of licensed large and small-scale mining companies. In comparison, the institutional
policy directive to temporarily prohibit all small-scale mining activities and to reintroduce sanity to the small-scale mining space accounted for at least some of the reduction in LULC changes in some mining landscapes, including the study districts (Forkuor et al. 2020). It is worth noting, however, that Operation Vanguard, the joint military-police force charged with enforcing the policy directive, has been criticized for being corrupt and colluded with illegal miners to perpetuate their activities. This was confirmed by a District Planning official and several key informants. Additionally, during the fieldwork, it was observed that illegal mining activities continued in almost every community visited, despite the presence of Operation Vanguard. The activities of Operation Vanguard were viewed as a money-making venture aimed at enriching the operations' top officials. An official at the district Assembly expressed regret that the district had not been granted permission to collect revenue from small-scale miners to support district development projects because the activities were deemed illegal. Rather than that, the Operation Vanguard personnel earn money from the miners by arresting them, demanding payment, and releasing them to resume their illegal mining.

Moreover, agricultural expansion was identified as a significant proximate driving force in the observed land cover conversions. Since the soil types in the case study support both food and cash crops, the district receives significant agricultural investment from both indigenous and external sources. The district is notable for being one of the first to see increased investment in cocoa production (Austin 1988). According to an interview with an official at the District Agricultural Office, plans to transform the district into a cocoa district53 are well underway. The status of a cocoa district is recognition of the significant contribution of the study district to cocoa production. Despite its prominence as a mining district, the district has been and continues to be an agrarian economy, with a higher proportion of its population engaged in agriculture, though this trend has slowed in recent years. According to the 2010 Housing and Population Census, 74% of the population was engaged in agriculture.

Agricultural expansion results in significant LULC changes, owing to the underlying factors of population growth and national agricultural policies. The population of the district was estimated to be 108,273 in 2000 and 134,331 in 2010. With a growth rate of 2.6, the estimated population in 2020 is 174,218 people, a nearly 30% increase over the 2010 estimate. The

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53 A cocoa district is different from the administrative district delineated for decentralisation purposes. They are made up of cocoa growing areas grouped together as a unit and can cut across different administrative boundaries.
population increase can be attributed to the high rate of net migration in search of work in mining sites. Additionally, the household size of the district is 4.5, which is slightly larger than the regional average of 4.1 (Ghana Statistical Service 2014a). This means that resources including cropland, are shared among a large group, placing a strain on existing resources and indirectly affecting existing LULC. For example, a lack of or a decline in access to cropland for farming because of population growth and large household sizes can result in land fragmentation, prompting individuals to alter or convert open forest and closed forest areas to cropland to meet their needs. Additionally, the implementation of the Planting for Food and Jobs policy, as well as other similar agricultural expansion policies, results in land cover conversion.

Additionally, lumbering, particularly from illegal chain saw operations, was identified as a primary driver of observed LULC changes. These land cover changes occurred primarily in forest reserves. As indicated on the LULC maps, the Anwiaso East Forest reserve in the western corner of the district was almost lost by 2020. Moreover, mining activities posed a significant threat to the Oda Forest reserve. Indeed, some illegal mining activities were occurring within the reserves at the time of the study. These illegal activities resulted in bitter complaints from study participants at Oda during the focus group discussion about this new development. According to the study participants, complaints have been lodged with the District Assembly. The Planning Office at the District Assembly confirmed this report, noting that the District Chief Executive has directed immediate action to halt this new development. Certain farmers were particularly enraged and concerned about this new development because they reported that portions of the forest reserve granted to them for farming purposes were gradually being encroached upon by illegal miners. These fears were realised when portions of the Oda Forest reserve in the neighbouring Amansie Central district were invaded by illegal miners in early January 2020 (See Figure 6.2), necessitating a field visit by the Minister of Lands and Natural Resources (MLNR), several Ministry officials, and Forestry Commission officials. The Minister is captured in the photograph inspecting equipment used by illegal miners. Additionally, heavy-duty machinery is visible in a mining pit. As a result of this encroachment on the forest reserve in Amansie Central, the Manso-Nkwata Traditional Council and its inhabitants have vowed to resist any attempt by people to mine in the Oda Forest Reserve at Aboaboaso in the Amansie South District (Peprah 2020). These vows, in my opinion, are merely complaints without the ability to be enforced, given the support of small-scale mining activities by some powerful political and local elites.
In an interview with a senior official at the Regional Forestry Commission office in Kumasi, it was revealed that the Forestry Commission is aware of the impending danger as well as the ongoing threats to forest reserves in the Amansie enclave but is powerless to intervene due to the influence of very powerful individuals. According to this top hierarchy, “the Forestry Commission is overwhelmed” by the issue of mining in forest reserves, and despite several field reports on the issue, nothing appears to be done to address the problem. This is because “illegal mining is a political issue that cannot be resolved” (KII_12_M_RS), as the key informant at the Forestry Commission noted. Additionally, it was noted that the guidelines on mining in forest reserves, which allow for exploration in production reserves comprising up to 2% of the total forest reserve, have been abused, ignored, and misappropriated.

Finally, poverty/unemployment was identified as a primary driver of observed changes in LULC. To my mind, poverty/unemployment as an underlying driver of LULC changes is relevant to all the proximate causes except for the expansion of built-up areas.
Numerous studies have established poverty/unemployment as a motivating factor for mining, particularly small-scale mining (Hilson and Potter 2003; Hilson 2009; Hilson and Garforth 2012, 2013; Afriyie et al. 2016). Similar justifications have been advanced for chain saw operations ((Marfo 2010; Afriyie and Abass 2020). The cumulative effect of mining, lumbering, primarily illegal chain saw operations, agricultural expansion, and urban expansion accounts for the study districts' high rates of deforestation and land degradation. I forecast future changes in land use and land cover for the next decade in the following section using two distinct scenarios: ‘business as usual’ and ‘remedial’.

6.6 Future land use and land cover predictions
Map 6.4 depicts the simulated LULC map for 2020 and the predicted LULC map for 2030 under the ‘remedial’ and ‘business as usual’ (BAU) scenarios, with associated statistics in Table 6.5.

Map 6.4: Simulated and predicted land use and land cover maps (a) Simulated land use and land cover map for 2020 (b) Predicted land use and land cover map for 2030 under the ‘remedial’ scenario (c) 2030 land use and land cover map predicted under a ‘business as usual’ scenario.

As shown in Table 6.5, I anticipate that under the current ‘remedial’ LULC scenario, the study districts will see a decrease in land degradation and deforestation, which, if maintained and
sustained, will improve the local landscape and well-being of the residents. In comparison to the 2020 LULC changes, except for cropland, which is projected to increase marginally at 887 ha (1.62%), all other land uses in the study district are projected to decline, while forest land cover is projected to improve.
Table 6.5: Area and percentage of land use and land cover (LULC) classes of 2020 classified and the predicted LULC for 2030 under remedial and business as usual scenarios

<table>
<thead>
<tr>
<th>LULC Classes</th>
<th>2020 LULC</th>
<th>2030 LULC</th>
<th>2030 LULC</th>
<th>2020 to 2030</th>
<th>2020 to 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (ha)</td>
<td>% Area</td>
<td>Area (ha)</td>
<td>% Area</td>
<td>Area (ha)</td>
</tr>
<tr>
<td>Water</td>
<td>3,484</td>
<td>2.83</td>
<td>2,465</td>
<td>2.00</td>
<td>4,082</td>
</tr>
<tr>
<td>Cropland</td>
<td>54,851</td>
<td>44.57</td>
<td>55,738</td>
<td>45.29</td>
<td>54,139</td>
</tr>
<tr>
<td>Mining</td>
<td>5,589</td>
<td>4.54</td>
<td>4,925</td>
<td>4.00</td>
<td>6,997</td>
</tr>
<tr>
<td>Closed Forest</td>
<td>14,074</td>
<td>11.44</td>
<td>15,236</td>
<td>12.38</td>
<td>12,525</td>
</tr>
<tr>
<td>Settlements/ bare land</td>
<td>11,308</td>
<td>9.19</td>
<td>8,951</td>
<td>7.27</td>
<td>15,772</td>
</tr>
<tr>
<td>Open Forest</td>
<td>33,763</td>
<td>27.43</td>
<td>35,752</td>
<td>29.05</td>
<td>29,552</td>
</tr>
</tbody>
</table>
Water and mining are expected to shrink by 1,019 ha (29%) and 663 ha (12%), respectively. Water scarcity is positively correlated with mining activities in the study districts. As a result, as mining declines, the accumulation of water pockets in mine pits decreases as well. This will result in a decrease in the negative externalities associated with increasing the number of mine pits filled with water, such as malaria infestations and death traps as observed by study participants. Additionally, land use in settlements/bare lands is projected to decline by 2,357 ha (21%). This decrease is primarily due to reductions in bare lands created by forest clearing for mining; thus, mining activities will decline.

Additionally, the remedial scenario anticipates an increase in forest cover in the study districts. The projected increases in open forest and closed forest are 1,162 ha (6%) and 1,990 ha (8%), respectively. These increases are the result of natural forest rejuvenation during the decade of non-disturbance to forest resources. To further improve forest cover, however, strategic policies aimed at land reclamation and tree replanting must be implemented. These must be politically neutral and streamlined to ensure the intended objectives are met. In an interview with a Forestry Commission director, it was revealed that certain individuals, groups of individuals, and institutions alike use the guise of land reclamation exercises to continue mining activities in forest reserves when permission is granted. The Forestry Commission has received several applications for land reclamation proposals under these guises. These proposals must be vetted, and if permission is granted for such exercises, they must be monitored on a regular basis.

In comparison to the ‘remedial’ LULC scenario, the ‘BAU’ scenario results in an increase in all land use and land cover classes. In comparison to the 2020 LULC, I forecast that water and mining land uses will grow by 599 ha (3%) and 1,409 ha (2%), respectively, at the expense of other land uses. Croplands and closed forests are expected to shrink by 712 ha (0.18%) and 1,549 ha (0.63%), respectively. It is worth noting that, despite the marginal reductions in comparison to the 2020 LULC changes, these are significant changes, particularly for the average smallholder farmer. This is because approximately 60% of all farms in Ghana are less than 1.2 ha in size, 25% are between 1.2 and 2.0 ha in size, and only 15% exceed 2.0 ha in size. The average farm size is less than 1.6 ha, with small and medium farms ranging in size from 1 to 10 ha accounting for 95% of total cultivated land (Environmental Protection Agency 2020). Thus, on average and all other factors being equal, approximately 445 farmers will be displaced in 2030 under the ‘BAU’ LULC change scenario for cropland. Additionally, the study projects
that settlements/bare lands and open forest will grow by 4,464 ha (1.23%) and 4,210 ha (0.26%) in 2030, respectively, under the ‘BAU’ scenario.

6.7 Chapter discussion and conclusions

Humans and their natural environments have intricate relationships. These intricate relationships serve as the broad foundation for human livelihood and sustenance. By extracting resources from the natural environment, human activities have a significant impact on the natural environment (Turner et al. 1990; Crutzen 2002; Goudie 2019). This study is predicated on the premise, as depicted in the conceptual framework that guides the study, that achieving food security outcomes and, ultimately, the general well-being of individuals is contingent on the relationship between humans and their environment on a broad level. Thus, in this chapter I have examined the human-environment relationship through a historical analysis of LULC changes over the last three decades. I have also demonstrated the value of integrating remote sensing/GIS and social sciences techniques to gain a holistic understanding of LULC changes.

According to the historical analysis and findings presented in the preceding sections, the case study, like other agro-ecological zones in Ghana with mineral deposits, has witnessed dramatic changes in land use and land cover (Snapir et al. 2017; Awotwi et al. 2018; Hausermann et al. 2018; Obodai et al. 2019; Boakye et al. 2020; Forkuor et al. 2020). An examination of the dynamic spatial changes, trends, and patterns of LULC from 1986 to 2020 reveals that mining activities, despite their relatively small area extent, are both directly and indirectly responsible for most of the deforestation and land degradation. I have demonstrated that mining as a land use is intricately linked to all the major LULC changes in the case study. For instance, mining activities, particularly illegal and informal, have a direct impact on open and closed forests, as well as cropland. Mining activities result in the direct clearing of land surfaces with or without vegetation, altering and/or changing the landscape. Indirectly, mining forces farmers who have been displaced from their farmlands voluntarily or involuntarily, with or without compensation, to relocate to new open forest and/or closed forest, thereby altering and/or changing the landscape (Hausermann et al. 2018; Obodai et al. 2019). From 2008 to the present, mining activities have been a significant driver of changes in the case study area.

Additionally, the study discovered an enormous expansion of cropland throughout the study period except for 2008, which coincides with the peak of mining activity, implying a trade-off between mining and cropland in favour of mining. The findings about the massive expansion
of cropland to meet the needs of the increasing population for food, fibre, and fire corroborate those of other studies (Deininger et al. 2011; Awotwi et al. 2018; Shoyama et al. 2018; Obodai et al. 2019; Zabel et al. 2019; Boakye et al. 2020; Lark et al. 2020; Schmidt and Thomas 2020). It is worth noting that much of the massive expansion of cropland in the case study over the last three decades has been devoted primarily to cash crop farming, including cocoa and oil palm. Food crops such as plantain (Musa paradisiaca), Cassava (Manihot esculenta), and maize (Zea mays), which constitute primary staple food in Ghana, were only cultivated during the early years of cocoa cultivation, for example, to provide shade for the young cocoa nursery. Once the tree plants mature, such food crops are abandoned, and only a few farmers continue to cultivate food crops for subsistence and/or sale on a small scale. This demonstrates how, to date, the agricultural systems in Ghana have been largely oriented around production for export markets and the global capitalist system as discussed in Chapter 5. Chapter 7 will provide an in-depth discussion of this and how the interplay of complex power relations entrenches this ‘business as usual’ to the detriment of the average farmer and influences their food security outcomes.

Cropland expansion significantly contributes to deforestation and, by extension, biodiversity loss due to alteration and/or habitat change (Pereira et al. 2012; Acheampong et al. 2019; Zabel et al. 2019). Between 1986 and 2020, the study discovered that a total of 27,333 ha, or approximately 36% of forest cover (open and closed forest), was lost to other land uses. This equates to an annual deforestation rate of 1.07% on average. Between 1990 and 2015, Acheampong et al., (2019) discovered an annual rate of deforestation in the Ashanti Region, where the study districts are located, ranging from 0.4% to 0.7%. Notably, 78% of these forest cover losses were attributed to the expansion of annual crop farms and tree crops. Similarly, this study determined that cropland expansion accounted for 80% of the change in forest cover. Around 60% of the closed forest was lost. This decrease was primarily caused by the massive reduction of portions of the Anwiaso East Forest reserve in the western corner of the case study. The Gyeni River Forest reserve, the Apamprama Forest reserve, and portions of the Oda River Forest reserve remained relatively intact. However, these forest reserves continue to be a hotspot for illegal mining activities. As explained during the results section, the Oda River Forest reserves in the neighbouring Amansie Central district were already under attack from illegal mining, and there are recent reports and documentaries (Cobblah 2021) of illegal miners operating in sections of the forest in the case study.
Chapter 6: Discussions and conclusions

Contrary to the assertion that all communities in the study districts were involved in illegal mining, the study discovered at least one community, Mem, where the chief has insisted for over a year that no mining activities occur in any part of the community. Although some members of this community disagree, the strong leadership of the chief has ensured that this directive has been followed to date. According to an interview with a key informant in the community, youth from this community travel to the neighbouring community (Agroyesum) to engage in illegal mining. Certain superstitious beliefs and assertions were also ascribed to the non-engagement of people with small-scale mining activities in the Mem community. According to the key informant, because the community is opposed to small-scale mining, whenever anyone attempts it, the extracted gold deposits turn to charcoal. These assertions were confirmed during an interview with the Chief and several community elders. According to the interview, the Chief was educated and well aware of the detrimental impact of mining on land and water resources, which explains his stance on mining in the community. According to him, the wealth of people is contingent on agriculture, and thus agriculture must be made lucrative to attract and retain youth.

As discussed in the results sections, the observed LULC changes can be attributed to a variety of factors. There were four major proximate and six underlying (Geist and Lambin 2002) factors identified. Mining, lumbering, construction, and cropland expansion are all proximate factors. Government policies, population growth, unemployment and poverty, agricultural challenges, improved and sophisticated technology, and finally, lax enforcement of law and corruption are all underlying factors. This discovery of these proximate and underlying factors corroborates the findings of several other studies (Hilson and Potter 2003; Marfo 2010; Hilson and Garforth 2012, 2013; Afriyie et al. 2016; Awotwi et al. 2018; Hausermann et al. 2018; Obodai et al. 2019; Boakye et al. 2020; Forkuor et al. 2020).

After four years of renewed commitment to eradicating or significantly reducing the negative impacts of illegal small-scale mining in Ghana, much more work remains to be done to sustain and improve on the few environmental gains made. The recent call by the President of Ghana during his final State of the Nation address to Parliament in 2020 for a 'open and honest conversation' on galamsey devoid of political lenses bolsters the above assertion and confirms the findings of a recent study by Wireko-Gyebi et al. (2020) that registered miners felt ‘left out’ of the entire process of eradicating illegal mining in Ghana. As a result, the Concerned Small-Scale Miners Association, and several civil society organisations, including the Centre
for Democratic Development (CDD), Arocha Ghana, and Green Advocacy Ghana, have warmly welcomed this call. One question that begs to be answered is how future decisions will affect future LULC changes. To address this, this study forecasted future LULC over a ten-year period using two scenarios based on the current situation, the ‘remedial scenario’, and the previous situation, the ‘business as usual’ scenario.

The analysis of these prediction scenarios indicated that the ‘business as usual’ model would result in rather undesirable LULC changes. The current minimal gains achieved through the implementation of a number of policies since 2016 will be reversed. This is because the study anticipates an increase in mining and water consumption of 599 ha and 1,409 ha, respectively, over the 2020 LULC. Additionally, croplands and closed forests are expected to shrink by 1,549 ha and 712 ha, respectively. This could result in the displacement of an average of 445 farmers, based on current average farm size dynamics.

Contrary to these predictions under the ‘business as usual’ scenario, if the measures implemented over the last four years are maintained and improved, some environmental improvements will occur in 2030 under the ‘remedial’ scenario. The study projects that water and mining will decline by 1,019 ha (29%) and 663 ha (12%) respectively under the ‘remedial’ scenario. This will mitigate the negative externalities associated with mining, such as poor health, death traps, prostitution, and armed robbery. Additionally, land use in settlements/bare lands is projected to decline by 2,357 ha (21%) due to reductions in bare lands created by forest clearing for mining. Additionally, the forest cover is projected to improve, with open forests and closed forests increasing by 1,162 ha (6%) and 1,990 ha (8%), respectively.

The study concludes, based on the preceding discussion, that integrating remote sensing/GIS and ethnographic methods (oral history and observation) to understand LULC changes provides more detailed and rich insights into LULC dynamics and the drivers initiating and/or perpetuating such changes than relying exclusively on remote sensing/GIS techniques or ethnographic methods. Additionally, the study concludes that, despite its smaller area extent than other LULC classes, mining is intricately related to all LULC classes and significantly contributes to the observed LULC changes in the case study.

Moreover, the findings highlight the importance of historical analysis using remote sensing and geographic information systems (GIS) tools in consistent with political ecology to provide a
comprehensive understanding of the environmental conversion factors affecting individuals' capabilities in achieving their functionings (livelihood and wellbeing) in relation to capability approach. Thus, it demonstrates the significance of combining political ecology and capability, as advanced by the conceptual framework that underpins this research.
CHAPTER SEVEN
THE CONTESTED INTERCONNECTIONS BETWEEN SMALLHOLDER FARMING AND MINING IN GHANA

7.1 Introduction

Agriculture, primarily crop farming, has coexisted in Ghana for centuries with other land uses, including mining. Several of the agroecological zones in Ghana overlap with areas of proven mineral reserves. For instance, the forest agroecological zone, which produces 57% of total food crop tonnage (Diao et al. 2019), overlaps with 61% of the mineral zones discussed in Chapter 2 and elaborated on in Chapter 5 (Refer to Map 2.1). These two subsectors are dependent on a finite resource (land), and each requires significant amounts of water to operate and is labour intensive. Accordingly, access to these critical resources is fraught with tensions, trade-offs, and disparate costs and benefits for various actors. It is important to identify these two sectors’ key actors and to assess their interests and influence on resource access, use, and management.

Guided by the conceptual framework, and drawing on Sen’s capability approach, smallholder farming and gold mining are conceptualised as ‘doings’ and food (in)security as ‘beings’. These comprise the ‘functionings’ of an individual. The accomplishment of these important functionings is contingent upon the individuals' capabilities (freedoms and opportunities). Additionally, these are influenced by a plethora of factors referred to as ‘conversion factors’ (Robyns 2005). Thus, this chapter examines the capabilities of smallholder farmers and gold miners to access land, labour, and water from a power relations and multi-scale viewpoint informed by a political ecology approach and considering existing laws, regulations, and customary norms and practices. Furthermore, the power relations of key actors are analysed and discussed, as they are a significant conversion factor. These analyses contribute to third research question, which is to ascertain the factors that influence the capability of miners and smallholder farmers to access critical resources. This chapter specifically addresses two interrelated questions: (i) what factors affect the ability of miners and smallholder farmers to

54 Functionings are the states of human beings (beings) and the activities (doings) that an individual can undertake. Refer to Chapter 2 for an elaborate explanation of these concepts as they relate to the capability approach.

55 Conversion factors explain the degree to which an individual can transform his/her resources into functionings (Robeynes 2016). Refer to Chapter 2 for an elaborate explanation of this concept as they relate to the capability approach.
access critical resources (land, water, and labour)? (ii) Who are the key actors in the mining and smallholder farming subsectors, and how are their power hierarchies and relationships structured? The chapter makes extensive use of primary data gathered through key informant interviews, semi-structured interviews, and focus groups with key actors at the local and national levels. Supplementing these data sources are participant observations and secondary sources of information.

Based on the findings, I argue that the once-coexisting subsectors of mining and smallholder farming are now engaged in fierce competition for access to critical resources (land, labour, and water), a situation shaped by the unequal power relations between the two subsectors’ key actors. The chapter demonstrates that while the capabilities for accessing these resources continue to dwindle for an increasing number of smallholder farmers, particularly food crop farmers, they are increasing for mining activities. This has significant consequences for food (in)security, which will be examined in greater detail in the following chapter. The chapter demonstrates how the rivalry between the two subsectors is facilitated and shaped by entrenched unequal power relations in favour of mining and externally negotiated neoliberal policies. Additionally, I argue that the activities of the small-scale mining sector are complex and heterogeneous, similar to those in Zimbabwe (Mkodzongi and Spiegel 2019), Tanzania (Fisher 2007, 2008), and the Philippines (Fisher 2007, 2008). (Verbrugge and Besmanos 2016). Contrary to the definition of small-scale mining as a “low-tech...” activity (Hilson et al. 2017, p.80), the majority of small-scale mining activities in the study district have evolved significantly, utilising sophisticated machinery, confirming Crawford et al. (2016) findings. This intensifies the rivalry between mining and smallholder farming, while also increasing the level of exploitation for some miners and smallholder farmers.

This chapter is divided into six sections. Section 7.1 introduces the chapter. Section 7.2 examines the capabilities for acquiring stakes in land suitable for mining and smallholder farming. Sections 7.3 and 7.4 analyse the capabilities of the two subsectors in terms of accessing labour and water, respectively. Section 7.5 identifies key actors within the two subsectors and delves into their power hierarchy and relationships. The chapter finishes by summarising the major findings of the chapter and making empirical conclusions from them in Section 7.6.
7.2 Land Access capabilities

7.2.1 The plurality of interests and ease of accessing land for mining

Land access is the most critical capability for mining and smallholder farming. This capability varies greatly across different groups of people and livelihood activities. Land is a finite resource that serves as the foundation for both mining and smallholder farming activities, and its access and use are governed by frequently complicated and varied legislation and procedures (Kasanga and Kotey 2001; Hausermann and Ferring 2018). Land access capability in Ghana is embedded two broad governing systems, namely the state and customary. The former is governed by enacted legislation and consists of state lands that the government acquires compulsorily by invoking applicable legislation. The latter, which is governed by customs, refers to vested lands belonging to customary authorities, such as stools\(^{56}\), skins\(^{57}\), clans, and families, or an individual. Customary authorities are estimated to possess over 80\% of land in Ghana under allodial title and are responsible for its allocation, administration, and management (Kasanga and Kotey 2001; MoFA 2018b). The most recent Land Act (Land Act, 2020, Act 1036) of Ghana distinguishes six distinct land interests: (a) allodial title; (b) customary law freehold; (c) common law freehold; usufructuary interest; (e) leasehold interest; and (f) customary tenancy interest ((The Parliament of the Republic of Ghana 2020)\(^{58}\). Different land interests are held in the study district for mining and smallholder farming, but the most prevalent are leasehold, customary law freehold, and customary tenancy. Each of these land interests is unique to a particular land use form (mine or crop farming) and to certain actors. In the next paragraphs I explained the land interests for mining (both large and small-scale) and smallholder farming.

7.2.1.1 Land interests for large scale mining

According to Article 257(6) of the 1992 Constitution of Ghana, the President is vested with all mineral resources in their natural state in the trust of the Ghanaian people. Accordingly, large scale mining corporations that meet the requirements for the award of mineral rights are granted land interests in the form of a mining lease for an initial period of 30 years or a shorter period agreed upon by the Minerals Commission and the Minister for Land and Natural Resources. Prior to the lease being awarded, large-scale mining corporations may apply for reconnaissance and prospecting licenses for a period of up to 12 months and 3 years, respectively. These

\(^{56}\) Stool represents the symbols of authority of chiefs in the southern parts of Ghana

\(^{57}\) Skins represent the symbols of authority of chiefs in the northern parts of Ghana

\(^{58}\) Details of individual land interest are provided in Chapter 4
Chapter 7: Land access capabilities

licenses enable the corporation to conduct an initial survey of the site and determine its suitability for commercial gold mining. According to an interview with a key informant at the Regional Forestry Commission Office, several organisations that hold these licenses engage in mining rather than prospecting\(^{59}\) or reconnaissance\(^{60}\) (KII_012_M_RS). This condition is most prevalent among small-scale mining companies and individuals. Regrettably, some of these licenses are issued in forest reserve areas. State authorities' inconsistent compliance monitoring has allowed this to grow for an extended period before being found, resulting in the loss of some forest reserves.

Following the recommendations at the National Consultative Dialogue on Small-Scale Mining\(^{61}\), the Ministry of Lands and Natural Resources issued a new directive directing individuals and/or companies engaged in reconnaissance and/or prospecting in forest reserves, with or without legal authorisation, to halt such activities until further notice (Ministry of Lands and Natural Resources 2021b). Additionally, the directive instructs the Minerals Commission, effective immediately, not to accept, process, or recommend the grant, including renewal and/or extension, of reconnaissance and prospecting licenses in forest reserves (ibid). While these new directives are commendable, they must be implemented and enforced immediately, as significant harm has already been done to numerous forest reserves. Thus, the instruction has elicited a mixed response. For example, a former Minister of Lands and Natural Resources has described the decree as “ridiculous” (Citinewsroom 2021), arguing that such prospecting in forest reserve regions is illegal and should never have been permitted in the first place. Despite this, the Media Coalition Against Galamsey praised the guideline for being “responsible” (Eshun 2021).

7.2.1.2 Land interests for registered small-scale mining

In the instance of registered small-scale mining, an individual, group of individuals, co-operative society or company is issued a mining license for a period of not more than five years, renewable once. According to the Minerals and Mining Act, 2006 (Act 703), this license is

\(^{59}\) Prospecting is a form of small-scale mineral exploration that is the initial step in the process of discovering a mineral deposit.

\(^{60}\) Reconnaissance is the preliminary assessment of the general geological features and characteristics of a region.

\(^{61}\) The President of Ghana during his last state of the nation's address in 2020 calls for a national dialogue on small-scale mining activities devoid of politics. This was actualised at the Accra International Conference Centre on 14th and 15th April 2021.
only to be awarded to Ghanaian citizens. This study discovered, however, that non-Ghanaians, particularly the Chinese, held such mining licenses. The participation of this foreign nationals in the small-scale sector was achieved by some legitimate concessionaires granting a portion or the entirety of their concession to these individuals or institutions. A Director at the Lands and Natural Resources Ministry corroborated the awarding of legal concessions to illegal miners for *galamsey* activities as follows:

“*Galamsey* is illegality and the security agencies in those districts where they take place are to ensure it does not happen. However, *galamsey* is a great business and those who have the concession sometimes give their lands away to be used by *galamseyers* in turn for money” (KII_006_M_NS).

Additionally, the involvement of powerful actors in the small-scale mining sector supports the entry of other nationals into the sector. This is substantiated by a recent exposé based on documentary video evidence that around 30 armed military troops were defending Chinese miners operating in the *Apamprama* Forest Reserve, which is located within the study district (Myjoyonline 2021). These engagements of foreign nationals with land interests demonstrate the porous nature of existing mining laws and regulations, on the one hand, and the ineffective monitoring and compliance activities of the state regulators, which are attributed to limited finances, insufficient staffing, technological and logistical constraints, on the other (Haglund 2008; Mcquilken and Hilson 2016; Adu-Baffour et al. 2021).

### 7.2.1.3 Land interests for illegal small-scale mining

In contrast to the mechanisms through which large-scale and legal small-scale mining enterprises acquire mineral rights, illegal small-scale miners typically acquire land interests through customary law freehold by outright acquisitions. These allocations were attributed to a variety of causes, including unequal power dynamics associated with access to land resources and difficulties associated with the method for assigning mineral rights\(^{62}\) by the Minerals Commission of Ghana. Granting customary law freehold interests in land for illicit mining

\(^{62}\) An in-depth discussion on the power relations among different actors will be offered in subsequent sections of this chapter.
activities through outright land purchases costs between ₵25,000 (US$4348)\textsuperscript{63} to ₵30,000 (US$5217) per 0.4 ha of cocoa-producing land and between ₵7000 (US$1217) to ₵10,000 (US$1739) per 0.4 ha of wetland areas. Farmlands containing food crops were compensated at a lower rate. When food crops are owned by an individual with a lesser land interest, such as through a customary tenancy agreement, the food crops are either not reimbursed at all or are compensated in very small quantities in addition to the sum paid to the landowner. Agya Yaw\textsuperscript{64}, a smallholder farmer in Adubia expressed this worry as follows:

“I had plantain (Musa paradisiaca) and cassava (Manihot esculenta) on it [land sold for galamsey]. The cassava was very fruitful, but they [illegal miners] had to destroy them. They were to pay me for the crops they destroyed but did not even finish the payment. They however paid the full amount for the land to my family which we have used to build a house in Manso Nkwanta” (SSI_AD005_M_FM).

Additionally, some young men and elderly women who are financially impoverished and have lesser land interests participate in the illegal small-scale mining area via customary tenancy agreements. Daily payments of land rentals ranging from ₵100 ($17) to ₵200 ($35) are made to landowners or their family members in exchange for access to and interest in places already mined by small-scale miners utilising washing plants, washing boards, or changfa\textsuperscript{65} crushing machine. This approach is predicated on the concept that nuggets of gold are always present in leftover debris from pre-existing mining operations involving heavy-duty machinery. Thus, a relatively ecologically friendly small-scale mining technique dubbed ‘hwiegumu’ (literally ‘pour it within’) is used to extract gold. It makes use of locally manufactured wooden or metal boards and mesh (Figure 7.1). This ‘hwiegumu’ technique is a subset of the alluvial placer method known as the dig-and-wash method and is used in wetland environments (Mantey et al. 2017). Previously excavated waste suspected of containing gold is ground up and put into a slurry before being washed through a sluice (covered in towels, carpets, blankets, or mesh-like materials) that captures the heavier deposits. These are then rinsed into a bucket and the

\textsuperscript{63} ₵ is the cedi symbol, which represents Ghana’s national currency. The dollar symbol $ symbolises the national currency of the United States of America. The cedi’s US dollar equivalent is calculated using the ₵1 to $5.75 exchange rate as of February 2021 (XE.com Inc), with figures rounded to the closest whole number.

\textsuperscript{64} A pseudonym.

\textsuperscript{65} Changfa is a Chinese made diesel powered rock crusher.
contents are sifted and separated until only a trace of material remains. The gold particles are visible at this stage (Mantey et al. 2017).

Another customary tenancy arrangement was discovered involving a group of young men and their 'sponsors' for acquiring interest in land for illicit mining. Under this method, a wealthy sponsor(s) acquires an interest in land and vests it in a group of young men who are unable to achieve direct ownership of land for mining under certain agreed-upon terms and conditions. Among these criteria is that gold extracted from the land is sold directly to the sponsor at the end of each working day at a rate specified by him. These rates are frequently lower than market rates, and hence most of the 'gains' and revenue from the mining activity end up with these 'unseen' and powerful sponsors (s). Second, a daily rate for land use is occasionally levied on workers at this site, which must be paid from the earnings of the day. Alternatively, a proportion of the mineral obtained for the day is agreed upon, with a bigger percentage going to the sponsor. When there are no mineral extracts available for the day (which is an uncommon occurrence), this has no financial consequences for the workers except for their human energy and fuel expenditures for pumping water. To maintain compliance and thwart dishonest
manoeuvres, the mining site is always staffed by a paid and trusted representative of the sponsor(s).

The diversity of customary tenancy agreements demonstrates the complicated and diversified nature of the small-scale mining sector (Fisher 2007; Verbrugge and Besmanos 2016). Additionally, the marginalisation of certain actors (Fisher, 2007, 2008; 2016; Verbrugge, 2015), particularly women and young people with limited capabilities, and the strong proclivity for capital accumulation through skewed revenue sharing arrangements are observable (Verbrugge 2014). Women with small land holdings and limited financial resources were shown to be the most marginalised in terms of land access for small-scale mining. The case of Enos Serwaa, 70, and her friend (See Figure 7.2), who were forced to loiter in a 'dig and wash alluvial' mining site to gain access to some earth materials to pan for small nuggets of gold, vividly demonstrates the extent of marginalisation regarding land access for mining.

Figure 7.2: Picture of an old woman and friend waiting to pan in a mining site
7.2.2 The plurality of interests and ease of accessing land for smallholder farming

Land interests were mostly acquired through usufructuary, customary freehold, and customary tenancy rights in smallholder crop farming. Around 71% of farmers interviewed acquired their current landholdings through usufruct, notably inheritance from a family member. This is the primary source of land interest in smallholder farming in Ghana, with most of the land held by indigenous people.

Additionally, 23% of farmers retain land rights through customary tenancy arrangements. Many of these agreements involved sharecropping or caretaking, with only a few vegetable farmers acquiring land interests through leasing agreements. Contractual arrangements for sharecropping are prevalent in cocoa agricultural areas and often involve an arrangement between native allodial title holders and migrant farmers. However, in recent years, these relationships have been cultivated between two indigenous peoples when one desires greater farmland, particularly considering land fragmentation caused by population growth. Under this model, migrant farmers are offered an interest in land for farming that is backed up by a variety of flexible contractual arrangements, the majority of which entail the landowner receiving a specified percentage of the produce from the farm. There are two distinct sharecropping systems: ‘abunu’ and ‘abusa’ (KII_006_M_NS). The ‘abusa’ method is based on the agreement that one provides his/her land to another to farm while making no contribution to farm management. When farm produce is sold, the landowner receives one-third of the proceeds, while the farmer receives the remaining two-thirds. The ‘abunu’ method requires the landowner to offer his or her land to another individual and contribute to its development, after which the revenues from the farms are split 50:50 (KII_006_M_NS). In the context of land use competition, these minor kinds of land interests facilitate multiple unequal power interactions and exploitations of migrant farmers (Nyantakyi-Frimpong and Bezner Kerr 2017).

Furthermore, the study discovered that just 6% of study participants owned customary freehold interests in land obtained through outright acquisitions of cash crop-producing or non-producing land. In the study district and throughout the country, outright purchases of land for smallholder farming activities are uncommon. This is because most farmers lack the disposable income necessary to purchase such land holdings. There are, however, a few well-established farmers who engage in other businesses who prey on farmers who are forced to sell their farms or property owing to financial troubles or to meet immediate demands.
Mr Antwi, a farmer who owns 17 ha of farmland, confirmed that other well-established farmers occasionally purchase farms/farmlands outright by stating:

“In this community, some farmers go through hardships which forces them to sell their land. Being a transport owner, I can buy some of such lands”.

(SSI_D03_M_FM).

The statement by Mr Antwi above describes how some farmers' vulnerabilities regarding their land interests are exploited by some elite farmers. It is worth emphasising that these vulnerabilities are exploited not only by elite farmers, but also by elite miners, who typically offer greater rates and are thus given first option when competing for such land holdings. This challenge, in combination with a variety of other problems, leads in difficulty getting new and/or extra land for smallholder farming, particularly among migrant farmers, as reported by 72% of farmers interviewed and corroborated by key informants and some focus group participants.

7.3 Labour access capabilities

In Ghana, 90% of the working-age population 15 years and older is employed in the informal sector (Ghana Statistical Service 2016). This number is significantly greater (96 %) in rural areas (ibid), which encompasses most of the communities in the study district. Agriculture, forestry, and fishing provide most people with their primary source of income. Following that are mining and quarrying, as well as other subsectors (Ghana Statistical Service 2014c). Apart from large-scale mining, small-scale mining (both legal and illicit) and smallholder farming are labour-intensive operations. Formal labour ties exist between mining corporations and labourers ranging from technical experts to informal labourers in large-scale mining. In small-scale mining and agriculture, informal labour relations remain, and labourers fall into the categories of family, casual/permanent, contractual, and occasionally child labour (common in cocoa farming and illegal mining). Spouses, children (adopted and biological), and other family members assist with weeding, planting, and harvesting. Smallholder farming is therefore more reliant on family labour than mining, which is dominated by casual labour relations.

Most casual labourers are migrant workers. When it comes to crop farming, many of these casual labourers are available seasonally (during field clearing/harvesting), however some work all year and are resident migrants in the communities. They assist with land removal and
preparation, weeding, fertilising, and chemical application, among other tasks. They earn approximately an average of between ₤25 ($4) and ₤35 ($6) per day. Their employers either provide food for them during working hours or pay them an additional 5 ($1) to obtain food. Additionally, some farmers organise contract workers (in groups) to work on farms. These agreements entail charging a certain fee, typically proportional to the size of farm, for the completion of a work.

It is worth mentioning here that pay for casual workers is gendered, with men always receiving at least ₤5 ($1) more than women. Such gendered patterns of payment also exist in small-scale mining labour interactions. The average daily wage at a small-scale mining site is between ₤20 ($3) and ₤80 ($14), depending on the precise responsibilities performed during the mining process. Digging, lode transportation, and panning are just a few of the responsibilities available. However, women were primarily allocated the task of lode conveyance, carrying the lodes for males to pan using head pans (See Figure 7.3). They are paid only ₤20 ($3), whereas men are paid at least ₤30 ($5) for labour in less lucrative mining sites (often already mined areas utilising indigenous methods) and up to ₤80 ($14), and above depending on the allocated duties.

Figure 7.3: Young women working in a small-scale mining site as load transporters
Reflecting on these findings, it is possible to deduce the unequal gendered labour relations connected with smallholder farming and small-scale mining. Other small-scale mining regions in Ghana and the Democratic Republic of Congo have similar unequal gendered labour arrangements (Buss et al. 2019; Arthur-Holmes 2020; Buss and Rutherford 2020). Second, the economic viability of mining may be determined by comparing it to farming in terms of daily labour wages for temporary workers. The higher daily wage in the mining subsector explains why casual employees choose mining locations to farms, and how this affects farming labour access capabilities. Given the lucrative daily wages available at mining sites, it is not uncommon for some farmers to work as casual employees. According to interviews with farmers, some farmers, particularly the young, have abandoned their farms in quest of quick cash via galamsey. Additionally, some prospective farmers are reluctant to enter the farming profession due to the profitable nature of small-scale mining. This was amply demonstrated by an Assembly member, who stated:

“‘The motivation for farming is very low now compared to mining where you reap profits immediately. This has caused more people to go into mining than agriculture. …this [challenges in agriculture] has forced many people to leave agriculture and divert into mining’” (ORH_02_WT).

Despite the preceding assertion that some existing farmers are abandoning agriculture, many existing farmers are elderly. Farmers interviewed have an average age of 55 years, which is consistent with the national average (MoFa 2011). However, approximately 51% of these farmers were older than the median age of 55, with some exceeding 70 years. This indicates that many existing farmers may be unable to engage in small-scale mining due to their advanced age, as small-scale mining activities need tremendous amounts of energy. Thus, it is the young aspiring farmer who is lured into small-scale mining. Additionally, this study discovered that some farmers engaged in both small-scale mining and crop farming. Two classifications of these groups were identified. The first group consisted of elite farmers who have the necessary resources (land and/or income) to pursue small-scale mining as a secondary source of revenue. The second category included those who work casually for a small-scale miner to raise income for farming activities.

Furthermore, the findings indicate a significant labour demand because of competition between mining and smallholder farming activities. This has resulted in an increase in labour expenses,
making it extremely difficult for many smallholder farmers to hire farm labourers. Most farmers interviewed (72%) expressed unhappiness with the difficulty of obtaining casual labourers to work on farms. Similar issues were expressed by several key informants and focus group participants. Galamsey activities have been criticised for the difficulty in hiring casual farm workers. Several farmers at various sampled research communities expressed the following concerns about the difficulty of obtaining casual employees for farming operations because of small-scale mining activities:

“Because of galamsey activities, it is difficult to get labourers to work on the farm. Everyone prefers to work in galamsey sites than to work in farming as the farmers pay less compared to mining”. (SSI_AD003_M_FM).

“Now it is very difficult getting labourers to work by day on your farms because of galamsey. But for the agrochemical we use, it would have been difficult weeding our farms. This is because the labourers will prefer to work in galamsey sites because of the high daily wages”. (SSI_D003_M_FM).

“It is very difficult to get labourers to assist with farm work here. Those who are available for farm work on a day are those who do not get employed for galamsey activities on that day. … we had this caretaker. He however mostly went to work on galamsey sites. He only visits the farm when he is unable to get a galamsey offer”. (SSI_W02_M_FM).

According to the remarks, the economic advantage mining in terms of higher compensation for labour creates a considerable barrier to agricultural labour accessibility. This challenge arises because of employees’ rational decisions to explore higher-paying opportunities. Additionally, the remark implies a reliance on agrochemicals because of the difficulty in securing temporary labour. The application of these agrochemicals poses serious risks to farmers and the environment. Clearly exemplified in the last quotation, even permanent personnel engaged by smallholder farmers are concerned about small-scale mining. These concerns show the immensity of the two subsectors’ labour competition.

Based on the overall labour relations between the two subsectors, it can be argued that small-scale mining has an economic advantage over smallholder farming in terms of labour attraction. This has several consequences for food security.
Chapter 7: Water access capabilities

To begin, the inability or inadequacy of smallholder farmers to access labour influences the entire farm size that may be farmed. Second, the high cost of labour because of mining competition implies farmers will either be unable to afford temporary workers or will be unable to engage the required number of workers to maintain current farms. This will result in overall production declines and will exacerbate the divide between poor farmers and rich miners. Some farmers were acknowledged to have adopted a new approach during the cocoa harvesting season because of exerting their agency in response to the uneven labour relations. Tuesdays, the day on which small-scale mining is not authorised in accordance with traditional norms, are repurposed for working on cocoa pods under this new plan. A farmer in Watreso explained this new method as follows:

“It is a problem [difficulty in getting labourers for farming]. Breaking the cocoa pods after harvesting is a great challenge now because of the galamsey activities as you won’t get labourers to assist. Tuesdays are taboo days here so there are no galamsey activities. So, what we do now is to wait for Tuesdays to get people to assist with that. This was never the case previously”. (SSI_W09_M_FM).

7.4 Water access capabilities

Water, food security, and nutrition are inextricably interrelated (Committee on World Food Security (CFS) 2015). Water is required for the progressive realisation of the right to an adequate diet within the context of national food security, as well as the right to safe drinking water and sanitation. A sufficient supply of water of the appropriate quality and quantity is fundamental for food production, processing, transformation, and preparation. Water promotes economic growth, livelihoods, and revenue generation, and helps billions of people get economic access to food (CFS, 2015). Nonetheless, water resources have been threatened by a variety of anthropogenic activities (Millenium Ecosystem Assessment 2005; Carpenter et al. 2011; Awotwi et al. 2018; Obodai et al. 2019). Water sedimentation, pollution, climate change, deforestation, landscape changes, and population growth are only some of the hazards.

As discussed in Chapter 6, the increasing deforestation and land degradation associated with mining and agriculture influences the water access capabilities of individuals and the community. Agriculture is estimated to be the largest consumer of water resources (70%) in the world (The World Bank 2017). However, this is not the situation in Ghana and many
African countries, where commercial farming is minimal and agriculture is rainfed, and the case study district is no exception. Small quantities of water are frequently required for domestic reasons and by farmers when mixing pesticides and/or fertilisers for use on the farm. On the contrary, significant water withdrawals are required for surface mining by large and small-scale mining companies and individuals. These withdrawals take a variety of forms, including surface water diversions or interferences to process mineral ores or dewatering mining sites for safe operations. Specifically, illicit small-scale mining sometimes occurs directly on surface water sources, impacting their quality and quantity. The semi-structured interviews, key informant interviews and focus group discussion results, as well as observation, indicate a progressive deterioration of river water quality and a near-complete loss of minor water bodies (streams and ponds) that serve as sources of drinking water and other domestic functions. The study participants uniformly stated that all major rivers and streams in the communities had been polluted (Figure 7.4) by galamsey activities, rendering them unfit for drinking water or agricultural use.

Figure 7.4: (a) The polluted Oda River at Watreso (b) the polluted Offin River at Keniago

The Oda and Offin rivers, which flow through various locations throughout the study area, the ‘Atemusu’ river in Watreso, the ‘Bonsa’, ‘Akentensua’, ‘Nsuo Apoo’, and ‘Nsuo Adei’ streams in Odaho, the ‘Adubia’ river, the ‘Adodo’ and ‘Kyekyewere’ streams in Adubia as well as other
smaller streams used for drinking water and agricultural uses, were destroyed, or heavily contaminated and diverted to other areas (SSI_W004_M_F; SSI_OD005_M_F; SSI_OD002_M_F; KII_007_M_LS; ORH_04_AD). Field visits to several of these natural water sources established the pollution status of numerous of the existing water resources, including Oda, Offin, Atemusu, and Watremu. Most of the mentioned minor streams had ceased to exist at the time of the study. The progressive pollution of water resources limits the amount of water that is safe for human consumption, hence constraining individuals’ water access capabilities. This reduction may contribute to future water scarcity, as all residents of the villages currently rely on a few boreholes. These boreholes are primarily funded by the District Assembly or large-scale mining institutions as part of their Corporate Social Responsibility initiatives. A group of individuals engaged in small-scale mining was identified as providing a borehole in the Mpatasie community (KII_009_M_LS). The heavy withdrawals of underground water for large-scale mining and some small-scale mining operations may eventually deplete the supply of water in these boreholes. This is because groundwater reserves take a long time to recharge, much more so given the current implications of climate change. Additionally, the increased cost of purchasing ‘sachet water’66 by some farmers whenever they must visit their farms will increase their household spending, robbing them of income that could have been utilised for other necessities.

Furthermore, water body pollution robs other users of their livelihoods. The Offin and Oda rivers, as well as several of its tributaries, provided employment for those who fished in them. The study discovered that fishing on the Oda and Offin rivers has decreased significantly, with some extremely determined fisherman fighting the odds and continuing to fish in the hope of catching some fish for subsistence. Figure 7.4a depicts a locally constructed canoe on the Oda River in Watreso, along with a fisherman about to try his luck at capturing some fish. The polluted water resource poses a significant risk to fishermen and their families. To begin, ‘the physical health of fishermen is imperilled by dissolved heavy metals found in polluted river bodies because of mercury and other chemicals used by small-scale miners. The study found that a Buruli ulcer outbreak happened several years ago among residents of communities along

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66 Sachet water is a packaged water of 500 mL. The package is made of polyethene plastic bags that are heat-sealed on either end.
the Offin River, such as Tontokrom and Keniago. Second, the ingestion of contaminated seafood may threaten the entire household of fishermen.

Moreover, these water resources that were previously used for year-round vegetable growing are no longer suitable for such uses due to pollution or destruction caused by small-scale mining activities. A focus group discussion with vegetable farmers revealed that, because of the destruction of small streams used to water vegetables, some farmers have resorted to collecting and using water in mine pits (FGD_OD001_VFM). Despite their awareness of the unfitness of such water for human use, these farmers were forced to utilise it. This could bring dissolved contaminants found in polluted water into the food chain, highlighting the possible health risk associated with insufficient water access capabilities.

The inadequate water access capabilities induced by small-scale mining operations highlighted thus far extend well beyond the mining operations' immediate jurisdiction. In other words, contamination of natural water bodies has negative externalities (Pigou 1920). For instance, the study discovered that the severely turbid and polluted state of the Oda River (See Figure 7.5) has a detrimental effect on the availability and expense of processing drinking water for residents of the Obuasi\textsuperscript{67} enclave. This is because the Oda River in Odas serves as a reservoir for water that is treated and distributed to residents of Obuasi and its environs by the Ghana Water Company Limited.

\textit{Figure 7.5: Turbid water from Oda River undergoing treatment to be used as drinking water}

\textsuperscript{67} Obuasi is a mining community and town in the Obuasi Municipality. It is the host community of AngloGold Ashanti, a global mining company in Ghana and elsewhere in the world.
The study discovered through an interview with an official at the managerial level at *Odaso* Water Company Limited that the highly turbid *Oda* River results in high production costs and an increasing loss of processed water. The key informant describes how illegal small-scale mining operations have impaired the processing of drinking water for numerous settlements outside the immediate proximity of small-scale mining operations as follows:

“In simple terms, the impact of the activities of illegal mining on water production here includes first, high cost of production. E.g., with the raw colour of 1000 [litres of water] a dose of 10ppm\(^{68}\) is required. This can translate in 24 hours into say 250kg of chemicals, but because of the turbid nature of the river, we are dosing now at 55ppm. This sometimes even go up to about 70ppm. In effects, more chemicals will be needed. Yesterday, for instance, we used 550kg of chemicals which is two drums and more. The second is process loss. A lot of processed water with chemicals are lost. With low turbidity, the dislodge valve will not be opened to dislodge them. This increases electricity cost because all turbidity is not rid of during the sedimentation process” (KII_002_M_LS).

Individuals' capabilities to achieve their functionings (doings - smallholder farming and mining) have been examined in the preceding sections. As discussed in Chapter 3 and depicted diagrammatically in the conceptual framework driving this study, the degree to which an individual can convert his or her resources into functionings (food security) is contingent on several elements referred to as conversion factors (Robeynes 2016). These variables are classed as personal, social, and environmental (Robeynes 2005, p: 99). As explained in Chapter 3, these conversion factors are reclassified into four categories for this study: 1) power relation factors (2) socio-economic factors (3) environmental factors, and (4) personal factors. The following section of this chapter discusses the power relations element. The hierarchy of power among the primary actors of mining and smallholder farming is identified and examined in detail. Additionally, the power dynamics between and among these key actors are discussed.

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\(^{68}\) Ppm is an abbreviation for ‘parts per million’. It is sometimes expressed as milligrams per litre (mg/L). It is the mass of a chemical or contaminate per unit volume of water.
7.5 Power hierarchy and relations among key actors

From the preceding sections, various state and non-state actors have varying interests and power capabilities in relation to mining and smallholder farming. These power relations are typically asymmetrical, culminating in disproportionate costs and benefits (Bryant 1997). These power relations are complicated in practice, and its constituents cannot be adequately described by a single model. However, based on the literature and primary data from fieldwork, I summarised the power relations among the key actors in the mining and smallholder farming subsectors and depicted them diagrammatically in Figure 7.6.

As illustrated in Figure 7.6, five key state and non-state actors hold and exert varying degrees of power to regulate access to mining and smallholder farming resources. These actors are indirectly influenced by globalisation and international actors’ neoliberal agendas. In simple words, the five identified principal actors can be classified into three non-exclusive tiers. Tier 1 is equivalent to the socially constructed global and national/regional scales, whereas Tiers 2 and 3 are equivalent to the local scale. At each level of power, one actor or a group of actors exercises direct influence over another actor. There are numerous categories of actors, each with a different level of power. I will explore relational power hierarchies and power relations between and among key actors in the next subsection.
7.5.1 Power hierarchies among key actors

To begin, the Ghanaian state actor, represented at the national scale by the Ministry of Lands and Natural Resources, the Ministry of Food and Agriculture, the Minerals Commission, the Water Resources Commission, and other related institutions and agencies, wields the highest form of power over any other non-state actor in terms of mining and smallholder farming. This is because the current laws and regulations of Ghana provide the state with excessive power.
over the governance and allocation of natural resources, often at the expense of less powerful parties. For instance, Sections 5(1) and 6(3) of the Minerals and Mining Act, 2006 authorise the Minister of Lands and Natural Resources “to negotiate, grant, revoke, suspend or renew mineral rights” and “issue the licence in the form and on conditions determined by the Minister” respectively. In practice, the implementation of such statutes confers undue power on state actors. As detailed in Chapter 5, these laws and regulations are structured and backed by externally negotiated neoliberal policies promoted by international organisations such as the World Bank and the International Monetary Fund, which promote capitalism in favour of foreign investors (Akabzaa and Darimani 2001; Abdulai 2017). Additionally, some of these laws erode the power of other actors, including traditional authorities, and commonly fail to adequately account for other less powerful actors, particularly the poor at the local scale, when it comes to land access for farming or mining. The excessive power of the state reflects a colonially orchestrated bifurcated state that exercises two distinct forms of power under a single hegemonic power: civil\(^69\) and customary\(^70\) and distinguishes between ‘citizens’ and ‘subjects’, ‘natives’ and ‘non-natives’ (Mamdani 2018, p. 61). It is important to note that traditional authorities and large-scale mining firms have power to influence state and international actors’ enacted laws through their consultation role throughout the drafting stages or in the lead-up to new legislation. Despite this, the influences of traditional authorities are typically weak, and unequal power relations among key actors manifest in state actors and large-scale mining firms dominating (Akabzaa et al. 2009). Some traditional authorities engage in direct negotiations with small-scale miners to exercise their agency and respond to their weak power, resulting in a parallel system of mining licencing in Ghana – the formal granted by state and the informal granted primarily by chiefs to illegal small-scale miners(Nyame and Blocher 2010; Bebbington et al. 2018).

Within the defined power hierarchy, the second significant non-state actor is the traditional authority, which include the king and various chiefs. In the Ashanti region, which includes the study district, there are three main hierarchies of traditional power. From the bottom, there are

\(^{69}\) Civil power was organised institutionally based on differentiations. It claims to defend rights ideologically, while economically it regulates market transactions and ensures the reproduction of market relations (Mamdani 2018, p. 60).

\(^{70}\) Customary power was organized institutionally based on power fusion. It claims to enforce custom from an ideological standpoint. Economically, it was situated at the crossroads of market and non-market relations, mediating the link via extra-economic coercion. Mamdani (2018, p. 60).
caretaker subchiefs referred to locally as ‘Odekuro’ who have jurisdiction over a specific area/community. Many of the study communities, for instance, were supervised by an Odekuro. These Odekuro are subordinate to a paramount chief who oversees several communities. Additionally, the paramount chiefs answer to the King (Asantehene), who serves as guardian of all territories in the Ashanti kingdom. Prior to independence, resource extraction and control were handled by hierarchies of traditional authority who served as trustees for the land owned by the entire population (Dumett, 1998) as detailed in Chapter 5. As illustrated in Figure 7.6, these traditional authorities implemented customary law and exercised direct control over the other three non-state actors operating in the mining and agriculture subsectors. Prior to independence, for example, traditional chiefs got one-third of the minerals mined in their territory, in addition to revenue from taxes and compulsory labour (Refer to Chapter 5 for details). Over smallholder farming, a similar level of power was exercised. The traditional rulers, as land guardians, oversaw the allocation of community lands to households and clans for agricultural purposes. Additionally, they benefited from farm produce presents and unpaid labour on their farms. From the colonial period to the present, colonial capitalism and its accompanying commercialisation of stool land have substantially undermined these direct powers of traditional leadership.

Furthermore, the post-independence nationalisation of mining activities, as well as the current regularised and liberalised mining system, which places the private sector (mostly foreign investors) at the centre of events, have all weakened traditional institutions’ power. Despite this, the traditional authority continues to hold substantial power, with an estimated 80% of all land interests in Ghana controlled by customary authorities (Kasanga and Kotey 2001; MoFA 2018b). Therefore, most mining (large-scale and small-scale) and agricultural operations occur on stool land. Following the illegal small-scale mining phenomenon, several chiefs have been charged with conspiring with illegal miners to perpetuate the illegality (Crawford et al. 2016; Crawford and Botchwey 2017). This is accomplished by allocating stool lands or authorising the use of family holdings for illegal mining. It is imperative to reiterate here that illicit small-scale mining cannot occur without the express authorisation of chiefs who function as custodian of lands in local communities. A clear example is the Mem case, where the chief has incessantly opposed any type of illegal small-scale mining activities. This is an extraordinary and unusual case in the mining zones of Ghana. Additionally, chiefs have played a significant role in recent land grabs in several districts of Ghana for commercial agricultural objectives (Cotula et al. 2009, 2014; Boamah 2014).
Chapter 7: Power hierarchy and relations among key actors

Moreover, the third tier of power is vested in large-scale mining corporations. Ghana initiated the Structural Adjustment Programme (SAP) in 1983 as part of a broader Economic Recovery Programme, as explained in Chapter 5. The SAP sought to address issues such as declining exports, a frail financial system impeding private investment and savings mobilisation, stagnating industry, and ineffective governmental administration, among others (Akabzaa & Darimani, 2001, p. 17). With mining being a significant export sector, the SAP incorporated various mining reforms. Among the significant mining sector policy reforms were changes to mining sector legislation to increase the sector’s attractiveness to foreign investment; increased fiscal liberation for the mining sector; strengthening and realignment of government support institutions for the mining sector; privatisation of state mining assets; and enactment of environmental laws and other mining sector legislation (ibid). These reforms, promoted by the World Bank and IMF in Ghana and other African mining countries, have reinvented the wheel, elevating large-scale mining corporations owned by foreign investors to prominence. Large-scale mining businesses' financial, technological, and institutional capabilities, to name a few, enable them to directly exert uneven power over both small-scale mining firms/individuals and smallholder farmers. Specifically, regarding small-scale mining, a large-scale ‘bias’ has been suggested (Hilson et al. 2017; Hilson 2019) and attributed as one of the variables impacting small-scale mining policy in Ghana and other African countries (Hilson 2019). It is worth highlighting that this ‘bias’ is not limited to small-scale mining but encompasses all land uses in mining towns, including crop farming. For example, key informant interviews revealed that fertile land for perennial (cocoa) and other food crops is ‘sacrificed’ for large-scale mining activity. Two important informants comprising an Assembly Member of the Amansie South District and a Chief Farmer/Leader of the District Farmers’ Association substantiated the widespread ‘bias’ toward smallholder in the following manner:

“The areas which used to be our food basket have all been taken over by the main mining company in this community, Asanko Mines. This area was known as ‘buo Kwaku’ [literally meaning Kwaku Hills]. This was an area where we harvest the greatest food crops, but Asanko Mines obtained the area as concession …” (ORH_04_AD).

71 A Chief Farmer is a renowned farmer with the largest farms and/or highest yields and often serves as the mouthpiece/leader of local farmers in a particular town.
"A greater part of the farming land in this community have been given out to Asanko Gold Mines as a concession. A large part of that land had cocoa on it, but they have all been destroyed" (KII_008_M_LS).

Also, small-scale mining institutions and people/groups of individuals are next in the power structure. This set of actors is exceedingly heterogeneous, and there are complex power relations between them. This group of actors operates legally or illegally and consists of both national and non-national actors, even though the subsector is a preserve of Ghanaians. Finally, smallholder farmers are classified into two non-exclusive groups: perennial cash crop farmers (cocoa, oil palm) and food crop/vegetable farmers. These group of actors are generally the weakest link in the power hierarchy, both in terms of influence and access to critical natural resources. Despite this, a distinct power structure exists between these actors, with peasant food crop farmers wielding and exerting the least power because of cash crop promotion. As discussed in Chapter 5, the promotion of cash crops at the expense of food has eroded the power of food crop producers, who bear the brunt of the other actors’ direct exertion of power. By examining smallholder farmer power dynamics through the lens of indigenous and migrant actors, we can see that migrant farmers are at the bottom of the power hierarchy, as discussed in the next section. Each of the five broad key categories of actors examined thus far in terms of its hierarchical structure possesses distinct power capabilities and is influenced by interconnections with others in distinctive ways. The next section explores the diverse power dynamics that exist between and among the main actors, as well as their ramifications.

### 7.5.2 Power relations between and among the different key actors

Distinct unequal power interactions were discovered between and among various actors within the power hierarchy in the preceding subsection. These disparate power relations were discovered to be consistent with land, water, and labour access capabilities. The severe practice of unequal power relations was seen regarding land access and was noteworthy among the three access capabilities. The study revealed two distinct land negotiation and acquisition practices in relation to the power dynamics of the actors involved. These practices culminated in the dispossession of land and/or farms by less powerful actors. These two practices are discussed in greater detail in the following paragraphs.

To begin, the initial practice of land negotiation and acquisition reveals the unequal power relations between the state, large-scale and registered small-scale mining entities/individuals
on the one hand, and all other actors on the other. During land negotiations and acquisition for mining activities, the excessive powers of the state are used to favour large-scale and registered small-scale mining institutions and individuals at the expense of other actors, particularly smallholder farmers. This conclusion is drawn from the fact that the state normally grants mining rights to these two actors with little or no concern for current land users, as long as the land in question does not overlap with existing concessions (Hausermann et al. 2018). For large-scale mining, which involves large tracts of land (between 21 and 132,300 ha) commonly belonging to diverse groups of individuals, families, or the stool, there is some formal recognition of existing land users and a streamlined approach to compensation, which is regularly mediated by a committee to arrive at “fair and adequate compensation” as defined in the compensation regulations (Government of Ghana 2012a, p. 2). According to a key informant at the Ministry of Land and Natural Resources, existing land users have a variety of possibilities. These include equal reinstatement, in which such land users are placed on land comparable to what they are losing and compensated for the hardships created. In this case, compensation comes in the form of an agreed-upon sum of money, commonly referred to as a “disturbance payment” (KII_006_M_NS). In other instances, landowners are compensated solely with an agreed-upon sum of money, and they decide how to spend the money (KII_006_M_NS). The latter was prominent in the study district. Following several rounds of negotiations, smallholder farmers and other current land users are compensated with a one-time cash payment. According to a key informant and a member of the compensation committee, these compensations are insufficient in light of the anticipated number of years farmers would benefit from their farms72 (ORH_04_AD). Another key informant and a member of the leadership of the District Farmers’ Association stated a similar concern, arguing that “with the bulk of money [compensation] at one time, many of them [farmers] wasted it and have become poor now” (KII_008_M_LS). According to this key informant, many farmers have become “miserable”. The farmers are miserable because their lands have been lost in perpetuity and their compensation has been depleted as well. These narratives were prevalent and not unique to smallholder farmers, individuals, or families that lost land to large-scale mining, but also to small-scale mining. Despite this, there are some success stories of people or families who have used their compensation for beneficial endeavours such as home construction. Chapter 8 will explore several of these beneficial outcomes, as well as some other negative unintended outcomes.

72 Farms with cocoa can continuously yield fruits for over 30 years.
Chapter 7: Power hierarchy and relations among key actors

The streamlined compensation mechanisms outlined above should normally apply to small-scale mining allocations as well, however this is not the case in practice. Rather than that, informal negotiations between mining license holders and existing land users continue (Hausermann et al. 2018). This may be explained by the fact that small-scale mining concessions are rarely granted on broad expanses of land, and these properties may belong to just one or a few persons or families. Numerous individuals claiming to have been granted mining permits come to the study communities without alerting current landowners/users and requesting that they vacate their property to allow for mining operations. According to an Assembly Member in one of the study communities, established land users are losing their farms to small-scale miners who claim to have been granted a concession on those lands:

“We had people coming from Accra with papers [purported mining licenses] that they have been granted a concession to mine by the Minerals Commission. People came from Accra, Takoradi and Tema that they have been granted a concession by the minerals commission to mine. People [farmers] had no choice but to sell their lands given out for concession. Even when you refuse to sell, you get calls from the elderly and reputable people from the community to sell. Those who share boundaries with concession lands also have no choice but to sell their lands because, with the mining activities, all the underground water goes into the mining pit leaving the crops with no water to thrive. The chief here does not even have much to do because the people come with genuine concession papers from Accra” (ORH_02_DT).

The below example demonstrates the diminished ability of present landowners/users, who are largely cropping farmers, to ‘sell off’ their land and/or farms for mining activities. Additionally, the limited power of the traditional authority (chiefs) in relation to the state regulator can be determined. Unlike large-scale mining where the Mining and Mineral Act requires the Minister to “give a notice in writing of a pending application for the grant of a mineral right in respect of the land to a chief or allodial owner and the relevant District Assembly” (Government of Ghana, 2006, Article 13(2), small-scale mining has no such requirements. This keeps chiefs and other traditional authorities in the dark about the allocation

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73 Receive some compensation for dispossession
of small-scale mining rights, which may contribute to their involvement in illicit small-scale mining.

Excessive state power in respect to farmers and traditional authorities can occasionally lead to conflict. A key informant in the Watreso community spoke to a conflict between some farmers and a Spanish mining business that had been awarded a mining permit. This conflict necessitated the involvement of the Minerals Commission of Ghana, which articulated the power of the state as owner of all mineral reserves in relation to the surface rights of farmers (ORH_02_DT).

The study discovered a second practice of land negotiation and acquisition based on the overwhelming powers of the state. This practice exists in the grey area between informality and illegality, and it occasionally flourishes on the principle of ‘survival of the fittest’. Many people, families, and sometimes traditional authority alienate their interests in land for illicit small-scale mining in response to economic hardships, pressure from powerful non-state actors, and a desire to exert agency in opposition to the overbearing powers of the state. It was determined that these land interest alienations for illegal small-scale mining were voluntary or involuntary. During a focus group discussion, Agya Mensah, a farmer, demonstrated the voluntary alienation of land interests for illicit small-scale mining by saying:

“Many landowners have sold their land for galamsey activities. They were not forced by the government to do so. … I have personally sold my land too for galamsey and spent the money” (FGD_OD02_CF).

This voluntary transfer of land interest for illicit small-scale mining was reiterated by a key informant as follows:

“I know a farmer who has refused to sell his cocoa farms despite all the people he shares boundaries selling theirs. Frankly, the farmers are not forced to sell their farmland. They sell them voluntarily when they consider the bulk of the money, they will get which they can never get from their farms” (KII_009_M_LS).
The findings revealed that voluntary alienation of land interest for galamsey activities began with wetlands. This occurs for one of three reasons. To begin, the marshes were endowed with mineral resources. Without conducting any tests, illegal miners could certify the existence of a gold resource through the grant of identical sites to recognised small-scale mining individuals or entities by the Minerals Commission of Ghana. The second, and perhaps most important, reason for alienating wetlands for galamsey purposes is a clear scorn for wetlands due to their failure to support cocoa cultivation. This demonstrates the grandeur accorded perennial crops, notably cocoa, at the expense of food crops and vegetables, as such wetlands served as the primary zones for food crop and vegetable growth. This comes at a cost, which will be discussed in further detail in the following chapter, with a particular emphasis on food security. Finally, the wetland region ensured availability to water for mineral ore washing. This is because they are located near water sources (rivers, streams). Additionally, the relatively high-water table in such places enables easy access to subsurface water supplies at a cheap cost and depth. Almost all wetlands in the study communities had been destroyed by illegal small-scale mining activities at the time of the study. These areas were barren, with some being worked on by ‘secondary’ and less well-equipped artisanal miners employing the 'hwiegumu' method described in a previous section.

With the depletion of mineral deposits in wetlands, farmlands, both cultivated and uncultivated, became the next target for illegal small-scale mining activities. According to a key informant, some illegal miners perform mineral exploration activities on farms/farmlands they assume contain mineral reserves without notifying farmers or landowners (KII_008_M_LS). When successful in their explorations, they negotiate the purchase of such territories. Certain farmers agree to willingly relinquish their land interests. However, some were forced to do so because of fear of losing their farms to illegal mining, as all the farms with which they share boundaries had been sold for illegal small-scale mining. Others were persuaded to sell their land for illegal mining by the deliberate damage of their farms by mine water, the restriction of access routes to their farms by mining trash, and the persuasive remarks of some illegal miners. A farmer in Watreso described his concern of losing his land to illicit mining following the sale of all the farms with whom he shares boundaries:

“I used to have some cocoa farm in a low-lying area. It was doing very well because of the water body and all-year-round moist nature of the land. However, some Chinese miners bought all the lands I share a boundary with
and only my land was left, so I had to sell also. If I do not sell, my cocoa will die because when they dig their pit, all the underground water moves into it depriving the other crops of water. If you do not sell, all the cocoa will die. But for this, I would never have sold that cocoa farm I had very good high breed cocoa on it [land alienated]. When they started buying the lands around that area for mining, we observed that those who didn’t sell theirs had their cocoa dying” (SSI_W07_M_FM).

This farmer mentioned in the following terms how illegal miners occasionally convinced them to alienate their rights in land for illegal mining by alerting them of the threats their activities posed to their farms.

“The Chinese man mining that area even told me that if I do not sell my land to them and they go, my cocoa will still die. Some who refused to sell had their cocoa dying. Some even regretted not selling. The Chinese man explained to us that they dig deep into the earth and so all the water in that area moves into their pits and thus our cocoa will not have enough water to thrive. Even when it rains, it drains into their dug pits” (SSI_W0_M_FM).

Also, during an Odaho focus group discussion, one farmer provided an illustrative example of how deliberate pumping of mining wastewater into their farms caused them to alienate their land interest for illegal mining:

“We have our crops on it [farmland] and my wife had even gone there to harvest some tomatoes just some few days. We went there after a few days only to observe that the galamsey activities ongoing in a nearby land have splashed their pit water on our farm. When this happens, the crops are not able to do well again so I had to sell the farmland” (FGD_OD02_CF).

The accounts of the farmers exemplify a widespread attitude among farmers who have lost their farms/farmlands to illegal small-scale mining. It depicts how smallholder farmers relinquish their interest in land to illegal miners owing to fear of loss, silent pressure, and deliberate and convincing manoeuvres by illegal miners.
Chapter 7: Power hierarchy and relations among key actors

The accounts detail the coercion that forced some farmers to exercise their agency by selling their farms. Individuals with less vested interests in land, whether through sharecropping, caretaking, or rental, were disproportionately affected by this temptation to sell farmland for illicit mining. The following account by Manu, a sharecropper in Watreso, substantiates the notion that those with lesser vested interests in land are adversely affected by land appropriation for small-scale mining:

“I once cultivated 3.7 ha of cocoa farm, but the owner of the land has made us sold it to be used for galamsey. The money he gave me from the sale is finished as I used it to pay for my children’s school fees. …. It was the owner of the land who decided to sell it. I tried convincing him severally not to, but he still insisted and was convinced by his nephew and sister to sell. This owner likes quarrelling and if I had not agreed for the farm to be sold, I am very sure he would have still gone ahead without me receiving my share of the proceeds from the sale. Moreover, our land was the last land in that area to be sold for galamsey. All other lands sharing boundaries with us were already sold” (SSI_W002_M_FM).

The narrative above demonstrates the vulnerability of less powerful individuals with limited land interests, as well as the exploitation of labourers by some farm owners. These exploitative tendencies are being fuelled by the increasing demand for land for small-scale mining. Additionally, the loss of farming livelihoods can be noticed in relation to the growth in demand for land for small-scale mining, which has several repercussions.

7.6 Chapter summary and conclusions

In this chapter, I have addressed and analysed the ability of major actors operating in the mining and smallholder farming subsectors to get access to and control critical resources (land, water, and labour), as well as the power hierarchy and relations among these key actors. The following paragraphs summarise the major findings and the conclusions that can be drawn from them.

To begin, I have demonstrated the diversity of acquiring interests in land for mining and smallholder farming purposes. These land holdings are governed by state and customary systems, with large-scale mining activities governed by stringent legislation and rules negotiated in favour of international investors. Capabilities for acquiring land for small-scale
mining were discovered to be partially legalistic, with a bigger share being customary and operating illegally. On the contrary, capabilities for acquiring land for smallholder farming are conventional. Thus, due to the vast powers connected with state juridical institutions, access to agricultural land was frequently hampered.

Second, I have demonstrated that unlike large-scale mining, which requires significant capital investment, small-scale mining, and smallholder farming both require significant labour. As a result, casual workers were a ‘hot commodity’, and small-scale mining firms/individuals, as well as smallholder farmers, were forced to compete for them. The findings demonstrated that labour access was skewed in favour of small-scale mining institutions and individuals. This is because small-scale mining firms/individuals paid a higher daily wage than smallholder farmers. Interestingly, both small-scale mining and smallholder labour relations were gendered, with women earning lower wages and allocated to lighter workloads. These findings corroborate those of Arthur-Holmes, 2020 and Buss & Rutherford, 2020; Buss et al., 2019 in different parts of Ghana and the Democratic Republic of the Congo, respectively.

Additionally, I have confirmed the competition for access to water resources between mining and smallholder farming. These ranged from large-scale mining firms withdrawing large amounts of surface and underground water to small-scale mining firms and individuals polluting surface water (rivers and streams) by denying and/or compromising use by farmers and other users whose livelihoods are dependent on water resources. Also, I have demonstrated that the negative externalities associated with mining-related contamination of water resources extended well beyond the region under study.

Furthermore, I have identified several state and non-state actors and classified them into five major power hierarchies based on the degree of power they possessed and exerted. Also, I have discussed the power relations between and among various power hierarchies. The findings have demonstrated the unequal power interactions between and among these major actors, which correspond to the identified power hierarchy. The disproportionate power of the state over other actors in the mining and smallholder farming sectors was confirmed.

Moreover, I have demonstrated that the mineral-related powers of the state are transferred to large and registered small-scale mining institutions and individuals at the expense of other actors (mostly smallholder farmers). In response to this and in exercising their agency, I have
showed that other actors, including certain traditional authorities and some farmers, alienate their farmlands for illicit small-scale mining, either voluntarily or undue pressure. It must be emphasized here that financial interests, fear of loss, silent pressure, and planned and persuasive manipulations by some small-scale mining operators all contribute to less financially endowed farmers outright alienating their farmlands. According to the findings, the actors that suffer the most from such trades are migratory farmers who have a diminished interest in mineralised fields.

From the foregoing summary of major findings, I argue that the hitherto coexisting subsectors of mining and smallholder farming are now engaged in fierce competition for access to critical resources (land, labour, and water). This rivalry is exacerbated by unequal power relations between the two subsectors' primary actors, which favour mining over smallholder farming. This holds great implications for food security as will be discussed in the next chapter. Additionally, based on the findings, I argue that the operations of the small-scale mining sector are complex and heterogeneous, comparable to those seen in Tanzania and the Philippines (Fisher 2007, 2008; Verbrugge and Besmanos 2016). Contrary to the categorisation of artisanal and small-scale mining as a “low-tech…” activity (Hilson et al. 2017, p.80), the bulk of small-scale mining activities in the study district have advanced significantly, requiring the use of sophisticated machinery, corroborating the findings of (Crawford et al. 2016). This intensifies its competition with smallholder farming and increases the level of exploitation experienced by some miners and farmers. Furthermore, the findings show the value of combining the political ecology and capability approaches in understanding how power relations and socio-economic factors influence the capabilities of accessing essential resources for gold mining and smallholder farming. For example, the analysis of power relations and hierarchy from a multi-scalar perspective in accordance with political ecology provides great insight into power relationships at different levels (national/regional and local scales) and among different actors, providing in-depth insights into individuals' capabilities in accessing important resources for the achievement of their functionings (livelihoods and wellbeing) in conformity with the capability approach.
CHAPTER EIGHT
THE IMPLICATIONS OF THE RELATIONSHIP BETWEEN MINING AND SMALLHOLDER FARMING FOR FOOD SECURITY

8.1 Introduction
According to the most current report by FAO, IFAD, UNICEF, WFP and WHO (2022), the world is not on track to meet the Sustainable Development Goal (SDG) 2.1 Zero Hunger target by 2030. This situation is aggravated further by the impacts of COVID-19 on global food insecurity (Akpaki et al. 2020; Loopstra 2020; Niles et al. 2020; The Lancet Global Health 2020; Dabone et al. 2021; Gundersen et al. 2021). The total number of hungry people is gradually increasing, with Africa considerably falling short of the 2030 Zero Hunger target (FAO, IFAD, UNICEF, WFP and WHO, 2022).

Almost every subregion of Africa has seen an increase in food insecurity. This has been ascribed to conflicts and violence, climate variability, and increased exposure to increasingly complicated, frequent, and intense climate extremes (FAO, IFAD, UNICEF, WFP and WHO, 2022). The socio-ecological footprints of mining in relation to agriculture and other land uses and cover types, as well the complex socioeconomic and asymmetric power relations between mining and smallholder farming actors in terms of access to critical resources (land, water, and labour), as discussed in the previous Chapters (6 and 7), have enormous implications for food security outcomes. Despite this, such implications have received little attention in the existing literature. The studies that have attempted to examine such impacts (positive, negative, intended, or unintended) have done so superficially, focusing on only one aspect of food security (availability or access) or on the relationships between small-scale mining and agriculture in general, without focusing on food security (Hilson and Garforth 2012, 2013; Labonne 2014; Danyo and Osei-Bonsu 2016; Hilson 2016b). Thus, building on earlier research and analysis in Chapters 6 and 7, I will critically examine the linkages between mining and smallholder farming, as well as the implications on all four dimensions of food security (availability, access, utilisation, and stability). This is a direct response to my fourth research question and encapsulates the conceptual foundation for this study as explained in Chapter 3. In other words, the state of being (food security) and the doings (relationships between small-scale mining and smallholder farming) that contribute to the functioning of an individual are explored. As represented in the conceptual framework, the culmination of these relationships is either an improved or poorer personal wellbeing.
Chapter 8: Introduction

This chapter makes extensive use of quantitative survey data, key informant interviews, semi-structured interviews, and focus group discussions. These datasets are supplemented with secondary data on food production and insecurity received from the Ghanaian Ministry of Food and Agriculture (Mofa) and the United Nations Food and Agricultural Organisation (FAO).

Based on the findings of this chapter, I argue that mining is a significant contributor to food insecurity and, consequently, to the poor health and well-being of many individuals, particularly women. In other words, mining impairs the functioning of individuals, leading in decreased well-being. Additionally, mining exacerbates ingrained social differentiations based on age, occupation, and wealth. The findings demonstrate that mining activities limit local food supply and lead to an increase in the prevalence of moderate (50.1%) and severe (13.3%) food insecurity. That is, approximately half of the entire population showed anxiety about food access or ran out of food at least once in the last 12 months due to a lack of money or necessary resources. This prompted individuals to take a variety of strategies, like consuming less healthy foods, consuming fewer foods, skipping meals, or consuming less food. On the other hand, approximately 13% of them reported going an entire day without meals at least once in the preceding 12 months, indicating their hunger predicament. This hunger scenario did not arise because of fasting or any religious observance, but rather because of a lack of finances to access food. Additionally, it was discovered that these food insecurity episodes related to gender, age, profession type, level of education, and income. Besides, 79% of women of reproductive age (15–49) do not meet the Minimum Dietary Diversity (MDD) standards, a metric that indicates micronutrient sufficiency and, thus, food quality. This has grave consequences for their reproductive health and overall well-being, as well as the health and well-being of their children, including unborn children. Further, due to the local issues of food availability and the accompanying food access and utilisation challenges, which are strongly associated with mining activities, there is no guarantee of food stability over time. This explains why more people are expressing concern about future food access and utilising a variety of coping mechanisms.

The chapter is divided into four sections. Section 8.1 introduces the chapter. Section 8.2 provides information about the sociodemographic features of the study participants, which forms the personal and socio-economic conversion factors that influence the actualisation of food security outcomes.
Section 8.3 discusses the interconnections between mining and smallholder farming and the consequences of this relationship on the four elements of food security. In Section 8.4, I present a summary of the chapter and the conclusions drawn.

8.2 Personal and socio-economic conversion factors

Following Chapter 7, this section examines the study participants' characteristics, which also serve as the basis for the personal and socioeconomic conversion elements that determine the capabilities for achieving food security outcomes (Refer to Conceptual framework in Chapter 3).

Table 8.1: Personal and Socio-economic characteristics of the sample

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total number of respondents</th>
<th>% or Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>460</td>
<td>36 ± 15.7</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>227</td>
<td>49.4</td>
</tr>
<tr>
<td>Women</td>
<td>233</td>
<td>50.6</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried</td>
<td>115</td>
<td>24.9</td>
</tr>
<tr>
<td>Married</td>
<td>345</td>
<td>75.1</td>
</tr>
<tr>
<td>Migration Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natives</td>
<td>324</td>
<td>70.5</td>
</tr>
<tr>
<td>Migrants</td>
<td>136</td>
<td>29.5</td>
</tr>
<tr>
<td>Employment Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>389</td>
<td>84.6</td>
</tr>
<tr>
<td>Unemployed</td>
<td>71</td>
<td>15.4</td>
</tr>
<tr>
<td>Level of schooling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary/none</td>
<td>348</td>
<td>75.6</td>
</tr>
<tr>
<td>Secondary</td>
<td>96</td>
<td>20.8</td>
</tr>
<tr>
<td>Higher</td>
<td>17</td>
<td>3.6</td>
</tr>
<tr>
<td>Average total monthly income (£)</td>
<td>387</td>
<td>552 ± 387</td>
</tr>
</tbody>
</table>

Table 8.1 contains descriptive statistics about the survey respondents. The mean age was 36 years (SD = ±15), which matches and validates the relatively young demographic of the research district. The youthful age population poses both an opportunity and a risk to food security outcomes. To begin, a youthful population provides a huge pool of labour for the mining and smallholder farming subsectors, respectively. The previous chapter discovered that the mining subsector benefited the most from the youthful population, sometimes at the expense of the smallholder farming subsector. Additionally, the youthful population creates an increasing market for agricultural products. Despite this, the youthful population has the potential to place a pressure on both the current and future food systems, as well as the natural ecosystem. To begin, the dietary requirements of a youthful population are greater than those of an older population, implying that there would be an increase in food demand. Second, with
average life expectancy in Ghana at birth being 64 years in 2019 (The World Bank, 2021), this indicates that many of the study participants will have nearly half (28 years) more years to live, holding all factors constant. These sustained high food demands will place a strain on both the current and future local food systems, as well as the natural ecosystem. As a conversion factor, the study participants' age influences their livelihood assets and the livelihood strategies they use to achieve food security (Chambers and Conway 1992). Additionally, various age groups respond differently to the vulnerabilities associated with food security.

Additionally, gender has a significant impact on the capability for achieving food security objectives. As demonstrated in Chapter 7, access to land and labour capabilities were gendered, with women disproportionately exploited in terms of labour wages. Also, despite their role as food stewards and cooks, women have limited access to resources, making them more vulnerable to rising food insecurity. Food insecurity is heavily gendered, with women experiencing it at a higher rate than males (FAO, IFAD, UNICEF, WFP and WHO, 2022). A recent study conducted in Sub-Saharan Africa discovered that proximity near mine sites increases the risk of food insecurity for women (Wegenast and Beck 2020). The participants of the study were 51% female, the majority (75%) of whom were married. Given the large household size of 4.5 in the district, many of these married women may be responsible for supplying food not only for themselves but also for these huge families.

Moreover, many study participants (71%) were native and had low levels of education (76%). These personal attributes may influence their capability to access food. For example, the migration status of an individual has a significant impact on their access to natural resources such as land for farming or mining. According to the findings of the preceding chapter, migrant farmers with smaller land interests were among the most affected by land dispossession. Additionally, given the rural nature of the study district, a low level of education is expected, which has a significant impact on the livelihood choices they can employ and their food security outcome. It is worth noting that the low level of education means that most research participants are ineligible for jobs in large-scale mining companies that require highly skilled labour.

74 Natives are individuals with either of their parents coming from the study communities or born in the study communities.
The difficulties of many youngsters to obtain employment in large-scale mining firms is cited as a reason in their engagement in small-scale mining, both legally and illegally (Afriyie et al. 2016). Further, as highlighted by a key informant (ORH_02_DT), small scale miners took advantage of certain farmers' low education and lack of information when it came to land negotiations and appropriation for mining. It was alleged that some small-scale miners produced forged documents purportedly obtained from the Minerals Commission to take over farms for mining purposes. Due to these farmers' poor levels of knowledge, they are unable to verify the authenticity of documents and hence succumb to such pretences as selling their farmlands for pitiful income compensations out of fear of losing the land without compensation.

Finally, a substantial proportion of study participants (80 % of total) were employed. This, of course, will influence their food security outcomes. However, the critical question is whether the earnings and income generated by various livelihoods are sufficient to cover the rising cost of living in the district. After adjusting for outliers, the average monthly income was €552 ($9775). This indicates that, even though a few people benefit from farming or mining, many people live in poverty.

8.3 Relationship between mining and smallholder farming and the implications on food security outcomes

As illustrated in the conceptual framework (Refer to Figure 3.1), and detailed in Chapter 3, the functionings of improved food security is inextricably linked to mining and smallholder farming. As discussed in Chapter 2, the relationships between mining and smallholder farming are argued as complementary or competitive. In addition to the relationships between key actors in the mining and smallholder farming subsectors in terms of their power hierarchy and relations, as well as their access to critical resources (land, labour, and water) as detailed in Chapter 7, I document in this section, the relationships between mining and smallholder farming in relation to food security. The analysis of semi-structured interviews, key informant interviews, and focus group discussions revealed the following associations, which are summarized in Table 8.2 in descending order of importance/weight.

75 The currency exchange rate was $1 to €5.7 as of February 2021 (XE.com Inc).
Table 8.2: Positive and negative relationships between mining and smallholder farming

<table>
<thead>
<tr>
<th>Positive Impacts</th>
<th>Negative impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>A ready market for cash crops for sale to miners and other related employees</td>
<td>Land/farm dispossession for mining activities</td>
</tr>
<tr>
<td>Employment opportunities</td>
<td>Destruction and pollution of natural water resources</td>
</tr>
<tr>
<td>Income generation to meet household needs</td>
<td>Reduction and loss of farm labour</td>
</tr>
<tr>
<td></td>
<td>Limited local food availability and access</td>
</tr>
</tbody>
</table>

In terms of food security, the most significant beneficial relationship between mining and smallholder farming is the ready market for cash crops. The burgeoning population of individuals engaged directly or indirectly in mining, along with the dwindling population of individuals engaged in farming, leads to a high demand for food crops. This creates a ready market for food crops for farmers and traders. The inherent obstacles smallholder farming and the ones linked with mining, such as farm/farmland losses and labour issues as discussed in Chapter 7, make it hard for farmers to meet the high demand for food crops and fully maximise the potential presented by a ready market. This is also due to the higher importance placed on perennial cash crops such as cocoa and oil palm in comparison to food crops. Many farmers cultivate food crops for subsistence, with only a handful cultivating them for market supply. By examining this rigorously, it is possible to corroborate the emphasis on export-led agriculture, which is reflected in the food availability situation mentioned briefly in subsequent sections of this chapter.

Another favourable outcome is the lucrative employment and income generation opportunities provided by mining. These favourable outcomes have been cited as one of the primary justifications for the formalisation of the sector (Maconachie and Hilson 2011; Hilson et al. 2017, 2019). Mining, notably small-scale mining, provides alternative livelihoods and income opportunities for some farmers in Ghana (Hilson and Garforth 2013), Zimbabwe (Chigumira 2018), Sierra Leone (Cartier and Burge 2011; Maconachie 2011), Burkina Faso (Werthmann 2009), and Malawi (Kamlongera 2011). However, these studies omit information about the kind of farmers who can benefit from the livelihood and income generation potential of mining. Not all farmers are eligible to benefit from alternative livelihood and income mining opportunities. Many farmers are unable to take advantage of these chances due to their age or
lack of resources (land and/or finances) ORH_04_AD. The operations of small-scale mining are strenuous, causing some miners to use illicit drugs such as marijuana and tramadol (KII_008_M_LS). Consequently, mining as an alternative livelihood option is limited to young capable farmers. This is one of the reasons why smallholder farming is a preserve of the elderly. For the elderly, who make up most farmers, mining is only possible as sponsors, which requires either land or financial ability. A number of these farmers have been identified who not only possess huge acreages of cocoa farms but also have access to family lands for illicit small-scale mining. Nana⁷⁶, a 10-ha cocoa farmer, assembly member, and small-scale miner with approximately 20 mining labourers, is one of these farmers.

A perceived distortion of entrenched social differentiation based on both ‘nominal’ and ‘graduated’ social parameters⁷⁷ (Blau, and Otis, 1967 cited in Catton 1978) was associated with small-scale mining. The construction of contemporary residences, either inside or outside the study district, was a significant outcome for those involved in small-scale mining and/or who received cash compensation for the sale of land for mining activities FGD_OD_002_CFM, SSI_AD_003; SSI_D001; SSI_D007; SSI_W_002). This favourable outcome was, however, more prevalent among some youth involved in small-scale mining. This has altered the status quo for cocoa farm owners, the majority of whom are elderly, who previously ranked highly in ‘the social hierarchy of society and received all the reverence and advantages associated with such a position. Due to mining activities, the wealth standing of some young small-scale miners has surpassed that of older cocoa producers. According to a well-known farmer, small-scale mining activities have resulted in a drop in the respect shown to senior farmers who used to own some of the 'nice' houses:

“Before the galamsey activities, farming and farmers were well respected in this community. There were few rich persons, so it was the cocoa farmers who were considered rich. If you can build with a good roofing sheet you are very much respected. With my two buildings at that time, whenever people visit this community, they were brought to my house. During those days, it was bamboo

⁷⁶ Pseudonym name
⁷⁷ The nominal parameters differentiate a population into sub-groups with discernible boundaries, but without necessarily ranking them while the graduated parameters differentiate people in a ranked ordered manner. In the study area, age, sex, and occupation were nominal parameters whereas wealth is a graduated parameter.
buildings. With the galamsey now, even young people have become rich and have built modern houses” (SSI_W_002_M_FM).

This quote implies the emergence of a new social class structure based on age, occupation, and wealth. As seen by the remark, wealthy young adults involved in mining are now accorded greater respect than the elderly farmer. Indeed, numerous modern houses were spotted during the fieldwork in practically all the study communities. These were said to be the property of indigenous mining 'gurus.' These mining gurus were mostly sponsors and proprietors of various small-scale mining enclaves that operated legally and illegally. Along with modern homes, some of these gurus own and operate fuel filling stations. These stations supplied fuel to their own and other mining operations. I interviewed one such guru who invited me into his modern home and showed me around. To begin, this house was walled in contrast to most dwellings with open traditional compound house plans. Second, the house was fitted with contemporary materials and technology, such as security doors, a 43-inch television, and sound systems. The flooring was tiled in what appeared to be costly Italian tiles. Additionally, the house was roofed with new Aluzinc coloured roofing sheets. This indicates that mining has bridged the gap of poverty and provided a possibility for some youth to own such contemporary homes. That said, such opportunities exist for a select few of these sponsors, while many individuals, both miners and those employed in other occupations, do not. As a result of this new social class system, many young people prefer to work in mining without regard for the environment.

The key adverse links between small-scale mining and smallholder farming, as summarised in Table 8.2, are all connected to the capability to access land, water, and labour, all of which were thoroughly explored in Chapter 7. In summary, Chapter 7 established that mining activities resulted in the voluntary and/or coercive alienation of farmland and the dispossessing of farmers. Additionally, mining activities have resulted in a large shift of casual labour from farming to mining, owing to the economic clout of mining. Further, the chapter discusses how pollution and degradation of natural water sources affect the food crops farming, notably vegetable farming. The following sections of this chapter will address the implications of the above-mentioned linkages between mining and smallholder farming on the four dimensions of food security (food availability, access, utilisation, and stability).
8.3.1. Availability of food

Food availability is a function of food production and trade and constitutes the supply side of food security (FAO 2008). The study district is an agrarian economy, and the availability of food is through domestic food production complemented with trade. Consequently, historical data on major food staples produced domestically for the last 19 years (2000 to 2019) were analysed to assess food availability.

Figure 8.1: Production of major food crops

Source: Statistical Research and Information Directorate (SRID) of MoFA Ghana 2020
According to the data, production of all major staple foods began to fall sharply in 2004 with some food crops having sporadic variations until 2016 and 2018. (Figure 8.1). For example, until 2019, maize (Zea mays) output, a major staple crop needed in the preparation of a variety of Ghanaian cuisines spanning from breakfast to dinner, remained low in comparison to pre-2004 levels. Additionally, from 2004 to the time of the study, cocoyam (Colocasia esculenta) production did not exceed pre-2004 levels. These eras of precipitous drops in the production quantities of the primary staple foods correspond to the second and third epochs of land use and land cover changes, which correspond to the graduated to accelerated and sharp increases in ecological footprints discussed in Chapter 6. As a result of these facts, a negative association between mining and food crop yields can be determined. The District Director of the Ministry of Food and Agriculture (MoFA) acknowledged this drop in main food crops because of mining activities (KII _001_M_LS).

As discussed in Chapter 7, active small-scale mining results in the encroachment of farms and arable lands, particularly those located in wetland areas suited for the cultivation of maize (Zea mays) and other food crops and vegetables. A Chief Farmer/Leader of the District Farmers’ Association as well as an Assembly Member at the District, confirmed the following implications of mining on food security:

“It [food security situation] is awfully bad! There is a grave difference in the food security situation now compared to what it used to be. As I mentioned earlier, all the areas which previously support food and cash crop production have been used for galamsey activities. Now only a side of the community is used for food thus there are food challenges here. …If you compare now to years past, there is a significant difference in food available in this community” (KII_008_M_LS).

“Formerly, you will notice people selling foodstuff on their head while others arrange these foodstuffs including plantain (Musa paradisiaca), cassava (Manihot esculenta), etc on small tables in front of their houses. However, now, this does not often occur. We must buy such foodstuff from Kumasi, even cassava. Just last three days, I roam this community in search of plantain but did not get some to buy which was not so previously. The areas which
used to be our food basket have all been taken over by the main mining company in this community, Asanko Mines. This area was known as ‘*buo Kwaku*’ [meaning Kwaku Hills]. This was an area where we harvest the greatest food crops, but Asanko Mines obtained the area as concession …” (ORH_04_AD).

These two comments demonstrate the drop in domestic food crop yields and, consequently, the challenge of domestic food availability in mining communities, which corroborates the findings of Wegenast and Beck (2020) in Sub-Saharan Africa and that of Danyo and Osei (2016) in Ghana. Furthermore, the quotations attribute the diminishing food availability in the community to both large-scale and small-scale mining operations. As a result, it can be argued that mining (on both a local and large scale) has a major impact on food supply.

Compounding the decline in domestic food production is the absence of an organised district market and inadequate road infrastructure throughout the district (KII_001_M_LS), both of which jeopardize the commerce side of food availability. To begin, the absence of an organised district market reduces local food supplies, forcing traders and/or families to travel to the regional capital (Kumasi) to supplement what is available locally. Second, the distance (67 kilometers one-way) between Kumasi and the district capital (Manso Adubia) as well as the poor road conditions raises transportation expenses for goods and services, hence increasing food prices in the district. Additionally, the dense population of the district (Ghana Statistical Service 2014a) exacerbates the falling food availability issue. Despite the limited food supply and other requirements, demand is high due to the burgeoning population as a result of immigration for mining activities. This leads in local food shortages and general price increases as a result of the increased demand for scarce food resources. A Chief Farmer/Leader of District Farmers’ Association and a farmer, expressing the sentiments of many, lamented the difficulty of food availability and its attendant skyrocketing prices as follows:

“The traders travel to Kumasi to get foodstuff like yam (*Dioscorea*) and cassava (*Manihot esculenta*). Even plantain (*Musa paradisiaca*), there are times it is exceedingly difficult to get here in this community and when you finally even get some, the prices are remarkably high. You can buy a bunch of plantain for thrice the cost it is sold in Kumasi. This is because of large
“It [small-scale mining] has led to hunger in this community. All those who are not able to engage in galamsey activities lack money and the prices of food are expensive here thus they are unable to buy” (SSI_AD003_M_FM).

The foregoing demonstrates the severity of the challenge of food availability posed by mining activities, compounded by infrastructural constraints. Interestingly, the quotations above imply certain things. To begin, food prices in the regional capital, an urban centre with minimal farming operations, are lower than in the study district, a rural farming district with a high proportion of low-income households. This has the potential to jeopardize the welfare of many persons, as food currently accounts for a significant portion of the income of poor rural households. Many individuals may lack the funds to spend on other essentials such as education, health, and entertainment. This is a grave condition, as the majority (68%) of research participants obtained food through food purchases, with only 28% acquiring food from their own production. It is worth mentioning, however, that farming households do supplement their food needs with food produced on their land.

Second, the last remark illustrates the disproportionate impacts of food availability, such as those linked with the main resource access capabilities mentioned in Chapter 6. These impacts are occupational and gendered in favour of male miners. Mining pays a greater daily or weekly wage than smallholder farming, which is seasonal in nature. As a result, many miners have regular disposable income to fulfil their food demands, in contrast to smallholder farmers, who must manage cash earned during the harvest season, the bulk of which may be spent on debt prior to the harvest season. Additionally, with daily or weekly wages that are higher than that of smallholder farmers, miners can afford rising food prices.

Furthermore, most miners are men, and as seen in Chapter 7, women who work in mining earn less than their male counterparts. Also, despite evidence indicating women spend substantial amount of their income on food (Meinzen-Dick et al. 2012), women have fewer options to

---

78 Most farmers earn a low wage and are rewarded seasonally dependent on the quantity of the land they cultivate. Cocoa farmers get paid at the completion of each crop harvest season. There are two seasons: the main season, which runs from October to February/March, and the minor season, which runs from April/May to mid-September.
pursue income-generating activities as a result of housekeeping and care tasks (Moser 2012). More, they have restricted access to productive resources (Johnson et al.; Doss et al. 2017; Kang et al. 2019). As a result of these findings, it may be deduced that the impacts of food availability will be experienced differently by individuals, with women bearing the brunt, as Wegenast and Beck (2020) discovered in Sub-Saharan Africa.

8.3.2. Access to food

Food access is related to food availability because it assesses not just food availability but also physical, economic, and social access to food (FAO, IFAD, UNICEF, WFP and WHO, 2022). Individuals' access to food is covered in this section. Individuals' perceptions of their current food access are compared to those from ten years earlier, when small-scale mining activity was not at its pinnacle as shown in Chapter 6. This is followed by a quantitative assessment of the prevalence of food insecurity, a measure of the access dimension of food security.

![Figure 8.2: Perception of current access to food compared to 10 years ago](image)

79 ‘Prevalence’, as used here refers to the percentage of people in the total population who are affected by food insecurity at different levels of severity.
Chapter 8: Relationships between small-scale mining and smallholder farming

As illustrated in Figure 8.2, more than half (54%) of study participants believe that their present access to food is either worse or slightly worse. Only a small proportion (8%) reported no change in their food access. From this, it can be deduced that there are challenges with food access. Thus, to properly comprehend the current level of food access, the Food Insecurity Experience Scale (FIES), elaborately discussed in Chapter 2 and 4, was applied. To reiterate, the FIES employs two thresholds to categorise the degree/severity of food insecurity (Refer to Figure 4.3). The first threshold is established at the severity level of the FIES item ATELESS (i.e., eating “less than you should”), and it distinguishes between the categories of ‘food secure or mildly food insecure’ and ‘moderately food insecure’. The second criterion is set at the severity level of the FIES item WHLDAY (“gone a whole day without eating”), which distinguishes the ‘moderately food insecure’ from the ‘severely food insecure’ categories (Caffiero et al. 2018; FAO,2018). Based on these thresholds, 32% of study participants are food secure or mildly food insecure, with an exceptionally low probability of experiencing moderate and severe food insecurity (See Table 8.3).

<table>
<thead>
<tr>
<th>Raw score</th>
<th>Weighted cases</th>
<th>% of individuals</th>
<th>Prob (moderate)</th>
<th>Prob (severe)</th>
<th>Prevalence rate (moderate)</th>
<th>Prevalence rate (severe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>149</td>
<td>32.4</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>13.4</td>
<td>0.02</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>2.2</td>
<td>0.10</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>1.5</td>
<td>0.40</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>2.2</td>
<td>0.71</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>47</td>
<td>10.1</td>
<td>0.94</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>19</td>
<td>4.1</td>
<td>0.99</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>87</td>
<td>18.9</td>
<td>1.00</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>70</td>
<td>15.2</td>
<td>1.00</td>
<td>0.56</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additionally, a sizable proportion (50.3 %) were moderately food insecure, comparable to the average prevalence rate of 51.1% in the total population of Ghana for the last three years (2017-2019) (FAOSTAT 2021). This statistic indicates that around half of the total population of the district experiences anxiety over food and has run out of food at least once in the last 12 months due to a lack of money and resources. This forced them to develop survival strategies such as consuming fewer foods than recommended, forgoing healthier foods, skipping meals, or eating little food. As a result, their access to consistent and nutritious meals is jeopardized. This has a detrimental impact on their diet quality, putting them at risk of a variety of forms of malnutrition and poor wellbeing. Alarming is the 13.3% of the study population who suffered
severe food insecurity in excess of the national average of 8.4% over the last three years (2017–2019) (FAOSTAT 2021). This reveals that less than two in ten individuals went to bed at least once in the preceding 12 months without eating for the full day due to a lack of money and resources. This demonstrates their level of hunger.

Food security relates to several socioeconomic parameters, including gender, age, employment position, educational attainment, and income level. Thus, two linear regression models were constructed to account for these variables of food security. Model 1 was a crude analysis that examined the association between each socio-economic variable and food security. Model 2 accounted for each of the variables that were found to be significantly associated with food security. Sensitivity analysis using binary logit regression found that the direction and magnitude were identical.

Table 8.4: Associations between socio-economic variables and food insecurity: Multivariate pooled linear analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (ref: men)</td>
<td>(0.801) (0.304)*</td>
<td>(0.769) (0.324)*</td>
</tr>
<tr>
<td>Age (in years)</td>
<td>(0.450) (0.010)*</td>
<td>(0.030) (0.013)*</td>
</tr>
<tr>
<td>Migration status (ref: native)</td>
<td>-0.364 (0.335)</td>
<td></td>
</tr>
<tr>
<td>Marital status (ref: married)</td>
<td>-0.936 (0.351)*</td>
<td>-0.479 (0.400)</td>
</tr>
<tr>
<td>Employment status (ref: employed)</td>
<td>0.474 (0.423)</td>
<td></td>
</tr>
<tr>
<td>Employment type (ref: others)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farming</td>
<td>1.524 (0.332)*</td>
<td>0.812 (0.413)*</td>
</tr>
<tr>
<td>Small-scale mining</td>
<td>0.463 (0.231)*</td>
<td>0.793 (0.235)*</td>
</tr>
<tr>
<td>Level of education (ref: basic/no education)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>-0.369 (0.187)*</td>
<td>0.087 (0.192)</td>
</tr>
<tr>
<td>Higher</td>
<td>-0.872 (0.271)*</td>
<td>-0.608 (0.314)*</td>
</tr>
<tr>
<td>Income (¢)</td>
<td>0.001 (0.001)*</td>
<td>-0.001 (0.001)*</td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td></td>
<td>0.125</td>
</tr>
</tbody>
</table>

* p < 0.05

The linear regression results (Model 2) indicate that gender, age, occupation type, level of education, and income are all independent predictors of food security, even after controlling for confounding variables. While marital status was found to be an independent predictor of food security, it was not found to be significantly associated with food security after adjusting for confounding variables. Expanding on this, the results (Model 2) indicate that age is
positively associated with food security ($\beta = 0.030$, SE = 0.013), $p = 0.063$). This means, the older people get, the more likely they are to experience food insecurity. Additionally, small-scale miners ($\beta = 0.793$, SE = 0.235, $p = 0.001$) and farmers ($\beta = 0.812$, SE = 0.413, $p = 0.050$) are more likely to experience food insecurity than other occupational categories. However, farmers (standardised $\beta = 0.018$) are more likely to face food insecurity than miners (standardised $\beta = 0.170$). Additionally, those with a higher level of education ($\beta = -0.608$, SE = 0.314, $p = 0.054$) were less likely to experience food insecurity in reference to obtaining a basic education. Finally, women ($\beta = 0.769$, SE = 0.324), $p = 0.018$) are more probable to experience food insecurity than men. In other words, more women than men in the study district face food insecurity. This has multiple ramifications for the nutritional wellbeing of women. The bivariate analysis of gender and food security, which employs the two previously described thresholds, reveals these distinctions considerably more clearly, as illustrated in Figure 8.3.

![Gender disparities in food security](image)

*Figure 8.3: Bivariate Analysis of the relationship between gender and food security*

As discussed in Chapter 2, the unidimensional (access dimension) character of the FIES necessitates the assessment of additional dimensions of food security to provide a holistic picture of the food security condition. Thus, the following paragraphs discusses the utilisation
dimension of food security, which is concerned with the nutritional components of food security.

8.3.3. Food utilisation

Physical availability and economic access to food do not necessarily translate into quality and adequate nutritional value for individuals. However, a favourable association has been demonstrated between individual dietary diversity and micronutrient adequacy, another key aspect of diet quality (Kennedy et al. 2007, 2010; Arimond et al. 2010a; Mallard et al. 2016; Zhao et al. 2017). Dietary diversity (DD)\(^80\) is a qualitative measure of food consumption and a proxy for nutrient adequacy of the diet of individuals (Kennedy et al. 2010). Women of reproductive age (WRA) dietary diversity assessments are significant since they are nutritionally sensitive and have higher micronutrient requirements. Additionally, given that a larger proportion of women than men experience food insecurity, the Minimum Dietary Diversity (MDD) for WRA (MDD-W) was used to understand the DD of women. The MDD-W is a food group diversity indicator that measures micronutrient adequacy across 11 micronutrients (Martin-Prevel et al. 2015). The MDD-W is a binary indicator that indicates whether or not women aged 15–49 years consumed at least five of ten defined food groups\(^81\) the preceding day or night (FAO and FHI 2016).

8.3.3.1 Minimum Dietary Diversity for women of reproductive age (MDD-W)

As depicted in Figure 8.5, grains, roots, and tubers (98%), meat, poultry, and fish (87%), and other vegetables (96%) are the major food groups ingested the day before the survey, consistent with Ayensu et al. (2020) findings. The high consumption of grains, roots, tubers, and vegetables is unsurprising, considering most traditional meals in Ghana and other regions of Africa are made from these food groups. It is, nevertheless, surprising and encouraging to discover that a sizable proportion (87%) of women consumed meat, poultry, and fish the day or night before the study, in contrast to the low proportions of women found by the study of Ayamba (2018) in the Upper East region of Ghana, where meat and poultry are in abundance. Increased consumption of meat, poultry, and fish by women the day or night before the study, is closely related to the surge of imported animal goods, particularly chicken, which sells at a lower price than domestically produced poultry. Less than two in ten research participants

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\(^{80}\) Chapter 2 contains an in-depth explanation of the concept of dietary diversity.

\(^{81}\) For a list of ten aggregated food groups, see Chapter 4, Table 4.8
consumed dark green leafy vegetables (12%), eggs (19%), dairy (18%), nuts and seeds (15%), and less than one in ten ingested other vitamin A-rich fruits and vegetables (9%), other fruits (8%), and pulses (9%).

![Percentage consumption of different food groups](image)

*Figure 8.4: Proportions of study participants consuming different food groups during the previous day of the survey*

The mean dietary diversity score (DDS) was $3.67 \pm 1.1$, with a theoretical DDS range of 0 to 10, based on the 10 aggregated food groups of the MDD-W. This mean score is less than the recommended score of 5 by the MDD-W. Furthermore, it is lower than the mean score of 4.40 obtained from pregnant women of all ages in the 2017 Ghana Micronutrient Survey (University of Ghana et al. 2017) and from pregnant women and adolescent girls in two recent studies conducted in the Ashanti region of Ghana by Ayensu et al. 2020 and Gyimah et al. (2021), respectively. Another study by Ayamba (2018) found a slightly higher mean dietary diversity score of $3.97 \pm 1.15$ in one of the poorest regions of Ghana, the Upper East region (Ghana Statistical Service 2018). This demonstrates the low dietary diversity of women, which can be attributed in large part to decreased local food supply and rising food prices connected with mining, as stated in the preceding section. It is worrisome to find that 79% of women did not achieve the minimum dietary diversity threshold, which means they ingested less than five food groups the previous day (See Table 8.5).
Chapter 8: Relationships between small-scale mining and smallholder farming

Table 8.5: Minimum Dietary Diversity of women of reproductive age

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDD-W Categories</td>
<td>3.67 ±1.1</td>
<td></td>
</tr>
<tr>
<td>Inadequate</td>
<td></td>
<td>157 (79.3)</td>
</tr>
<tr>
<td>Adequate</td>
<td></td>
<td>41 (20.7)</td>
</tr>
</tbody>
</table>

8.3.3.2 Relationships between MDD-W and the socio-demographic characteristics of study participants

It is important to investigate whether the dietary diversity score obtained from the women was related to their sociodemographic attributes in any manner. Hence, a cross-tabulation analysis was done, the findings of which are summarised in Table 8.6. Table 8.6 indicates that no statistically significant correlations exist between the dietary diversity of women and their sociodemographic attributes at a significance level of 0.05. This suggests that the adequacy or inadequacy of the dietary diversity of women is unrelated to their age, migration status, marital status, employment position, or degree of education and income. This findings is similar to the study by Gyimah et al. (2021), which revealed no correlations between dietary diversity and sociodemographic variables, except for education and community type (rural). All the study communities in this study were rural. The findings also authenticate a concern by a miner that even when miners have money to purchase food, they are unable to obtain the variety and quality of food they desire (SSI_025_M).
Table 8.6: Relationship between dietary diversity and socio-demographic characteristics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dietary Diversity</th>
<th>Pearson Chi-Square</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inadequate</td>
<td>Adequate</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;19</td>
<td>9 (4.5)</td>
<td>1 (0.5)</td>
<td>0.735</td>
</tr>
<tr>
<td>20-49</td>
<td>148 (74.7)</td>
<td>40 (20.2)</td>
<td></td>
</tr>
<tr>
<td><strong>Migration Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natives</td>
<td>103 (52.0)</td>
<td>29 (14.6)</td>
<td>0.384</td>
</tr>
<tr>
<td>Migrants</td>
<td>54 (27.3)</td>
<td>12 (6.1)</td>
<td></td>
</tr>
<tr>
<td><strong>Educational Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No education</td>
<td>36 (18.2)</td>
<td>8 (4.0)</td>
<td>1.373</td>
</tr>
<tr>
<td>Basic education</td>
<td>95 (48.0)</td>
<td>23 (11.6)</td>
<td></td>
</tr>
<tr>
<td>Higher education</td>
<td>26 (13.1)</td>
<td>10 (5.1)</td>
<td></td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never married</td>
<td>23 (11.6)</td>
<td>5 (2.5)</td>
<td>2.049</td>
</tr>
<tr>
<td>Married</td>
<td>80 (40.4)</td>
<td>20 (10.1)</td>
<td></td>
</tr>
<tr>
<td>Cohabitng</td>
<td>39 (19.7)</td>
<td>14 (7.1)</td>
<td></td>
</tr>
<tr>
<td>Widow/Divorced/Separated</td>
<td>15 (7.6)</td>
<td>2 (1.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Employment Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>130 (65.7)</td>
<td>34 (17.2)</td>
<td>0.001</td>
</tr>
<tr>
<td>Unemployed</td>
<td>27 (13.6)</td>
<td>7 (3.5)</td>
<td></td>
</tr>
<tr>
<td><strong>Type of employment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farming</td>
<td>34 (20.7)</td>
<td>10 (6.1)</td>
<td>1.388</td>
</tr>
<tr>
<td>Mining</td>
<td>13 (7.9)</td>
<td>4 (2.4)</td>
<td></td>
</tr>
<tr>
<td>Trading</td>
<td>51 (31.1)</td>
<td>14 (8.5)</td>
<td></td>
</tr>
<tr>
<td>Civil/Public Service</td>
<td>2 (1.2)</td>
<td>1 (0.6)</td>
<td></td>
</tr>
<tr>
<td>Artisans</td>
<td>30 (18.3)</td>
<td>5 (3.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Monthly Income</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No income</td>
<td>1 (0.6)</td>
<td>0 (0.0)</td>
<td>3.129</td>
</tr>
<tr>
<td>Below 100</td>
<td>8 (4.4)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>100 to 500</td>
<td>77 (42.5)</td>
<td>21 (11.6)</td>
<td></td>
</tr>
<tr>
<td>Above 500</td>
<td>55 (30.4)</td>
<td>19 (10.5)</td>
<td></td>
</tr>
</tbody>
</table>

### 8.3.4. Food stability

Individuals must always have access to sufficient food to be food secure. This is dependent upon the supply and accessibility of food being adequate, consistent, and reliable. To achieve food stability, there must be no abrupt shocks or cyclical events that put individuals at risk of not reaching their nutritional requirements (FAO 2006). From the ongoing discussions, mining, especially small-scale mining, poses a threat to stable food availability and accessibility. Local food shortages and price increases caused by reduced food crop output over time because of

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82 Income is measured in Ghana Cedi (¢). 1¢ is equivalent of $0.17 as of 2nd July 2021
mining activities expose many people to food insecurity. As described in the part on food access, many individuals were forced to adopt new coping mechanisms in response to the resulting threat to their food security position. These coping mechanisms included consuming few foods, comparatively less healthy foods, skipping meals, or consuming less food at a time. This explains why a large proportion of individuals have a high prevalence of moderate to severe food insecurity. In the following, a Chief Farmer at Odaho expresses grave concern and anxiety about the future stability of food:

“The galamsey can lead to hunger because it has destroyed all our arable lands. In the future, we may not have any food crops and will have to buy everything [food crops]. We cannot live on only rice \((Oryza sativa)\), we need plantain \((Musa paradisiaca)\), cassava \((Manihot esculenta)\), cocoyam \((Colocasia esculenta)\), and other traditional food crops which in the future we will not be able to get due to the galamsey activities” (KII_010_M_LS).

This comment reflects the fears of many people, both miners and farmers, about the future stability of food. Additionally, it demonstrates the loyalty of the people to their traditional staple foods, regardless of the availability of rice \((Oryza sativa)\) on the market. Rice is singled out in this context due to its ready availability on the market, facilitated by importation. Rice dishes, particularly among the elderly, are not regarded ‘essential’ or ‘special’ in comparison to their traditional dishes such as ‘fufu’, ‘banku’, and other local specialties. Thus, the decrease in the key commodities used to prepare these local foods, together with their growing prices over time, represents a significant shock and setback to their food security outcomes.

Additionally, as discussed in Chapter 6, the historical ecological footprints of mining, particularly the increased deforestation and land degradation over time, have the potential to contribute to local-scale climate variability/change (Voldoire and Royer 2004; D’Almeida et al. 2007; Mahmood et al. 2010, 2014; Davidson et al. 2012; Lawrence and Vandecar 2014). Three farmers from diverse communities indicated the following in relation to some observed changes in the weather conditions of their respective areas as follows:
“As noted by my brother, before the deforestation and use of the wetlands for galamsey activities, rainfall pattern in this community was good. We used to even use the water from the *Oda* River to water our vegetables. Currently, with the high rate of deforestation and the destruction of the wetlands, the rains do not fall frequently as they used to. For vegetable farmers, it is even worse. Without pumps to irrigate the farm, you cannot do it. I have personally cultivated some vegetables and even after you have pump water into the farm to irrigate it, it seems as if you have not done anything. It is not easy at all” (FGD_W01_CF).

“It [small-scale mining] has devastating effects on farmers. It reduces water sources…Previously, you could witness vapour from the river which also aided rainfall but now it is heavily polluted. Rains in this area have reduced” (SSI_K04_M_FM).

“It [small-scale mining] has affected us in many ways. There is a decline in rainfall and temperatures are increasing” (SSI_D07_M_FM).

The preceding quotations reflect perceived changes in the climatic conditions of the study district. These observed alterations of increased temperatures and lower rainfall have the potency to disrupt agriculture (Zhao et al. 2005; Lawrence and Vandecar 2014) and exasperate the issues linked with food supply and access throughout time (FAO, IFAD, UNICEF, WFP and WHO 2018). Thus, food stability will suffer in the long run.

### 8.4 Chapter summary and conclusions

In this chapter, I have conducted an in-depth examination of the relationships between mining and smallholder farming, as well as the consequences for food security. I have demonstrated that positive and negative interconnections exist between scale mining and smallholder farming. The positives were overwhelmingly individualistic in nature, benefiting individuals or families with greater land interests. On the other hand, the disadvantages were communal in nature, resulting in externalities that extended beyond the study communities. The primary benefit was the stimulation of economic activity within the various communities, which results in a source of livelihood, income, and market sources.
This economic stimulus was found to be more helpful to the young and a contributing factor in the perception of entrenched social differentiation based on age, occupation, and wealth. Considering this economic stimulus, several scholars have advocated for the formalisation of the small-scale mining sector, which contributes far more to the local economy than formalised large-scale mining. Despite these positive associations, a significant negative association between the two subsectors was the alienation of land/farms for mining via voluntary and involuntary accumulation through dispossession with or without compensation. These interactions were found to have a detrimental impact on individual and community food security. To begin, there are concerns about local food availability due to falling food crop yield because of farm and/or farmland alienation for mining activities. Food insecurity is aggravated by inadequate road networks, growing population, the absence of an organised market, and the resulting price increases.

Second, I have examined the food access status of individuals using the food insecurity experience survey (FIES) underpinned by the Rasch model. The results indicate a high prevalence of moderate food insecurity of 50.1% indicating that people are concerned about their access to food and are developing survival strategies such as eating fewer foods, sacrificing healthy foods, skipping, or eating less food, and occasionally running out of food. Alarming was the prevalence rate of severe food insecurity at 13.3%, which was much higher than the national rate of 8.4% for an average of three years. This means that less than one in ten people went an entire day without food.

Additionally, dietary diversity measurements for women of reproductive age (WRA) are crucial, as women are disproportionately nutritionally susceptible, despite their higher micronutrient requirements. Accordingly, I have measured the utilisation dimension of food security using the Minimum Dietary Diversity for Women of Reproductive Age (MDD-W), a tool developed by the FAO and FHI. The findings indicate that women have a low dietary diversity score. In other words, women consumed a smaller variety of foods. Women were unable to satisfy the required dietary diversity food score in a sizable proportion (79%) of cases. This suggests they eat less than five of the ten food groups required for adequate micronutrient intake. This micronutrient deficiency jeopardizes their health and has an adverse effect on their general well-being, as well as that of their unborn babies and neonates.
Finally, I have demonstrated that the constraints related with food availability and access jeopardise individuals’ food stability. In most cases, the decline in production of important basic foods during the last decade resulted in price volatility and upward adjustments. This results in shocks for individuals, particularly those who do not see a gain in income from their source of income. Additionally, individuals are shocked by perceived climate changes caused by the ecological footprints of deforestation and land degradation caused by mining activities. These shocks influence the economic access to food of an individual and, as a result, their food stability, resulting in the adoption of various mitigation mechanism such as eating less, skipping foods, and choosing less healthy foods, among others.

The findings of the chapter have demonstrated the impacts of mining, particularly, small-scale mining on the four pillars of food security. In contrast to previous research that examined the impacts of mining on either food availability or access or agriculture in general, this chapter have examined the impact of mining on all four dimensions of food security (availability, access, utilisation, and stability). This comprehensive investigation sheds light on the linkages between mining and smallholder farming, as well as the impacts of these relationships on individual well-being. I conclude from the findings that mining, notwithstanding its socio-economic stimulus effect on the local economy, has a major impact on the four dimensions of food security. Accordingly, mining is a significant contributor to food insecurity and, as a result, to the poor wellbeing of many people. The most vulnerable members of society, particularly women and the elderly, are the most adversely impacted by mining in terms of food security. Additionally, mining exacerbates ingrained social divisions based on age, occupation, and money.

Furthermore, this chapter builds on previous chapters, which were underpinned by a blend of the political ecology and capability approach as advanced in the conceptual framework, by demonstrating the influence of personal and socio-economic factors on individuals' capabilities in achieving their food security outcomes and, as a result, their wellbeing. It can therefore be concluded that the conceptual framework that advocates for combining the political ecology and capability approaches can provide a robust, nuanced, and comprehensive understanding of the factors that influence individuals' capabilities to achieve their food security outcomes as individuals, with implications for the community at large.
CHAPTER NINE
SUMMARY AND CONCLUSIONS

9.1 Introduction
This thesis has explored the interconnections between small-scale mining and smallholder farming and the implications of their interaction for food security. I have highlighted how structural and economic reforms implemented both within the mining and agriculture sectors from the pre-colonial period to now have had similar and opposing impacts on the two sectors. I have also demonstrated how these impacts, which encompass socio-economic and ecological impacts set the pace for conflict between the two sectors, widening the scope of previous studies in this area. Furthermore, I have explained how, despite occupying a smaller area than other land use and land cover classes, mining is intricately linked to all land use and land cover classes and significantly drives the observed changes in parallel with farmland expansion. In addition, I have demonstrated how the once coexisting subsectors of mining and smallholder farming face fierce competition for access to essential resources (land, labour, and water), driven by unequal power relations among the key actors in both subsectors. The complex and heterogenous nature of the small-scale mining sector, as well as its remarkable progression from low-tech to advanced technology, were also evidenced. Finally, I have revealed how mining contributes greatly to food insecurity and, subsequently, the low well-being of a considerable number of individuals, especially women.

This chapter draws the curtain on the entire thesis by restating the research questions that guided the study; summarising the novel conceptual framework that guided the research; and providing an overview of the mixed method and geospatial methodologies used to respond to the research questions critically and holistically. Additionally, the chapter summarises major research findings, makes policy recommendations to support decision-making processes, provides directions for future research, and presents the overall conclusions of the study.

The chapter is organised into eight sections. Following the introduction section, I outline in Section 9.2 the overarching and specific research questions that this study sought to address. I summarized the novel conceptual framework and the integrated mixed methods and geospatial methodologies that steer the study in the Sections 9.3 and 9.4, respectively. In Section 9.5, I summarized the major research findings and offered some policy recommendation based on
the findings in Section 9.6. In Section 9.7, I provided some direction for future research and the conclusion drawn from this study in the final section.

9.2 The overarching and specific research questions
Informed by the gaps in knowledge summarised in Chapter 2 and the conceptual framework discussed in Chapter 3, this thesis has provided answers to the overarching question:

- What relationships exist between small-scale mining and smallholder farming, and what are the impacts of such relationships on achieving improved food security outcomes at both the individual and community level?

The four interconnected specific research questions (RQ) provided in Section 1.1 have been addressed:

**RQ. 1:** How have structural and economic reforms influenced the mining and agricultural sectors of Ghana over time? What are the consequences of these reforms?

**RQ. 2:** What has been the pattern of land use and land cover change over time in selected mining hotspot landscapes in south-eastern Ghana, and what factors may have contributed for these changes? How would future land use and land cover look in the next decade under ‘business as usual’ and ‘remedial’ scenarios?

**RQ. 3:** What factors affect the ability of miners and smallholder farmers to access critical resources (land, water, and labour)? Who are the key actors in the mining and smallholder farming subsectors, and how are their power hierarchies and relationships structured?

**RQ. 4:** How are mining and smallholder farming related? What is the state of food security (availability, access, utilisation, and stability) in a mining hotspot in the south-eastern part of Ghana?

9.3 A combined capability and political ecology approach
This thesis has used a novel combination of capability and political ecology approaches to gain a better understanding of the interrelationship between mining and smallholder farming, as well
as the implications for food security. As elaborately discussed in Chapter 3, Sen's capability approach is a robust theoretical lens through which to fully understand individuals’ general well-being and diverse factors affecting wellbeing and livelihoods in relation to food security. Despite this, Sen's capability approach falls short of adequately capturing power dynamics or the human-environment connections; thus, it was complemented with the political ecology approach which lends itself well to capture these features from historical and multi-scalar perspectives. Thus, a novel combination of the capability approach and political ecology was advocated and used effectively to address the research questions of this study.

9.4 A snapshot of the integrated mixed methods and geospatial methodologies

To address the research questions, I have used a pragmatist research paradigm that included a mix of qualitative, quantitative, and geospatial tools and techniques, as discussed in detail in Chapter 4. Ghana was used as a single country case study. Two districts in Ghana were chosen as case studies: Amansie West and South. This was narrowed down to six representative Amansie South communities for in-depth and critical analysis of the cases and research subjects. The quantitative component of the study used 460 randomly selected study participants from the sampled locations as the unit of analysis. For the qualitative component, I selected 85 key actors including farmers and miners, agricultural, forestry, land, and natural resource officials at the local and national/regional scales using purposive and snowball sampling approaches as the units of analysis. For the geospatial component, Landsat satellite images were downloaded, analysed, and used to develop a model that could be used to understand and predict the ecological footprints of mining over time. The primary data collection methods were survey, interviews, focus group discussion and observations. The data gathered were analysed using thematic analysis, trend analysis, the Rasch model, linear and binary logit regression models, as well as descriptive statistics such as cross tabulations, frequencies, and percentages. At various stages of data analysis, the various datasets were combined and triangulated. For instance, historical perspectives gleaned from focus groups and interviews supplemented geospatial data collected from satellite images. Additionally, qualitative data fleshes out some quantitative information, such as those on food supplies.
Chapter 9: Summary of major findings

9.5 Summary of key research findings

Four empirical chapters were provided, each addressing a sub-question of the research and utilising a range of data analysis tools and approaches, as detailed in Chapter 3. I offer a summary of the major research findings from the four empirical chapters in this section.

9.5.1 Historical political ecology of mining and agriculture in Ghana

Since pre-colonial times, the mining and agriculture sectors of Ghana have been subjected to several economic and structural policy regimes that have influenced their current state of operation. These measures have both complementary and opposing effects. Numerous studies have chronicled the shifting landscapes of these two sectors, but independently and without regard for the ecological consequences of such policy regimes (See for example, Bebbington et al. 2018; Teye and Torvikey 2018). I have expanded on previous works in this thesis by examining new regulations and measures affecting small-scale mining, as well as the ecological impacts associated with these sectors through time.

Beginning from the precolonial period until the current year of study (2021), this thesis has noted the continual reduction in the power of chiefs in relation to mining and smallholder farming. Great power was vested in the colonial government and later to the state following independence, however colonial legacies still persist. Influenced by neoliberal ideas championed by international organisation from the early 1980s, the state has entrusted more power indirectly to foreign investors in relation to natural resource access. Thus, there has been a continuing drive for a liberalised system and the promotion of export led mining and agriculture. As discussed in Chapter 5, this thesis has revealed the promotion of export led commodities like gold and cash crops such as cocoa, oil palm at the expense of food crops by peasant farmers. The study found that this export-driven and modernisation policies were accompanied with grave ecological footprints from both mining and agriculture. Beginning in 2008, the ecological footprints of small-scale mining garnered significant attention, attributable to increased gold prices and the sophisticated nature of small-scale mining operations. Additionally, the study identified flashpoints of conflict between mining and smallholder agriculture because of their spatial interconnection. These grounds of contention were amplified by the reforms.
9.5.2 Gold mining's ecological footprints, drivers, and future predictions

Even though mining occupies a smaller geographical area than other land use and land cover classes, it is intrinsically tied to and greatly influences the land use and land cover changes seen in mining areas. Thus, analyses of historical and predicted land use and land cover changes in mining environments shed light on the ecological footprints of mining. These types of evaluations are critical for long-term planning and management of natural resources. Thus, by combining geospatial and social research approaches, I have assessed the land use and land cover dynamics and driving forces. Additionally, I have employed CA-Markov models to forecast the future dynamics of land use and land cover over the next decade under ‘business as usual’ (BAU) and ‘remedial’ scenarios. Based on the analysis, I have found four distinct periods of land use and land cover dynamics for mining footprints: period of no to limited increase, gradual to accelerated increase, sharp increase, and gradual decrease. These land use and land cover dynamics were found to relate to three significant ecological impacts of mining, both directly and indirectly: land degradation, deforestation, and water pollution and diversion. Numerous degraded areas were also observed. Additionally, I have found that the quality and quantity of natural water resources had been damaged, with far-reaching costs to individuals and communities. Furthermore, forest resources dropped over the 34-year period, with a total of 27,333 ha representing 36% of forest cover being lost at a rate of 1.07% each year. Also, I have estimated increases in mining and water land uses at the expense of forest ecosystems and their associated negative externalities under the BAU scenario using the CA-Markov model. On the other hand, I have predicted that forest ecosystems and livelihoods will be protected under the remedial scenario, reversing the prediction provided under the BAU scenario.

9.5.3 The contested interconnections between smallholder farming and mining

Several of the agroecological zones in Ghana correspond with proven mineral deposit areas. For instance, the forest agroecological zone accounts for 57% of total tonnage of food crops (Diao et al. 2019), while mineral zones account for 61%. Small-scale mining and smallholder farming both rely on a finite primary resource (land), and both require significant amounts of water and labour. Thus, access to these vital resources is laden with tensions, trade-offs, and disparate costs and benefits for various actors. It is vital to identify and evaluate these two sectors' key actors, as well as their interests and influences on resource access, usage, and management. Smallholder farming and gold mining were conceptualised as ‘doings’, while
food (in)security was thought as ‘beings’, following the conceptual framework underpinned by Sen's capability approach. The beings and doings form the ‘functionings’ of an individual. These vital functionings are dependent upon the capabilities (freedoms and opportunities) of an individual which are influenced by a range of elements referred to as ‘conversion factors’ (Robyns 2005).

To complement the capability approach, political ecology was used to gain a thorough understanding of how power relations and hierarchy affect the capabilities of smallholder farmers and miners to access land, labour, and water for the functioning (doings) of smallholder farming and mining, as well as the functioning (beings) of food security at the local, national, and regional scales.

I have found a three-tiered power hierarchy among the major actors of mining and smallholder farming. The three-tier power hierarchy is composed of the following: (i) the state, (ii) traditional leaders and large-scale mining businesses, and (iii) small-scale mining firms/individuals and smallholder farmers. Global actors shaped this three-tier system indirectly. Additionally, I have discovered that the formerly coexisting subsectors of mining and smallholder farming are now competing for access to critical resources (land, labour, and water), a situation defined by unequal power relations between the major actors of the two subsectors. Further, I have demonstrated the complexity and heterogeneity of the small-scale mining sector, as evidenced in Zimbabwe (Mkodzongi and Spiegel 2019), Tanzania (Fisher, 2007–2008), and the Philippines (Verbrugge & Besmanos, 2016). Contrary to the characterisation of small-scale mining as a “low-tech...” activity (Hilson et al. 2017, p. 80), the findings of this study have indicated that the bulk of small-scale mining activities in the case study have advanced significantly, requiring sophisticated machinery, corroborated by Crawford et al. (2016). This exacerbates the competition between mining and smallholder farming.

### 9.5.4 The implications of mining and smallholder farming relationships on food security

The world is not on track to achieve the Sustainable Development Goal (SDG) 2, Zero Hunger by 2030 (FAO, IFAD, UNICEF, WFP and WHO 2022). This situation is exacerbated further by the impacts of COVID-19 on global food insecurity (Akpaki et al. 2020; Loopstra 2020; Niles et al. 2020; The Lancet Global Health 2020; Dabone et al. 2021; Gundersen et al. 2021).
Chapter 9: Summary of major findings

The total number of hungry people continues to grow, and Africa has been noted as being far behind schedule in meeting the Zero Hunger objective by 2030. (FAO, IFAD, UNICEF, WFP and WHO, 2022). The socio-ecological footprints of mining on smallholder farming, created by complex socioeconomic and unequal power relations incorporated in existing policies and regulations at many scales explored in Chapters 6 and 7, have profound implications for food security outcomes. Despite this, such implications have received little attention in the existing literature. The studies that have attempted to examine such impacts (positive, negative, intended, or unintended) have done so superficially, focusing on only one aspect of food security (availability or access) or on the relationships between mining and agriculture in general, without focusing on food security (Hilson and Garforth 2012, 2013; Labonne 2014; Danyo and Osei-Bonsu 2016; Hilson 2016b). Consequently, building on previous research and analysis from previous chapters of this thesis, I have critically examined the relationships between small-scale mining and smallholder farming, as well as the implications of the relationship on all four dimensions of food security (availability, access, utilisation, and stability). I have demonstrated that mining contributes significantly to food insecurity and, as a result, to the poor health and well-being of many people, particularly women. Also, I have demonstrated how mining impairs individuals’ functioning, resulting in poor wellbeing status for half (50.1%) and 13% of study participants, respectively, who were found to be experiencing moderate or severe food insecurity. Additionally, I have demonstrated how 79% of women of reproductive age (15–49) were unable to achieve the minimum dietary diversity (MDD) standards, a measure of micronutrient adequacy and, consequently, food quality. Besides, I have demonstrated how local issues with food availability, as well as linked challenges with food access and utilisation, compromise food stability over time, forcing more people to adopt alternative coping mechanisms.

9.6 Policy recommendation

9.3.1 Land reclamation for food security

Massive degradation of land and farms was highlighted as one of the primary ecological impacts of small-scale mining. Land reclamation is necessary for the express purpose of restoring degraded farmlands for food crop production. The government should spearhead this initiative in partnership with the business sector. Farmers should be assigned reclaimed areas, with women given precedence, and the lands should be used exclusively for food crop cultivation. The implementation of this strategy will provide food options and revenue from
the sale of such food crops to women who bear the brunt of food insecurity, thereby improving their food security outcomes and those of their children.

9.3.2 Improved transportation and the establishment of market centres
The findings of this thesis indicates that inadequate and poor road networks and the absence of a market centre severely limit the availability of local food. This obstacle has ramifications for many facets of food security (access, utilisation, and stability). Thus, the priority of the government should be on the construction of main roadways connecting important mining districts to regional and national highway networks. As trade expands because of improved road networks and market centres, local food supply increases, contributing to food security.

9.3.3 Land use regulation enactment and enforcement
As a result of the findings of major changes in land use and land cover, it is necessary to enact and execute regulations guiding land use in mining hotspots. Under such laws, individual lands must be demarcated for specified land uses. Additionally, existing regulations governing the use of natural water and forest resources should be evaluated, new ones enacted, and suitable mechanisms for their implementation and enforcement put in place. For instance, the recent regulation barring any mining activities on natural river bodies and forest reserves should be carefully enforced and strengthened. The findings of the thesis indicate that enforcing current laws is a significant challenge; the government must address this issue proactively, and civil society may assist by holding government institutions accountable for their actions.

9.3.4 Update of existing laws and regulations to reflect the complexity and heterogeneity of small-scale mining
The findings of a complex and heterogeneous small-scale mining sector underscore the importance of revising legislation and policies to reflect current developments. For example, the new laws/regulation should draw a clear distinction between artisanal and small-scale mining and make provisions for each. Additionally, the new laws/regulations should address foreign national engagement in small-scale mining, as well as the sophistication level at which each different mining category or scale can operate. Appropriate processes should be put in place, backed up by rules and regulations, to ensure that such laws are effectively implemented and enforced.
Chapter 9: Recommendations and direction for future research

9.3.5 Interconnected policies within the mining and agricultural sector

In a variety of ways, mining and agriculture are intricately interwoven. These ties are based on their operational spatiality, socioeconomic relationships, and environmental connections. Due to these connections, policies undertaken in one sector may have similar or antagonistic consequences on the other. Between the two subsectors, there is a need for integrated policy planning and implementation. In these two sectors, the institutions responsible for policy formation, planning, and implementation must collaborate and agree on common goals. This is particularly necessary in terms of smallholder food farming and addressing food insecurity directly in mining hotspots.

9.3.6 Streamlining small-scale mining activities to generate revenue through taxation

The findings demonstrate the economic impact of small-scale mining in terms of employment and income generation. Despite the economic benefits to its actors, illicit small-scale mining does not directly contribute to the revenue of the state or local government. This can be due in part to their illicit operation of the small-scale mining sector. The state must streamline the activities of small-scale miners to generate revenue for the state and local governments through taxes.

9.7 Direction for future research

To begin, the mixed method case study supported by a blend of political ecology and capability approach models, as well as the integrated mixed and geospatial methods advocated in this thesis, can be useful in future research to better understand the small-scale mining and agriculture nexus and its implications for food security in a various economic, social, environmental, geographic, and governance contexts.

Additionally, this thesis has demonstrated that the three ecological footprints of deforestation, land degradation, and pollution and loss of natural water resources have dire consequences for local climate variability, with additional implications for food security. Future research can investigate local climate changes in mining hotspots, as well as their consequences for food security and farmer resilience. This is especially important given the high reliance on natural weather components on smallholder farming activities in mining hotspots. Issues like soil fertility, rainfall, temperature, and irrigation water availability, as well as farmers' adaptive
Chapter 9: Thesis conclusions

skills to changing conditions, would be significant to acquire a comprehensive understanding of food insecurity issues in mining hotspots.

9.8 Conclusions
I studied the interrelationships between small-scale mining and smallholder farming in this thesis, utilising south-eastern Ghana as a case study, as well as the ramifications of this link for food security. I have adequately addressed four interrelated research sub-questions: how structural and economic reforms have influenced mining and agricultural activities in Ghana over time, and what are the consequences of these reforms; what has been the pattern of change in land use and land cover in mining hotspot landscapes in south-eastern Ghana over time, what factors may have accounted for these changes, and how would future land use and land cover look in the next ten years if ‘business as usual’ and ‘remedial’ scenarios were used; what factors affect the ability of miners and smallholder farmers to access critical resources (land, water, and labour), who are the key actors in the mining and smallholder farming subsectors, and what is their power hierarchy and relationship; and what are the relationships between mining and smallholder farming, and what is the state of food security (availability, access, utilisation, and stability) in a mining hotspot in the south-eastern part of Ghana? This thesis provides novel empirical evidence on the impacts of small-scale mining on food security, demonstrating the value of integrating mixed and geospatial methodologies. Additionally, this thesis demonstrated the importance of integrating political ecology and capability approach into studies on natural resource governance and food security. Therefore, this thesis constitutes significant research advancement for four primary reasons. To begin, the findings of the thesis substantiate the profound impacts of mining on food security, thereby addressing a knowledge gap regarding these impacts. Second, the findings of this thesis can be used to inform strategic policy decisions by government agencies, regulatory organisations, and think tanks, among others, regarding the mining and agricultural subsectors, as well as food security. There are few, if any, authoritative and comprehensive sources currently available on the impacts of mining on food security in Ghana and other mining countries. Third, the methodological integrations employed in this research enhances existing methods and opens the way for future relevant research, permitting multi- and inter-disciplinary collaboration for optimum research impact. Finally, the novel combination of political ecology and capability approaches lays the groundwork for future research by providing a solid theoretical foundation and framework.
As such, this thesis lays the groundwork for future study into the consequences of mining on food security across a range of contexts and situations.

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## Appendix 1: List and details of in-depth inter of interviews

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<th>Code</th>
<th>Date of interview</th>
<th>Place of interview</th>
<th>Occupation/Social position</th>
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<td>Smallholder Farmer</td>
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<td>7</td>
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<td>12(^{th}) Mar 2020</td>
<td>Residence, Datano</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>8</td>
<td>SSI_DT003_M_SF</td>
<td>12(^{th}) Mar 2020</td>
<td>Residence, Datano</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>9</td>
<td>SSI_DT004_M_SF</td>
<td>12(^{th}) Mar 2020</td>
<td>Residence, Datano</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>10</td>
<td>SSI_DT005_M_SF</td>
<td>16(^{th}) Mar 2020</td>
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<td>Smallholder Farmer</td>
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<tr>
<td>11</td>
<td>SSI_DT006_M_SF</td>
<td>16(^{th}) Mar 2020</td>
<td>Residence, Datano</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>12</td>
<td>SSI_DT007_M_SF</td>
<td>17(^{th}) Mar 2020</td>
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<td>Smallholder Farmer</td>
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<tr>
<td>13</td>
<td>SSI_DT008_M_SF</td>
<td>17(^{th}) Mar 2020</td>
<td>Residence, Datano</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>14</td>
<td>SSI_DT009_M_SF</td>
<td>24(^{th}) Mar 2020</td>
<td>Residence, Datano</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>15</td>
<td>SSI_DT010_M_SF</td>
<td>24(^{th}) Mar 2020</td>
<td>Residence, Datano</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>16</td>
<td>SSI_DT011_F_SF</td>
<td>24(^{th}) Mar 2020</td>
<td>Residence, Datano</td>
<td>Smallholder Farmer</td>
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<tr>
<td>17</td>
<td>SSI_KG001_M_SF</td>
<td>4(^{th}) May 2020</td>
<td>Farm, Kaniago</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>18</td>
<td>SSI_KG002_F_SF</td>
<td>4(^{th}) May 2020</td>
<td>Residence, Kaniago</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>19</td>
<td>SSI_KG003_F_SF</td>
<td>4(^{th}) May 2020</td>
<td>Residence, Kaniago</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>20</td>
<td>SSI_KG004_M_SF</td>
<td>5(^{th}) May 2020</td>
<td>Residence, Kaniago</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>21</td>
<td>SSI_KG005_M_SF</td>
<td>5(^{th}) May 2020</td>
<td>Residence, Kaniago</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>22</td>
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<td>20(^{th}) May 2020</td>
<td>Residence, Mem</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>23</td>
<td>SSI_MM002_F_SF</td>
<td>20(^{th}) May 2020</td>
<td>Residence, Mem</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>24</td>
<td>SSI_MM003_M_SF</td>
<td>20(^{th}) May 2020</td>
<td>Residence, Mem</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>25</td>
<td>SSI_OM001_F_SF</td>
<td>6(^{th}) May 2020</td>
<td>Residence, Odaho</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>26</td>
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<td>6(^{th}) May 2020</td>
<td>Residence, Odaho</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>27</td>
<td>SSI_OM003_M_SF</td>
<td>6(^{th}) May 2020</td>
<td>Residence, Odaho</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>28</td>
<td>SSI_OM004_M_SF</td>
<td>7(^{th}) May 2020</td>
<td>Residence, Odaho</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>29</td>
<td>SSI_OM005_M_SF</td>
<td>7(^{th}) May 2020</td>
<td>Residence, Odaho</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>30</td>
<td>SSI_OM006_M_SF</td>
<td>8(^{th}) May 2020</td>
<td>Residence, Odaho</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>31</td>
<td>SSI_OM006_M_SF</td>
<td>8(^{th}) May 2020</td>
<td>Residence, Odaho</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>32</td>
<td>SSI_WT006_M_SF</td>
<td>8(^{th}) May 2020</td>
<td>Residence, Odaho</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>33</td>
<td>SSI_WT006_M_SF</td>
<td>8(^{th}) May 2020</td>
<td>Residence, Odaho</td>
<td>Smallholder Farmer</td>
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<tr>
<td>34</td>
<td>SSI_WT007_M_SF</td>
<td>25(^{th}) May 2020</td>
<td>Residence, Watreso</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>35</td>
<td>SSI_WT008_M_SF</td>
<td>25(^{th}) May 2020</td>
<td>Residence, Watreso</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>36</td>
<td>SSI_WT009_M_SF</td>
<td>26(^{th}) May 2020</td>
<td>Farm, Watreso</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>37</td>
<td>SSI_WT010_M_SF</td>
<td>27(^{th}) May 2020</td>
<td>Residence, Watreso</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>38</td>
<td>SSI_WT011_M_SF</td>
<td>27(^{th}) May 2020</td>
<td>Residence, Datano</td>
<td>Smallholder Farmer</td>
</tr>
<tr>
<td>39</td>
<td>SSI_WT012_M_SM</td>
<td>27(^{th}) May 2020</td>
<td>Residence, Datano</td>
<td>Small-scale Miner</td>
</tr>
<tr>
<td>40</td>
<td>SSI_DT001_M_SM</td>
<td>18(^{th}) May 2020</td>
<td>Mining site, Datano</td>
<td>Small-scale Miner</td>
</tr>
<tr>
<td>41</td>
<td>SSI_DT002_M_SM</td>
<td>18(^{th}) May 2020</td>
<td>Mining site, Datano</td>
<td>Small-scale Miner</td>
</tr>
<tr>
<td>42</td>
<td>SSI_DT003_M_SM</td>
<td>19(^{th}) May 2020</td>
<td>Mining site, Datano</td>
<td>Small-scale Miner</td>
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<tr>
<td>43</td>
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<td>Small-scale Miner</td>
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<tr>
<td>44</td>
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<td>Mining site, Datano</td>
<td>Small-scale Miner</td>
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</tbody>
</table>
Appendix 2: Codes and details of oral histories

<table>
<thead>
<tr>
<th>No.</th>
<th>Code</th>
<th>Date of interview</th>
<th>Place of interview</th>
<th>Occupation/Social position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ORH_001_DT</td>
<td>20\textsuperscript{th} Mar 2020</td>
<td>Residence</td>
<td>Assembly Member</td>
</tr>
<tr>
<td>2</td>
<td>ORH_002_WT</td>
<td>5\textsuperscript{th} May 2020</td>
<td>Infront of shop</td>
<td>Assembly Member</td>
</tr>
<tr>
<td>3</td>
<td>ORH_003_KG</td>
<td>6\textsuperscript{th} May 2020</td>
<td>House of Assembly Member</td>
<td>Traditional Leader/Non-elected Assembly Member</td>
</tr>
<tr>
<td>4</td>
<td>ORH_004_AD</td>
<td>18\textsuperscript{th} Jun 2020</td>
<td>Office Space at Adubia</td>
<td>Non-elected Assembly Member</td>
</tr>
<tr>
<td>5</td>
<td>ORH_005_MM</td>
<td>19\textsuperscript{th} Jul 2020</td>
<td>Chief Palace</td>
<td>Traditional Leader</td>
</tr>
<tr>
<td>6</td>
<td>ORH_006_MM</td>
<td>19\textsuperscript{th} Jul 2020</td>
<td>House of leader</td>
<td>Traditional Leader</td>
</tr>
</tbody>
</table>

Appendix 3: Codes and details of key informant interviews

<table>
<thead>
<tr>
<th>No.</th>
<th>Code</th>
<th>Date of interview</th>
<th>Place of interview</th>
<th>Occupation/Social position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>KII_001_LS</td>
<td>11\textsuperscript{th} Mar 2020</td>
<td>Office, Amansie South District Assembly</td>
<td>A Director of Agriculture</td>
</tr>
<tr>
<td>2</td>
<td>KII_02_M_LS</td>
<td>20\textsuperscript{th} Mar 2020</td>
<td>Odaso Office, Ghana Water Company</td>
<td>A Manger at Ghana Water Company</td>
</tr>
<tr>
<td>3</td>
<td>KII_03_M_LS</td>
<td>22\textsuperscript{nd} Mar 2020</td>
<td>Residence at Watreso</td>
<td>A leader of local farmers association</td>
</tr>
<tr>
<td>4</td>
<td>KII_04__M_NS</td>
<td>14\textsuperscript{th} May 2020</td>
<td>Director’s Office, Ministry of Food and Agriculture, Accra</td>
<td>A Director at Crop Directorate of Ministry of Food and Agriculture</td>
</tr>
<tr>
<td>5</td>
<td>KII_05_F_NS</td>
<td>21\textsuperscript{st} May 2020</td>
<td>Director’s Office, Ministry of Food and Agriculture, Accra</td>
<td>A Director at the Policy Planning, Monitoring and Evaluation Directorate of Ministry of Food and Agriculture</td>
</tr>
</tbody>
</table>
6 KII_6_M_NS 26th May 2020 Director’s Office, Ministry Lands and Natural Resources, Accra A Director at the Lands Directorate of the Ministry Lands and Natural Resources

7 KII_7_M_LS 7th May 2020 Residence Agricultural Extension Officer

8 KII_8_M_LS 19th Jun 2020 Residence Chief Farmer/Leader of Farmers Association

9 KII_9_M_LS 18th Jun 2020 Office space at Amanse South District Assembly A District Planning Officer

10 KII_10_M_LS 11th Jun 2020 Residence, Odaho Chief Farmer

11 KII_11_M_LS 12th Jun 2020 Residence, Mem Chief Farmer

12 KII_12_M_RS 19th Jun 2020 Office Space at Regional Forestry Commission A Regional Manager at the Forestry Commission, Kumasi Office

13 KII_13_M_NS 22nd Jun 2020 Office Space, Accra A Manager at the at the Minerals Commission, Accra

14 KII_14_M_LS 4th May 2020 Residence, Kaniago Chief farmer

15 KII_15_M_LS 20th May 2020 Residence, Mem Chief farmer

16 KII_16_M_LS 23rd Jul 2020 On phone Agricultural Extension Officer

17 KII_17_M_LS 16th Mar 2020 Residence, Datano Agricultural Extension Officer

18 KII_18_M_LS 10th Jul 2020 On phone, Mem Assembly Member

19 KII_19_M_LS 15th Jul 2020 Residence, Kaniago Assembly Member

Appendix 4: List of Focus Group Discussion

<table>
<thead>
<tr>
<th>No.</th>
<th>Code</th>
<th>Date of interview</th>
<th>Community/Place of interview</th>
<th>Occupation/Social status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FGD_AD001_CFM</td>
<td>11th March 2020</td>
<td>Amansie South District Assembly</td>
<td>Cash/food farmers</td>
</tr>
<tr>
<td>2</td>
<td>FGD_D_001_CFM</td>
<td>11th March 2020</td>
<td>Farmer’s residence at Datano</td>
<td>Cash/food farmers</td>
</tr>
<tr>
<td>3</td>
<td>FGD_OD001_VFM</td>
<td>5th May 2020</td>
<td>Odaho Market Centre</td>
<td>Vegetable farmers</td>
</tr>
<tr>
<td>4</td>
<td>FGD_OD002_CFM</td>
<td>6th May 2020</td>
<td>Odaho Public Primary School</td>
<td>Cash/food farmers</td>
</tr>
<tr>
<td>5</td>
<td>FGD_W001_CFM</td>
<td>7th May 2020</td>
<td>Watreso Community Centre</td>
<td>Cash/food farmers</td>
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</table>
Appendix 5: Item parameters and statistics for the 8 FIES items

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Severity</th>
<th>Standard Error</th>
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<tr>
<td>Worried</td>
<td>-4.21</td>
<td>0.29</td>
</tr>
<tr>
<td>Healthy</td>
<td>-1.88</td>
<td>0.28</td>
</tr>
<tr>
<td>Fewfoods</td>
<td>-1.59</td>
<td>0.29</td>
</tr>
<tr>
<td>Skipped</td>
<td>-0.88</td>
<td>0.28</td>
</tr>
<tr>
<td>Ateless</td>
<td>-0.34</td>
<td>0.26</td>
</tr>
<tr>
<td>Ranout</td>
<td>1.53</td>
<td>0.24</td>
</tr>
<tr>
<td>Hungry</td>
<td>2.40</td>
<td>0.25</td>
</tr>
<tr>
<td>Whlday</td>
<td>4.98</td>
<td>0.32</td>
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</table>
### Appendix 6: Residual correlations among FIES items

<table>
<thead>
<tr>
<th></th>
<th>Worried</th>
<th>HEALTHY</th>
<th>FEWFOODS</th>
<th>SKIPPED</th>
<th>ATELESS</th>
<th>RANOUT</th>
<th>HUNGRY</th>
<th>WHLDAY</th>
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</thead>
<tbody>
<tr>
<td>Worried</td>
<td>1.000</td>
<td>0.167</td>
<td>0.076</td>
<td>-0.082</td>
<td>0.009</td>
<td>0.000</td>
<td>-0.154</td>
<td>0.000</td>
</tr>
<tr>
<td>HEALTHY</td>
<td>0.167</td>
<td>1.000</td>
<td>0.574</td>
<td>0.089</td>
<td>-0.112</td>
<td>0.004</td>
<td>-0.065</td>
<td>0.000</td>
</tr>
<tr>
<td>FEWFOODS</td>
<td>0.076</td>
<td>0.574*</td>
<td>1.000</td>
<td>0.333</td>
<td>-0.040</td>
<td>0.009</td>
<td>-0.066</td>
<td>0.000</td>
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<tr>
<td>SKIPPED</td>
<td>-0.082</td>
<td>0.089</td>
<td>0.333</td>
<td>1.000</td>
<td>0.067</td>
<td>0.023</td>
<td>-0.066</td>
<td>0.000</td>
</tr>
<tr>
<td>ATELESS</td>
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<td>1.000</td>
<td>0.039</td>
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<tr>
<td>RANOUT</td>
<td>0.000</td>
<td>0.004</td>
<td>0.009</td>
<td>0.023</td>
<td>0.039</td>
<td>1.000</td>
<td>0.060</td>
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<tr>
<td>HUNGRY</td>
<td>-0.154</td>
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</tr>
<tr>
<td>WHLDAY</td>
<td>0.000</td>
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<td>0.000</td>
<td>0.000</td>
<td>0.001</td>
<td>-0.040</td>
<td>-0.026</td>
<td>1.000</td>
</tr>
</tbody>
</table>
Appendix 7: HREC favourable opinion

HREC/3390/Obodai: HREC Favourable Opinion
Research-REC-Review <research-rec-review@open.ac.uk>
Mon 18/11/2019 10:22
To: Jacob.Obodai <jacob.obodai@open.ac.uk>; Research-REC-Review <research-rec-review@open.ac.uk>
Cc: Shonil.Bhagwat <shonil.bhagwat@open.ac.uk>; Giles.Mohan <giles.mohan@open.ac.uk>

Dear Jacob

This message confirms that the research protocol for the following research project, as submitted for ethics review, has been given a favourable opinion on behalf of The Open University Human Research Ethics Committee. This is subject to you confirming that you and your researcher’s have read and will abide by the OU's lone worker policy.

Project title: The Impact of Artisanal and Small-Scale Mining Activities (ASM) on Food Security in Ghana

HREC approval date: 15/11/2019

As part of your favourable opinion, it is essential that you are aware of and comply with the following:

1. You are responsible for notifying the HREC immediately of any information received by you, or of which you become aware which would cast doubt on, or alter, information in your original application, in order to ensure your continued safety and the good conduct of the research.

2. It is essential that you contact the HREC with any proposed amendments to your research, for example - a change in location or participants. HREC agreement needs to be in place before any changes are implemented, except only in cases of emergency when the welfare of the participant or researcher is or may be affected.

3. Your HREC reference number has to be included in any publicity or correspondence related to your research, e.g. when seeking participants or advertising your research, so it is clear that it has been agreed by the HREC and adheres to OU ethics review processes.

4. Researchers should have discussed any project-related risks with their Line Manager and/or Supervisor, to ensure that all the relevant checks have been made and permissions are in place, prior to a project commencing, for example compliance with IT security and Data protection regulations.

5. Researchers need to have read and adhere to relevant OU policies and guidance, in particular the Ethics Principles for Research with Human Participants and the Code of Practice for Research - http://www.open.ac.uk/research/governance/policies

6. The Open University's research ethics review procedures are fully compliant with the majority of research council, professional organisations and grant awarding bodies research ethics guidelines. Where required, this message is evidence of OU HREC support and can be included in an external research ethics review application. The HREC should be sent a copy of any external applications, and their outcome, so we have a full ethics review record.

7. At the end of your project you are required to assess your research for ethics related

https://outlook.office.com/mail/id/AAQkAGJjY2NhYWRkLWNiZjE...2Zi05YTY1LTE0MGYwMzhmNTU0AQ4AOGXN0gtET7pjio162CG5%2By%3D Page 1 of 2
issues and/or any major changes. Where these have occurred you will need to provide the Committee with a HREC final report to reflect how these were dealt with using the template on the research ethics website -
http://www.open.ac.uk/research/governance/ethics/human/review-process/final-report
(HREC Final Report form)

Sent on behalf of the Human Research Ethics Committee

Dr Claire Hewson  Professor Louise Westmarland  Dr Duncan
Banks  Chair  Deputy Chair  Deputy Chair

Human Research Ethics Committee - Research, Enterprise and Scholarship (RES)
The Open University, Walton Hall, Milton Keynes, MK7 6AA
Email: research-rec-review@open.ac.uk  Tel: 01908 654849
http://www.open.ac.uk/research/governance/ethics/human

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Appendix 8: Information sheet for key informants

RESEARCH STUDY PARTICIPANT INFORMATION SHEET

Hello, my name is Jacob Obodai. I am a PhD Student from the Open University in the UK. I would like to inform you about my study entitled: “The Impact of Artisanal and Small-Scale Mining Activities (ASM) on Food Security in Ghana”.

This information leaflet explains what this study is about and helps you to decide about taking part.

My study seeks to understand the impacts of artisanal small-scale mining (ASM) activities on food security. Impacts here includes both the positive and/or negative, intended and/or unintended effects of an activity (ASM). Food security on the other hand talks about whether food is available, and that people have access to them or not. Also, it looks at how diverse the available foods are to people and their usage by individuals in the community. Finally, food security deals with the stability of food i.e. are food available throughout the year?

I will ask you some questions about the major policies and regulations guiding ASM and/or smallholder farming activities in Ghana. I would also be grateful if you could provide information on the gaps as well as the synergies or otherwise of these policies and regulation and the way forward. This interview should take between 30 to 45 minutes and would take place in your office or any convenient place of your choice. Your responses would be captured on an Android Tablet and further synchronised to a safe and secured server at the Open University. This is to avoid a lot of bulky paper work and to ensure safe and secured storage and transfer of the information gathered for data analysis.

Please understand that your participation is strictly and entirely voluntary, and you are not being forced to take part in this study. The choice of whether to participate or not, is yours alone. If you choose not to take part, you will not be affected in any way whatsoever. If you agree to participate, you may stop participating in the research at any time and tell me that you do not want to continue. If you do this, there will be no penalties and you will not be prejudiced in any way.

The interview would be done in English Language and your answers would be stored electronically and used for research or academic purposes now or later in ways that will not reveal who you are. Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be linked to a fictitious code number or a pseudonym (another name) and you will be referred in this way in the data, any publication, report or other research output. The information you provide would be kept for a maximum of 10 years before they are discarded. This is to ensure ample time for verification of any aspects of the data when the need be. You have the right to redraw your consent to be part this study at any time up until the data have been analysed and published. That is, you can decide you no longer want your answers to be considered part of the pooled data from all the Participants of this study. You can do this by reporting at the Planning Office of the District Assembly. Alternatively, you can call or email the Researcher directly latest by the end of June 2019 when the data collection would have ended, and data analysis would have begun.

You have two options of giving consent; you can either give verbal consent or written consent. You are not forced to give one form of consent over the other. Both forms of consent are valid and carry the same weight.
Appendix 9: Information sheet for computer assisted personal interviewing

RESEARCH STUDY PARTICIPANT INFORMATION SHEET

Hello, my name is ______________________. I am currently working with Mr Jacob Obodai, a PhD Student from the Open University in the UK to collect data for his study. I would like to inform you about his study which is entitled: “The Impact of Artisanal and Small-Scale Mining Activities (ASM) on Food Security in Ghana”.

This information leaflet explains what this study is about and helps you to decide about taking part.

Mr Obodai’s study seeks to understand the impacts of artisanal small-scale mining (ASM) activities on food security. Impacts here includes both the positive and/or negative, intended and/or unintended effects of an activity (ASM). Food security on the other hand talks about whether food is available, and that people have access to them or not. Also, it looks at how diverse the available foods are to people and their usage by individuals in the community. Finally, food security deals with the stability of food i.e. are food available throughout the year?

I will ask you some questions about your personal food security situation and the activities of ASM in this community. This questioning should take between 20-30 minutes and would take place at your home or any convenient place of your choice. Your responses would be captured on an Android Tablet and further synchronised to a safe and secured server at the Open University. This is to avoid a lot of bulky paper work and to ensure safe and secured storage and transfer of the information gathered for data analysis.

Please understand that your participation is strictly and entirely voluntary, and you are not being forced to take part in this study. The choice of whether to participate or not, is yours alone. If you choose not to take part, you will not be affected in any way whatsoever. If you agree to participate, you may stop participating in the research at any time and tell me that you do not want to continue. If you do this, there will be no penalties and you will not be prejudiced in any way.

The questioning would be done in your local language and your answers would be stored electronically and used for research or academic purposes now or later in ways that will not reveal who you are. Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be linked to a fictitious code number or a pseudonym (another name) and you will be referred in this way in the data, any publication, report or other research output. The information you provide would be kept for a maximum of 10 years before they are discarded. This is to ensure ample time for verification of any aspects of the data when the need be. You have the right to redraw your consent to be part this study at any time up until the data have been analysed and published. That is, you can decide you no longer want your answers to be considered part of the pooled data from all the Participants of this study. You can do this by reporting at the Planning Office of the District Assembly. Alternatively, you can call or email the Researcher directly latest by the end of June 2019 when the data collection would have ended, and data analysis would have begun.

You have two options of giving consent; you can either give verbal consent or written consent. You are not forced to give one form of consent over the other. Both forms of consent are valid and carry the same weight.
Appendix 10: Information sheet for in-depth interviews

RESEARCH STUDY PARTICIPANT INFORMATION SHEET

Hello, my name is Jacob Obodai. I am a PhD Student from the Open University in the UK. I would like to inform you about my study entitled: “The Impact of Artisanal and Small-Scale Mining Activities (ASM) on Food Security in Ghana”.

This information leaflet explains what this study is about and helps you to decide about taking part.

My study seeks to understand the impacts of artisanal small-scale mining (ASM) activities on food security. Impacts here includes both the positive and/or negative, intended and/or unintended effects of an activity. Food security on the other hand talks about whether food is available, and that people have access to them or not. Also, it looks at how diverse the available foods are to people and their usage by individuals in the community. Finally, food security deals with the stability of food i.e. are food available throughout the year?

I will ask you some questions about your livelihood activities. Specifically, I would like to know your ease of access to land and labour for your activities as well as the benefits and challenges confronting your livelihood. This interview should last between 30 to 45 minutes and would take place in your home or workplace or any convenient place of your choice. Your responses would be captured on an Android Tablet and further synchronised to a safe and secured server at the Open University. This is to avoid a lot of bulky paper work and to ensure safe and secured storage and transfer of the information gathered for data analysis.

Please understand that your participation is strictly and entirely voluntary, and you are not being forced to take part in this study. The choice of whether to participate or not, is yours alone. If you choose not to take part, you will not be affected in any way whatsoever. If you agree to participate, you may stop participating in the research at any time and tell me that you do not want to continue. If you do this, there will be no penalties and you will not be prejudiced in any way.

The questioning would be done in your local language and your answers would be stored electronically and used for research or academic purposes now or later in ways that will not reveal who you are. Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be linked to a fictitious code number or a pseudonym (another name) and you will be referred in this way in the data, any publication, report or other research output. The information you provide would be kept for a maximum of 10 years before they are discarded. This is to ensure ample time for verification of any aspects of the data when the need be. You have the right to redraw your consent to be part this study at any time up until the data have been analysed and published. That is, you can decide you no longer want your answers to be considered part of the pooled data from all the Participants of this study. You can do this by reporting at the Planning Office of the District Assembly. Alternatively, you can call or email the Researcher directly latest by the end of June 2019 when the data collection would have ended, and data analysis would have begun.

You have two options of giving consent; you can either give verbal consent or written consent. You are not forced to give one form of consent over the other. Both forms of consent are valid and carry the same weight.
Hello, my name is Jacob Obodai. I am a PhD Student from the Open University in the UK. I would like to inform you about my study entitled: “The Impact of Artisanal and Small-Scale Mining Activities (ASM) on Food Security in Ghana”.

This information leaflet explains what this study is about and helps you to decide about taking part.

My study seeks to understand the impacts of artisanal small-scale mining (ASM) activities on food security. Impacts here includes both the positive and/or negative, intended and/or unintended effects of an activity (ASM). Food security on the other hand talks about whether food is available, and that people have access to them or not. Also, it looks at how diverse the available foods are to people and their usage by individuals in the community. Finally, food security deals with the stability of food i.e. are food available throughout the year?

I would like us to discuss about the history of land cover and land uses and how such land cover and uses have changed over time in this community. In addition, I would like us to discuss how access to land and labour in this community has been over time and if there are any power relations as far as these two resources are concerned. This discussion should take between 45 minutes to 1 hour and would involve a group of between 6-8 individuals with same occupation (farming or mining) as you. The discussion would take place at a private open space in the community or at the District Assembly Conference Hall.

Please understand that your participation is strictly and entirely voluntary, and you are not being forced to take part in this study. The choice of whether to participate or not, is yours alone. If you choose not to take part, you will not be affected in any way whatsoever. If you agree to participate, you may stop participating in the research at any time and tell me that you do not want to continue. If you do this, there will be no penalties and you will not be prejudiced in any way.

Your answers will be taped recorded to reduce the interview time, disruptions from trying to write every answer you provide and for easy retrieval of information later. The discussions would be done in your local language and your answers would be stored electronically on the Open University’s secure environment and used for research or academic purposes now or later in ways that will not reveal who you are. Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be linked to a fictitious code number or a pseudonym (another name) and you will be referred in this way in the data, any publication, report or other research output. The information you provide would be kept for a maximum of 10 years before they are discarded. This is to ensure ample time for verification of any aspects of the data when the need be. You have the right to redraw your consent to be part this study at any time up until the data have been analysed and published. That is, you can decide you no longer want your answers to be considered part of the pooled data from all the Participants of this study. You can do this by reporting at the Planning Office of the District Assembly. Alternatively, you can call or email the Researcher directly latest by the end of June 2019 when the data collection would have ended, and data analysis would have begun.

Please remember that you do not have to answer any questions about anything that makes you feel uncomfortable. Also, please note that while people in the group will be told to keep to themselves what is discussed at the meeting, some participants might talk about it to other people afterwards. Therefore, please make sure that you say only what you need to say. Thus, all participants in the
Informed Consent for the Impact of Artisanal and Small-Scale Mining activities on Food Security Study 2020

Jacob Obodai, PhD Student, Department of Geography, Faculty of Arts and Social Sciences (FASS)

Please tick the appropriate boxes

1. Taking part in the study
I have read and understood the study information dated 01/10/2019, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction. □ □

I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time up until data have been analysed and published, without having to give a reason. □ □

I understand that taking part in the study involves responding to some sets of interview questions and that my responses will be audio-recorded and stored on a secure server for processing and analysis. □ □

I agree to the interview being audio-recorded. □ □

2. Use of the information in the study
I understand that information I provide will be used for dissertation writing, journal publications, reports and policy briefs □ □

I understand that personal information collected about me that can identify me, such as my name or where I live, will not be shared beyond the study team. □ □

I understand that my data will be stored on a secure server and locked cabinets for up to 10 years after which it will be destroyed. □ □

I agree that my information can be quoted in research outputs. □ □

3. Future use and reuse of the information by others
I give permission for the de-identified (anonymised) transcripts, audio recording, and survey database, that I provide to be deposited in a specialist data centre after it has been anonymised, so it can be used for future research and learning.

4. Signatures

Name of participant [IN CAPITALS] □ Signature □ Date

For participants unable to sign their name, mark the box instead of signing

This impact of artisanal and small-scale mining activities on food security research project has been reviewed by, and received a favourable opinion, from the OU Human Research Ethics Committee - HREC reference number: XXXX.

http://www.open.ac.uk/research/ethics/
## Informed Consent for the Impact of Artisanal and Small-Scale Mining activities on Food Security Study 2020

Jacob Obodai, PhD Student, Department of Geography, Faculty of Arts and Social Sciences (FASS)

### Please tick the appropriate boxes

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

### 1. Taking part in the study

I have read and understood the study information dated 01/10/2019, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.  

I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time up until data have been analysed and published, without having to give a reason.  

I understand that taking part in the study involves responding to some sets of survey questions and my responses will be captured on a tablet and stored on a secure server for processing and analysis.

### 2. Use of the information in the study

I understand that information I provide will be used for dissertation writing, journal publications, reports and policy briefs.  

I understand that personal information collected about me that can identify me, such as my name or where I live, will not be shared beyond the study team.  

I understand that my data will be stored on a secure server and/or in a locked cabinet for up to 10 years after which it will be destroyed.  

I agree that my information can be quoted in research outputs.

### 3. Future use and reuse of the information by others

I give permission for the survey database, that I provide to be deposited in a specialist data centre after it has been anonymised, so it can be used for future research and learning.

### 4. Signatures

Name of participant [IN CAPITALS] | Signature | Date  
---|---|---

For participants unable to sign their name, mark the box instead of signing

This impact of artisanal and small-scale mining activities on food security research project has been reviewed by, and received a favourable opinion, from the OU Human Research Ethics Committee - HREC reference number: XXXX.

http://www.open.ac.uk/research/ethics/
Appendix 14: Consent form for focus group discussions

# Informed Consent for the Impact of Artisanal and Small-Scale Mining activities on Food Security Study 2020

Jacob Obodai, PhD Student, Department of Geography, Faculty of Arts and Social Sciences (FASS)

Please tick the appropriate boxes

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

1. **Taking part in the study**
   - I have read and understood the study information dated 01/10/2019, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction. □ □
   - I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time up until data have been analysed and published, without having to give a reason. □ □
   - I understand that taking part in the study involves responding to some sets of survey questions and my responses will be captured on a tablet and stored on a secure server for processing and analysis. □ □

2. **Use of the information in the study**
   - I understand that information I provide will be used for dissertation writing, journal publications, reports and policy briefs. □ □
   - I understand that personal information collected about me that can identify me, such as my name or where I live, will not be shared beyond the study team. □ □
   - I understand that my data will be stored on a secure server and/or in a locked cabinet for up to 10 years after which it will be destroyed. □ □
   - I agree that my information can be quoted in research outputs. □ □

3. **Future use and reuse of the information by others**
   - I give permission for the survey database, that I provide to be deposited in a specialist data centre after it has been anonymised, so it can be used for future research and learning.

4. **Signatures**

   __________________________________________________________________________________________

   Name of participant [IN CAPITALS]  ] Signature  Date

   For participants unable to sign their name, mark the box instead of signing

   [ ]

This impact of artisanal and small-scale mining activities on food security research project has been reviewed by, and received a favourable opinion, from the OU Human Research Ethics Committee - HREC reference number: XXXX.

http://www.open.ac.uk/research/ethics/
### Appendix 15: Confusion matrices and accuracy for land use and land cover (LULC) map of 2008

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### Appendix 16: Confusion matrices and accuracy for land use and land cover (LULC) map of 2015

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Appendix 17: Confusion matrices and accuracy for land use and land cover (LULC) map of 2020

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<th>Closed Forest</th>
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THE OPEN UNIVERSITY

THE ARTISANAL AND SMALL-SCALE MINING AND FOOD SECURITY STUDY 2020

SURVEY QUESTIONNAIRE

NAME OF COMMUNITY: ________________________________

ENUMERATOR: ________________________________________  CODE: [blank]

TIME BEGUN: [blank]  TIME COMPLETED: [blank]

Appendix 18: Questionnaire implemented in SurveySolutions
DEAR RESPONDENT,

Thank you for your acceptance to participate in this study. This study seeks to understand the impacts (both negatives and positives; intended and unintended) of artisanal small-scale mining activities on food security. The information you provide will assist me to produce a piece of scientific knowledge on these impacts to inform decision making. I wish that you provide and take full participation in the survey by responding to all the questions. The survey will take about 20 to 30 minutes of your time. However, participation in this study is entirely voluntary and you reserve the right to decide not to respond to certain questions or withdraw at any time in the course of the survey with no queries whatsoever. However, I wish you can stay and respond to all my questions. Notice that the information, you share will be only used for academic purposes and will be treated as strictly confidential as practicable. It will be reported in a way that no one will know your identity. You will not be physically harmed in any way by taking part in this study.

The research has been approved by the Human Research Ethics Committee (HREC) of The Open University, United Kingdom. If you have any questions and queries concerning this research, please do not hesitate to contact me at +233246234239 (Ghana) or +44190854423 (United Kingdom). You may also contact my academic supervisors, Prof Giles Mohan (+441908653654) and Dr Shonil Bhagwat (+441908655375) of the Faculty of Arts and Social Science (FASS), The Open University, United Kingdom.

Thank you,

Jacob Obodai

The Open University
SECTION 1: DEMOGRAPHIC INFORMATION

1. What is your gender?
   Female…………………………………0
   Male………………………………..1

2. What is your age? ………………………

3. What is your migration status?
   Native………………1  SKIP>>Q5)
   Migrant …………….2

4. If migrant, indicate place and country of origin…………………………………………

5. How long have you lived in this community?
   Less than 1 year…………………1
   2 – 4 years…………………………2
   5 – 9 years ..........................3
   10 years and above………………4

6. What is your level of schooling?
   No formal education ...............1
   Basic school education.............2
   High school education.............3
   College/tertiary education........4

7. What is your current marital status?
   Never married........................1
   Currently married ..................2
   Cohabiting............................3
   Widowed...............................4
   Divorced/separated..................5

8. What is your employment status?
   Employed......................1
   Unemployed……………2 (SKIP>>Q11)

9. What is your primary occupation?
   Farming..............................1
   Artisanal Small-Scale mining ......2
   Trading...............................3
   Civil/Public Service..................4
   Other (specify)......................5

10. What is your secondary occupation if any?
    Farming..............................1
    Artisanal Small-Scale mining ......2
    Trading...............................3
    Civil/Public Service..................4
    Not applicable........................99
    Other (specify)......................
### SECTION 2: ACCESS TO FOOD

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<thead>
<tr>
<th>No</th>
<th>Label</th>
<th>Questions in English</th>
<th>Twi Translated Questions</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WORRIED</td>
<td>During the last 12 Months, was there a time when you were worried you would not have enough food to eat because of a lack of money or other resources?</td>
<td>Enam se wonni sika ne akadee bi nti no, na wodwene ho paa se wonnya aduane dodoo a wo pe nni</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>HEALTHY</td>
<td>Still thinking about the last 12 Months, was there a time when you were unable to eat healthy and nutritious food because of a lack of money or other resources?</td>
<td>Wo koso dwini bosome dumien yи ntam yи a, mmere bi si ye a woandidi yiye efiri se na sika anaa mmoaye foforo bi nni ho?</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>FEWFOODS</td>
<td>Was there a time when you ate only a few kinds of foods because of a lack of money or other resources?</td>
<td>Enam se wonni sika ne akadee bi nti no, na aduane potee, kakra bi ena na wodie</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>SKIPPED</td>
<td>Was there a time when you had to skip a meal because there was not enough money or other resources to get food?</td>
<td>Enam se wonni sika ne akadee bi nti no, na wonntumi nnidi bere ano-bere ano</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>ATELESS</td>
<td>Still thinking about the last 12 Months, was there a time when you ate less than you thought you should because of a lack of money or other resources?</td>
<td>Wo koso dwini bosome dumien yи ntam yи a, mmere bi si ye a wodidi kitiwa bi efiri se na sika anaa mmoaye foforo bi nni ho?</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>RANOUT</td>
<td>Was there a time when your household ran out of food because of a lack of money or other resources?</td>
<td>Enam se wonni sika ne akadee bi nti no, eto da a aduane a wone wo fiefoo benya adie no tumi sa</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>HUNGRY</td>
<td>Was there a time when you were hungry but did not eat because there was not enough money or other resources for food?</td>
<td>Enam se wonni sika ne akadee bi nti no, eto da a ekom de wo dee, nanse wonnidi</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>WHOLEDAY</td>
<td>During the last 12 months, was there a time when you went without eating for a whole day because of a lack of money or other resources?</td>
<td>Wo bosome ahorow dumien yи etam yи no, mmere be wo ho a Enam se wonni sika ne akadee bi nti no, eto da a, wobuada?</td>
<td>No</td>
</tr>
</tbody>
</table>
9. How would you describe your access to food about 10 years ago in this community?
   Better……………………………..1
   Slightly better…………………..2
   No change………………………...3(>>4)
   Slightly worse…………………..4
   Worse……………………………...5

10. Kindly explain your answer above (probe for adequate access from own production or purchase)

11. How do you cope when you do not have adequate access to food?
SECTION 3: FOOD UTILISATION (DIETARY DIVERSITY SCORE)

Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning.

[Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients. When the respondent has finished, probe for meals and snacks not mentioned]

<table>
<thead>
<tr>
<th>Breakfast</th>
<th>Snack</th>
<th>Lunch</th>
<th>Snack</th>
<th>Dinner</th>
<th>Snack</th>
</tr>
</thead>
</table>

When the respondent recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.

<table>
<thead>
<tr>
<th>No.</th>
<th>Food Categories</th>
<th>Description/Examples</th>
<th>Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Food made from grains</td>
<td>Porridge, bread, rice, pasta/noodles, or other foods made from grains. Eg. Banku,</td>
<td>No…0</td>
</tr>
<tr>
<td>2</td>
<td>White roots, tubers, and plantains</td>
<td>White potatoes, white yam, white cassava, or cocoyam, other foods made from roots, tubers, or plantain</td>
<td>No…0</td>
</tr>
<tr>
<td>3</td>
<td>Pulses (beans, peas, and lentils)</td>
<td>Mature beans or peas (fresh or dried seed), lentils or bean/pea products, including hummus, tofu, and tempeh</td>
<td>No…0</td>
</tr>
<tr>
<td>4</td>
<td>Nuts and seeds</td>
<td>Any tree nut, groundnut/peanut or certain seeds, or nut/seed “butters” or pastes</td>
<td>No…0</td>
</tr>
<tr>
<td>5</td>
<td>Milk and milk products</td>
<td>Milk, cheese, yoghurt, or other milk products but NOT including butter, ice cream, cream, or sour cream</td>
<td>No...0</td>
</tr>
<tr>
<td>---</td>
<td>------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>6</td>
<td>Organ meat</td>
<td>Liver, kidney, heart or other organ meats or blood-based foods</td>
<td>No...0</td>
</tr>
<tr>
<td>7</td>
<td>Meat and Poultry</td>
<td>Beef, pork, lamb, goat, rabbit, game, chicken, duck, or other birds</td>
<td>No...0</td>
</tr>
<tr>
<td>8</td>
<td>Fish and seafood</td>
<td>Fresh or dried fish, shellfish, or seafood</td>
<td>No...0</td>
</tr>
<tr>
<td>9</td>
<td>Eggs</td>
<td>Eggs from poultry e.g., chicken, duck, guinea fowl or any other egg</td>
<td>No...0</td>
</tr>
<tr>
<td>10</td>
<td>Dark green leafy vegetables</td>
<td>Dark green leafy vegetables, including kontomire, Alefu, gboma, bitter leaf, cassava leaf, Ayoyo etc</td>
<td>No...0</td>
</tr>
<tr>
<td>11</td>
<td>Vitamin A rich vegetables, roots, and tubers</td>
<td>Carrots, sweet potatoes</td>
<td>No...0</td>
</tr>
<tr>
<td>12</td>
<td>Vitamin A rich fruits</td>
<td>Ripe mango, ripe papaya, dried peach</td>
<td>No...0</td>
</tr>
<tr>
<td>13</td>
<td>Other vegetables</td>
<td>Other vegetables e.g., tomato, onion, eggplant</td>
<td>No...0</td>
</tr>
<tr>
<td>14</td>
<td>Other fruits</td>
<td>Other fruits</td>
<td>No...0</td>
</tr>
<tr>
<td>15</td>
<td>Oils and fats</td>
<td>Oil, fats, or butter added to food or used for cooking</td>
<td>No...0</td>
</tr>
<tr>
<td>16</td>
<td>Sweets</td>
<td>Sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies, and cakes</td>
<td>No...0</td>
</tr>
<tr>
<td>17</td>
<td>Spices, condiments, beverages</td>
<td>Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages</td>
<td>No...0</td>
</tr>
<tr>
<td>18</td>
<td>Did you eat anything (meal or snack) OUTSIDE the home yesterday?</td>
<td></td>
<td>No...0</td>
</tr>
</tbody>
</table>

18. What is your primary source of obtaining food?
   Own production, gathering, hunting, fishing ..............................................1
   Purchased ........................................................................................................2
   Borrowed, bartered, exchanged for labour, a gift from friends or relatives......3
   Food aid ..........................................................................................................4
   Other (specify) ...............................................................................................


SECTION 4: INCOME ANALYSIS/ ACCESS TO LAND

1. Please estimate your total monthly income as an individual ……………………………………GHC

2. Please tell me whether your income comes from the following sources during the past twelve months. Please, indicate the two main sources and the amount received per period.

<table>
<thead>
<tr>
<th>Source of Income</th>
<th>Amount per period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Main</td>
</tr>
<tr>
<td>Formal employment for a private company</td>
<td></td>
</tr>
<tr>
<td>Formal employment for the state or state enterprises</td>
<td></td>
</tr>
<tr>
<td>Artisanal Small-Scale Mining</td>
<td></td>
</tr>
<tr>
<td>Farming</td>
<td></td>
</tr>
<tr>
<td>Pensions</td>
<td></td>
</tr>
<tr>
<td>Remittances from abroad</td>
<td></td>
</tr>
</tbody>
</table>

3. Do you own land?
   Yes…………………………………..1
   No………………………………….2 >> **SKIP to Q5**

4. If yes, what is the size of your land? ……………………………………………………………

5. What is the main purpose (s) for your land?
   Currently unoccupied……………………………….1
   Tree cropping…………………………………………………..2
   Food cropping…………………………………………………..3
   Mixed cropping (tree and food cropping)………………..4
   Artisanal and small-scale mining…………………..5
   Other (specify)……………………………………………………

6. Have you ever lost land (either forcefully or voluntarily) to artisanal small-scale mining activities?
   Yes…………………………………..1
   No……………………………….2

7. If yes, what was the size of the land you lost to artisanal small-scale mining?
   ……………………………………………………………………………………………………………........

8. Can you briefly explain to me the processes leading to the lost of this land for artisanal small-scale mining?
   ……………………………………………………………………………………………………………........
Appendix 19: Interview guide for farmers

General Background
1. What is your gender?
2. How old are you?
3. Are you from this community?
4. If migrant, where did you migrate from and how long you been here?
5. What is your highest level of education?
6. What is the size of your household?
7. What is your marital status?

Information on Food Crop Production
8. What is the size of your farm(s)?
9. How long have you been in farming?

| 10. What are the major crops grown by you? (List in order of importance) | 11. How many times per year is each crop planted? | 12. During which months are these crops planted and harvested? | 13. What is the average yield per crop planted in unit’s measure?
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1….Jan 7….Jul 2….Feb 8….Aug 3….Mar 9….Sept 4….Apr 10….Okt 5….May 11….Nov 6….Jun 12….Dec</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>Planted Harvested</td>
<td></td>
</tr>
</tbody>
</table>
b. No………………………………………..2

16. If yes, what other job do you engage in? (Probe for how long in that job, reasons for engaging in another job, prospects, and revenue from that job)

17. What is the average income you derive from this other job (probe for monthly, yearly etc.)?

Access to land, water, labour, and market for farming

18. How did you obtain land for your farming activities (probe for what type of land title one holds (e.g., allodial title, sharecropping, free hold), cost if purchase, processes of land allocation etc.)?

19. Can you describe to me the ease of access to land in this community for farming activities over the past 10years or so prior to the peak in ASM activities? (Probe for timelines, what is meant by easy or difficulty etc.)

20. Have you ever given/lost a parcel of land to ASM activities (probe for size of land, processes of land loss, compensations)

21. Do you employ other labourer (s) on your farm? (Probe for how many, wages paid, ease of getting labour)

22. How would you describe access to labour for farming activities over the past 10years or so prior to the peak in ASM activities in this community?

23. What about water?

24. Has the increase in the activities of ASM in this community influence the marketing of your agricultural products in anyway and how?

25. In general, what do you think are the impacts of artisanal and small-scale mining activities on farming in this community (probe for negative/positive; intended and unintended) and to you.

26. What are your views on current and existing policies guiding small holder farming in the country and your community? (Probe for specific policies)

27. What are your views on the co-existence of small-holder farming and ASM activities in this community?
Appendix 20: Interview guide for miners

General Background
1. What is your gender?
2. How old are you?
3. Are you from this community?
4. If migrant, where did you migrate from and how long you been here?
5. What is your highest level of education?
6. What is the size of your household?
7. What is your marital status?

Capability to mine
8. Can you please tell me about your job as a miner? (Probe for numbers of years as a miner, if mining is the main sources of livelihood or alternative livelihood, other livelihood alternatives pursued apart from mining, how one became a miner etc.)
9. On average how much do you earn being a miner (probe for timelines: week, months etc.; are there peak and lean season)
10. Do you mine on your own mining concession? If you yes, what were the processes you went through to gain a mining concession? (Probe for ease of this processes etc., how many people work on your concession? What are the backgrounds of people employed on your concession? If no, what arrangements do you have as a miner working on another person’s concession or site?
11. Is your mining concession or the one you work on formally and legally registered? Can you tell me a little more about how it was registered if so?
12. What was the land use for your mining concession or site prior to it been mined for gold? Did you have to pay any compensation?
13. Can you please tell me, how people in general obtain land for mining in this community?

Impacts of mining on food security
14. In your view, what are the impacts of artisanal and small-scale mining activities on food security in this community? (Probe for access to land for farming, market for agricultural products, diversity of foods, income for buying food, competition for labour etc.).

Policy and regulations
15. What are your views on current and existing policies guiding small holder farming in the country and your community? (Probe for specific policies)
16. What are your views on the co-existence of small-holder farming and ASM activities in this community?
Appendix 21: Guide for focus group discussion with farmers

General Information
Coordinates:……………………………… Place of Discussion:………………………………
Time started:………………………………Time Ended:……………………………………
Total number present:……………………………………………..Date:…………………….

Oral History on Land Use and Land Cover Changes
1. Can you please briefly provide a general history of this community?
2. What was the predominant land use and land cover in this community?
3. What are some of the observed changes in land use and land cover over time?
4. What factors may have accounted for these changes?
5. What are the implications of these changes on food security (probe for implications on access, availability, utilisation, and stability)?

Access to Land, Water and Labour
1. What is the ease of access to land for farming activities in this community? (Probe for processes, power relation etc.)
2. What is the ease of access to labour for farming activities in this community? (Probe for wages.
3. What is the ease of access to water for farming activities in this community? (Probe for quality of water)

Power relations
1. Comparatively, which activity, small holder farming and, artisanal and small-scale mining, tend to have the greatest power in this community and why?
2. Kindly explain to me the power dynamics between farming and ASM? (Probe for the processes and how such powers are exercised)
Appendix 22: Guide for focus group discussion with miners

General Information
Coordinates:……………………………… Place of Discussion:………………………………
Time started:………………………………Time Ended:……………………………………
Total number present:……………………………………………..Date:…………………….

Oral History on Land Use and Land Cover Changes
6. Can you please briefly provide a general history of this community?
7. What was the predominant land use and land cover in this community?
8. What are some of the observed changes in land use and land cover over time?
9. What factors may have accounted for these changes?
10. What are the implications of these changes on food security (probe for implications on access, availability, utilisation, and stability)?

Access to Land, Water and Labour
4. What is the ease of access to land for mining activities in this community? (Probe for processes, power relation etc.)
5. What is the ease of access to labour for mining activities in this community? (Probe for wages.
6. What is the ease of access to water for mining activities in this community? (Probe for source of water, quantity needed, processes involved in getting water)

Power relations
3. Comparatively, which activity, small holder farming and, artisanal and small-scale mining, tend to have the greatest power in this community and why?
4. Kindly explain to me the power dynamics between farming and ASM? (Probe for the processes and how such powers are exercised)
Appendix 23: Guide for key informant interviews at the national scale

General Information
Coordinates:……………………………… Place of Interview:………………………………
Time started:…………………………….Time Ended:……………………………………
Date of Interview: …………………………..Position of Interviewee:………………………

1. How long have you been in this position? How many people work under you and with you in this office? Kindly brief me about your role in this establishment.
2. What are some of the major policies and regulations currently guiding the operations small-holder farming activities in Ghana?
3. In your opinion, what are some of the gaps in these policies and regulations?
4. Do you have an idea about some of the major polices and regulations also guiding ASM activities? If you do, kindly explain to me some of these policies and regulations and their gaps.
5. What are your views on the co-existence of smallholder farming and artisanal small-scale mining in the light of current policies and regulations guiding these two sectors (probe for specific policies/regulations, social relation, and power? their interpretations, implementations, and effects)
6. What are your views on the ease of access to land and labour for small holder farming activities in communities where ASM activities are predominant? (Probe for land access processes, costs of land and labour).
7. What are some of the peculiar challenges as far as food security is concerned in districts/communities with predominant ASM activities? (Probe for what the challenges are and what the ministry is currently doing about them).
8. What are some of the impacts (both positive/negative) of ASM on food security observed by your institution if any? (Probe for all dimensions of food security and how such impacts are experienced by different actors in the community)
9. What strategies can be employed in the realization and enhancement of food security outcomes in ASM dominant communities?