Assessment of the impacts of artisanal small scale gold mining on environmental governance within the Mazowe catchment

BY

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DEDICATION

To my mother who is ever-sacrificing for me to achieve my dreams, my husband Leon who has been there in trying times and my son Eli who is an everlasting source of joy.
ACKNOWLEDGEMENTS

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# Table of Contents

Table of Contents

DEDICATION .............................................................................................................. ii  
ACKNOWLEDGEMENTS .......................................................................................... i  
TABLE OF CONTENTS .......................................................................................... ii  
ABSTRACT ................................................................................................................ iv  
CHAPTER ONE: INTRODUCTION ........................................................................... 1  
  1.1. Introduction ........................................................................................................ 1  
  1.2. Background ......................................................................................................... 1  
  1.3. Research objectives ............................................................................................. 5  
    1.3.1. General objective ............................................................................................ 5  
  1.4. Problem statement ............................................................................................... 6  
  1.5. Justification .......................................................................................................... 6  
  1.6. Thesis outline ....................................................................................................... 7  
CHAPTER TWO: LITERATURE REVIEW ............................................................... 8  
  2.1. Introduction .......................................................................................................... 8  
  2.2. Theoretical framework ......................................................................................... 8  
  2.3. Artisanal small-scale gold mining and its related conflicts ................................. 11  
  2.4. Conflicts associated with artisanal small-scale gold mining and agriculture ....... 12  
  2.5. Environmental governance within the mining sector ....................................... 14  
  2.6. Zimbabwean legislation on environmental governance ..................................... 18  
    2.6.2. Environmental Management Act of 2002(20:27) ...................................... 19  
    2.6.3. The Rural District Councils Act of 1989 (29:13) ....................................... 19  
    2.6.4. The Forest Act of 1949 (19:05) ................................................................. 19  
    2.6.5. The Mines and Minerals Act of 1961 (21:05) ........................................... 19  
CHAPTER THREE: METHODOLOGY ................................................................. 20  
  3.1. Introduction .......................................................................................................... 20  
  3.2. Aims and related methods .................................................................................... 20  
  3.3. Research design ................................................................................................... 21  
  3.4. Study area ............................................................................................................ 23  
  3.5. Primary data collection ......................................................................................... 25  
    3.5.1. Quantitative data ............................................................................................ 25
CHAPTER FOUR: RESULTS AND DISCUSSION ................................................................. 32
4.1. Introduction ........................................................................................................ 32
4.2. Summary of the artisanal small scale miners and mining activities ..................... 32
4.3. Spatial distribution of artisanal miners and small-scale gold mills ....................... 35
4.4. Impact of artisanal small scale gold mining on environmental conflicts ............... 36
  4.4.1. Land related conflicts .................................................................................. 37
  4.4.2. Water-related conflicts .............................................................................. 49
  4.4.3. Authority-related conflicts ........................................................................ 55
4.5. Challenges faced by stakeholders in effecting good environmental management .... 56
4.6. Conclusion ......................................................................................................... 59

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS .................................... 60
5.1. Introduction ........................................................................................................ 60
5.2. Conclusions ........................................................................................................ 60
5.3. Recommendations ............................................................................................ 62

References ................................................................................................................ 68
APPENDIX 1: QUESTIONNAIRE SURVEY ................................................................. 72
APPENDIX 2: FOCUS GROUP DISCUSSION QUESTIONS ........................................... 77
APPENDIX 3: STAKEHOLDER KEY INFORMANT INTERVIEW .................................... 78
APPENDIX 4: LOCATIONS OF ARTISANAL SMALL SCALE GOLD MINERS ............... 81
APPENDIX 5: LOCATIONS OF GOLD STAMP MILLS IN UPPER MAZOWE .......... 82
LIST OF TABLES

Table 1.1: Specific objectives and research questions .................................................................5
Table 3.1: Research model ...........................................................................................................20
Table 4.1: Percentage changes in land cover in the Upper Mazowe sub-catchment ..................48
Table 4.2: Water quality parameters of artisanal gold mining effluent .....................................51
LIST OF FIGURES

Figure 3.2: Study area within Mazowe Catchment ................................................................. 25
Figure 4.1: Demographic profile of artisanal miners .............................................................. 32
Figure 4.2: Summary of artisanal miners and mining activities in Upper Mazowe sub-catchment ...... 34
Figure 4.3: Driving factors of artisanal gold mining ................................................................. 35
Figure 4.4: Spatial distribution of artisanal miners and small-scale gold stamps ......................... 36
Figure 4.5: Participatory drawing of land use changes between 2002 and 2016 (Jumbo) .................... 43
Figure 4.6: Participatory drawing of land use changes between 2002 and 2016 (Bhuka) ..................... 45
Figure 4.7: Land-use patterns in Upper Mazowe sub-catchment in 2001 ................................. 46
Figure 4.8: Land-use patterns in the Upper Mazowe sub-catchment in 2006 and 2015 .................. 47
Figure 4.9: Respondents’ views presence of water conflicts ..................................................... 51
Figure 4.10: Flow direction map of Upper Mazowe sub-catchment ......................................... 54
Figure 4.11: Environmental regulatory board in Upper Mazowe sub-catchment ......................... 56

LIST OF PLATES

Plate 1: land degradation caused by artisanal miners .............................................................. 38
Plate 2: Artisanal gold mining encroaching into sorghum field ............................................... 40
This study focused on assessing the impacts of artisanal small-scale gold activities on the environmental governance of the Mazowe catchment. A representative sample of 32 respondents was selected from three sites with the Upper Mazowe sub-catchment. To gain further perspectives into the environmental conflicts occurring within the Mazowe catchment, 6 key informant interviews and 3 focus group discussions were conducted. The findings from the research showed that artisanal gold mining has surpassed agriculture as the main livelihood activity, providing income for both men and women. Due to the success of artisanal gold mining in the area, environmental conflicts among different users within the catchment became inevitable, with the conflicts based on the usage of land and water resources. Most of the conflicts occurred between artisanal gold miners and regulatory authorities due to the illegal status of artisanal gold mining in Zimbabwe and the need for the regulatory authorities to maintain the integrity of the environment while attempting to eliminate artisanal gold mining activities. The conflicts within the Mazowe Catchment were reflective of how environmental governance is being implemented in the area. The study recommends that the government recognize artisanal gold mining activities and to provide opportunities for artisanal miners that will formalize them as small-scale miners. Stakeholders should be funded to enable them to rehabilitate the environment as well as to engage with artisanal small-scale gold miners so as to minimize environmental conflicts and to impose good environmental governance within the area.
CHAPTER ONE: INTRODUCTION

1.1. Introduction
In this first chapter, the aim and objectives of the research as well as the background of the assessment of the impacts of artisanal small-scale gold mining on the environmental governance within the Mazowe Catchment, Zimbabwe.

1.2. Background
Artisanal small scale mining (ASM) in developing countries is inclusive of both legal and illegal operators (Shoko, 2002). ASM can be an individual or collective activity that is highly labour-absorptive and involves the exploitation and raw material processing of mineral deposits (Bryceson, 2015). The activity is generally characterized by a lack of technical and management skills, as well as the production of minerals from uncertain reserves. Most artisanal miners are informal, highly nomadic and do not usually set up proper infrastructure such as housing and sanitation facilities (Bryceson et al. 2012). The sector has catalyzed itself as a prompt primary, secondary and tertiary employment opportunity for both skilled and unskilled people (Bryceson et al. 2012). ASM has been advantageous in allowing the exploitation of mineral ore bodies that are too small or remote for the intensive investment required for large-scale, commercial mining (Hinton et al. 2003). According to Mawowa (2013), the ASM industry provides a temporal survival strategy to poverty and unemployment. However, ASM is also associated with social and economic problems such as diversion of livelihoods from sustainable activities, substance abuse, child labour and environmental damage. The ASM sector has the potential to negatively affect the communities in which it occurs, at times providing them with little or no benefit. These negative social, ecological and economic impacts often lead to
conflicts within the areas whereby ASM activities occur and the occurrence of conflicts is a reflection of the state of environmental governance within a region. Environmental governance describes the manner in which authority is exercised over natural resources by decision-makers who range from governmental ministers, property owners to farmers (WRI, 2004).

In Zimbabwe, artisanal small scale gold mining has intensified due to increasing poverty levels and perennial drought occurrences. This corresponds with findings within this research that show that resettled farmers have resorted to ASM as an alternative livelihood, and are working in cooperation with miners to allow mining activities on their farms. ASM has been adopted as part of a coping strategy to minimize the negative effects of economic hardships and drought (Hayes and Perks, 2012). Artisanal mining is potentially more lucrative than agriculture, gaining momentum in the past two decades (Mabhena, 2012). Zimbabwe has an estimated population of 500 000 people who are directly involved in ASM activities, with at least two million people being sustained by it as a livelihood activity, both directly and indirectly (Spiegel, 2009). The recent rise in artisanal gold mining in the country can be attributed to an economic decline that has led to retrenchments, high unemployment rates as well as the increased incidence in droughts (Spiegel, 2009). This has resulted in many people resorting to ASM as an informal livelihood activity and farmers exploring non-agricultural incomes. This has made gold panning a primary source of livelihood in resource-rich rural communities, with a complimentary relationship existing between ASM and subsistence agriculture (Hilson, 2011), as will be discussed in Chapter 4. The classification of ASM is dependent on the size of the mining operation; their legality; and the methods used to carry out the mining activities (Shoko, 2002; Mawowa, 2013). For this study, ASM is inclusive of small, legal and illegal miners who use basic and rudimentary methods and processes to extract mineral resources. According to Ncube (2015) ASM in the
country consists of an estimated 25,000 registered mining claims, and over 400,000 unregistered illegal miners. Of these, an estimated 153,000 miners are women and children (Salih, 2002; Ncube, 2015). The continued poor performing macroeconomic environment in the country is likely to increase the number of people involved in ASM across the country (Ncube 2015). The registered miners have certified small claims and gold processing mills that are recognized by the Ministry of Mines (Phiri, 2009). Unregistered miners are viewed as informal and their operations illegal and subsequently their practices are considered a criminal activity (Mawowa, 2013). This study highlights the dynamics of environmental governance in the Mazowe catchment area but outlining the conflicts that exist between miners and state authority such as the police. Banchirigah and Hilson, (2010) argue that ASM can lead to a population influx and create conflict with existing miners, communities and indigenous populations. These conflicts can be based on environmental degradation where water resources are polluted through mercury usage and siltation. Conflicts over the environment and natural resources arise when the involved parties disagree over the management, distribution and protection of their resources and distribution (Hilson, 2011).

ASM activities are usually either carried out in alluvial or hard rock deposits (Jonsson and Bryceson, 2009). Alluvial mining consists of extracting material from sand and gravel in riverbeds, while hard rock deposits are drilled or blasted so as to loosen the mineral ore (Jonsson and Bryceson, 2009). The sector is male dominated, but with some women and children being involved in mineral processing (Phiri, 2009). ASM is generally characterized by labor intensive, inefficient methods and exploitation of mineral deposits, poor management and work conditions and unpredictable output of minerals (Mawowa, 2013). It has proven to be an important sector in the production of minerals in Zimbabwe as it requires a small amount of capital to be carried
out. Small scale mining provides an increase in economic and political power. The extractive sector contributed to 25.8% of gross domestic product (GDP), making the industry a critical instrument of political and economic power thus bringing about positive social development (CNRG, 2013). While artisanal small-scale gold mining allows for employment, it is associated with ecological hazards. Artisanal small-scale gold mining has been recognized as one of the major drivers which are responsible for the destruction of the environment (Love, 2002). The ecological impacts related to artisanal small scale gold mining include land degradation, deforestation, deterioration of water quality, air pollution, siltation of water sources and an overall loss in biodiversity (Dreschler, 2001). Artisanal gold mining promotes the destruction of large areas of land; vegetation is destroyed and leaves soils vulnerable to erosion and possible contamination by mercury. Environmental degradation leads to loss of livelihoods, ecosystem services to local communities, reduced food security as well as increased disease spread and incidence (Miththapala, 2008). In this study, the extent of environmental degradation is determined by land use/land cover changes and participatory GIS. The changes in land use/land cover will be linked to the occurrence of conflicts and how this has affected environmental governance in Chapter 4 of this thesis.

Environmental governance is regarded as a method of preventing conflict (Salih, 2002). It consists of traditions, customs and policies that regulate the usage and management of natural resources target to effect order and predictability to cases where competition and conflicting interests are present. Natural resources extraction and ASM activities lead to conflicts when the benefits are not shared equally in a community, decisions are made by stakeholders without the involvement of the community and environmental impacts are not well-addressed (Darimari et
Direct competition over resources needed to sustain livelihoods such as water, cropland and forest can trigger conflicts among users (Hentschel, 2002).

1.3. Research objectives

1.3.1. General objective

The main objective of the research is to determine the effects of artisanal small scale mining and gold processing mills on environmental governance within the Mazowe catchment. Table 1.1 shows the specific objectives and the related research questions:

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Research questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To explore how participatory mapping and GIS can be used to identify land changes due to artisanal mining and gold processing mills.</td>
<td>1. How can participatory mapping and GIS be used to examine the conflicts surrounding ASM?</td>
</tr>
</tbody>
</table>
| 2. To analyze the factors surrounding environmental conflicts among different actors within the Mazowe Catchment in relation to ASM activities. | 1. What kinds of conflicts exist among miners, other land and water resource users?  
2. What are the probable causes and effects of conflict within the catchment between miners and other land users?  
3. Which group of land and water users has been mostly affected by the conflicts?  
4. What institution forms exist within the catchment to manage conflicts over natural resource use and what is their effectiveness? |
| 3. To identify and explain existing land and water resource use and access amongst ASM miners, other land users and main key actors within the Mazowe Catchment. | 1. Which resources are available in the catchment?  
2. How accessible are the available land and water resources to ASM miners and other land users?  
3. Who controls these resources? |
| 4. To determine how artisanal small scale gold mining is contributing to | 1. What is the effect of pollution on stakeholder relations within the area? |

Comment [v1]: I thought this objective was necessary to link the RS work based on LULC as well as participatory mapping.

Comment [v2]: This objective is in the presentation, I rephrased it based on Dr Mabiza’s comments as well as critique of DGES, was told to write ‘factors’ instead of ‘causes’.

Comment [v3]: You suggested this objective on one of the first drafts that you revised and Dr Mabiza suggested that ‘resource use’ was too broad hence I narrowed it down to ‘land and water resource’ use.
1.4. Problem statement
Most research has focused extensively on the contribution of detrimental ASM activities such as water pollution and land degradation (Phiri 2009; Shoko 2002) and little attention has been placed to issues pertaining to environmental governance in the Mazowe Catchment in relation with artisanal and small scale mining and other land users. This study bridges this gap by analyzing environmental governance in the context of conflict and cooperation by miners and other land users in the Mazowe catchment. This approach grounded in the framework of political ecology provides nuanced information on environmental governance in mineral-rich localities and how it is implemented/negotiated amongst different stakeholders. The study proposes the possible policies and solutions that can be crafted regarding environmental governance to the rural communities as well as their involvement in the decision-making processes and management of their natural resources.

1.5. Justification
ASM activities are an important economic activity in Zimbabwe that contributes to livelihoods and regeneration of the economy. Due to the poor macroeconomic environment, it is expected that ASM is likely continue to expand and place stress on limited land and natural resources. This study aims to contribute towards the understanding of resource conflicts existent in the Mazowe Catchment and areas of cooperation among different actors in the area. ASM threatens to be a factor underlying environmental conflicts through land degradation and water contamination. This can limit access to clean water and arable land for locals within the area. Through the mapping of land use/land cover changes and participatory resource mapping, the study analyzes the extent of environmental damage caused by ASM in the catchment area and
how different stakeholders are navigating the problems. There is a need to know how those factors may inform efforts to ameliorate natural resource conflicts and environmental governance. This study is crucial to local communities and policy makers as it is directed towards good environmental governance practices through environmental conflict resolution.

1.6. Thesis outline
This thesis is divided into five chapters. Chapter Two contains a literature review related to the theoretical framework and theory based on environmental conflicts and environmental governance. Chapter Three provides a geographical description of the study area and the methodology utilized for the research. Chapter Four shows the results obtained from the study and a discussion of the survey, interviews and spatial data to assess the factors underlying environmental conflicts and their effects on environmental governance. Chapter Five contains possible recommendations so as to ensure good environmental governance within the Mazowe Catchment.
CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction
This chapter focuses on the theoretical framework upon which the research is based on and theory discussed in the literature on global and local studies of the impact of ASM on both natural resource conflicts and environmental governance.

2.2. Theoretical framework
This research guided is guided by the political ecology framework. Political ecology developed as a subfield to geography (Escobar 1996). Political ecology is an area in geography that investigates human-environment relationships, with a particular focus being concentrated on political factors affecting environmental management and degradation of natural resources (Bebbington, 2008). Political ecology emerged as a way of formulating solutions to social and environmental problems prominent in third world countries (Bryant and Bailey, 1997), with Zimbabwe being an example. The main arguments of political ecology are:

- Changes in the environment are distributed unequally among actors with economic, social and political differences being attributed to this.
- Unequal distribution of environmental changes either strengthens or reduces the existing social and economic inequalities among actors.
- Unequal distributions of the costs and benefits of environmental change has political implications due to the altered power relationships that result (Bryant and Bailey, 1997).

It serves to address unequal power relations regarding access to and control over resources (Guthman, 1997). In the context of this research, political ecology argues that to have a full understanding of environmental conflicts, the power relations among different stakeholders within artisanal small scale gold mining industry have to be analyzed. This study utilizes
political ecology as a theoretical and analytical tool to assess how the environment is valued by different groups of actors. The core assumption of political ecology in relation to environmental conflicts is that nature and society are mutually interlinked. The environment can be viewed as a platform of contested entitlements and cultural meanings. As a result, environmental conflicts are social, economic, political and cultural conflicts.

Political ecology in relation to environmental conflicts can be based from a post-structuralist perspective where Marxist traditions are taken into consideration (Escobar, 1996). Under Marxist traditions, conflicts are regarded as a part of society and most conflicts occur without having attention addressed to them because they are controlled by the powerful state through police and the army as well by intimidated by imprisonment (Blackie and Brookfield, 1987). This framework has been utilized in addressing human-wildlife conflict (Gupta, 2013), (Kideghesco, 2006) and land degradation (Blackie and Brookfield 1987). The findings from research that applied the political ecology framework showed that in the case of human-wildlife conflicts, local people lost their livelihoods, homes and conflict resulted due to more powerful actors employing conservation strategies without consideration for the people. (Blackie and Brookfield 1987) found that land degradation occurred due to the interaction of humans and their natural environment which was influenced by social, economic and political factors.

Environmental conflicts with regards to artisanal-small scale mining can be understood as a product of human needs not being met due to competition of natural resources among different users and unequal power among actors which lead to the theme of environmental governance. There are three factors that induce resource scarcity and conflict and these are demand-induced through population growth which creates an increased need or reliance for a resource, supply-induced where the existing resources are made scarce through degradation and environmental
change and structural-induced whereby an unequal distribution of resources exists among different actors either as individuals or as a group. Supply-induced and demand-induced natural resource conflicts are due to a resource being utilized and not having time to replenish thereby the demand for the resource becomes excessive (Mamimine et al. 2001). The growth rate of the population can also lead to increased demand over a resource, as common with artisanal small-scale miners who are nomadic in nature. The environmental conflicts within the Mazowe catchment can be viewed mainly as structural-based due to the uneven distribution of land and water resources within the community which is characteristic of artisanal small-scale mining activities. The environmental conflicts can be summarized as follows:

Resource scarcity + population growth + structural inequalities » resource seizure, marginalization, migration» environmental conflict

The environmental conflicts within the Mazowe catchment in relation to artisanal small-scale gold mining activities will be regarded as structural-based natural resource scarcity, with the conflicts escalating due to poor environmental governance where policies are not practiced properly to maintain equity among all actors and due to the prevailing economic crisis which exaggerates the intensity of the conflicts. The use of land and water resources in the Mazowe catchment is contested by different actors who have different interests, values and influence. The powerful actors within the catchment have influence over two discourses. Within the discourses, either those involved in ASM proceed with their activities in order to have a livelihood in the current economic crisis without concern for the needs of local people in the area or the local people in the communities affected by ASM participate in management of their land and water resources in such a way to benefit from them while allowing for sustainability.
2.3. Artisanal small-scale gold mining and its related conflicts
Artisanal small-scale gold mining has expanded over the past decade and this has resulted in intensified environmental and social challenges which include the destruction of land, water resources, vegetation and community livelihoods (Singh, 2005).

Natural resources are distributed unevenly in spatial and temporal dimensions, creating challenges in how they are managed and allocated (UNEP, 2015). The availability of natural resources at a particular location cannot be predicted accurately beforehand. Natural resources are of critical importance as they serve a range of purposes: economic (agriculture, transport, energy, industry), environmental (ecosystem services) and social (household consumption). Effective resource and environmental governance is the solution to sharing natural resources among its users and resolving conflicts over the resources among stakeholders (UNEP, 2015).

Tensions are unavoidable as competition for resources increases (Stevens et al. 2013). Disputes occur between livelihood groups when unexpected changes occur with the change in the availability or quality of the natural resources (Stevens et al. 2013). Changes may be brought about by human activity, natural variation or climate change. The risk of conflict increases when two or more actors with unequal power and influence are facing a scarcity in a particular resource with no other alternatives (Priscoli and Wolf, 2010). Whether existing natural resources in an area bring about conflict depends on the governance systems that have been set up. Environmental conflicts are disagreements between different parties within society over alternative resource uses or allocation of environmental impacts (Muradian et al. 2004). Artisanal small-scale activities are among the most environment-intensive sectors and this has invoked environmental conflicts at both global and local scales (Martinez-Alier, 2001). Environmental conflicts in relation to artisanal small-scale mining are often related to:
i. a lack of adequate environmental awareness and concern by artisanal miners and small-scale operators.

ii. administrative constraints that are related with the difficulty of regulatory authorities in controlling a large number of artisanal miners especially in remote areas.

[Adapted from Tarras-Wahlberg (2002)]

2.4. Conflicts associated with artisanal small-scale gold mining and agriculture

Globally, mining activity is found to be in competition with agriculture in the rural areas, where both allow for economic development (Slack, 2013). These two activities tend to take place in the same areas which brings their compatibility into question. Mining produces extensive water pollution and land degradation which has a direct impact on agricultural production. These impacts are often detrimental, with the use of polluted water making previously fertile lands unusable (Slack, 2013).

Mining activities in Zimbabwe are mainly carried out in the highveld, in the source areas of river catchments which gives rise to conflicts between the need of miners to discard large volumes of waste and the water quality needs of the environment, of agricultural and other water users (Pachawo, 2013). Artisanal mining has the potential to alter hydrological regimes, as well as the quality and quantity of the downstream water due to its occurrences in catchment areas (Sosa and Zwaarveen, 2012). Artisanal mining also is extensive and utilizes large amounts of land which would have been reserved for agricultural activities or the provision of ecosystem services to the surrounding communities. Catchment areas are highly productive for agricultural activities and can therefore give rise to conflicts between ASM miners and farmers as the wastes that have been disposed of negatively affect soil and water quality, thereby having an impact on
agricultural productivity and the quality of the produce (Priscoli and Wolf, 2010). Disregard of environmental governance issues is viewed as a threat to the environment and a potential cause of conflict within societies and larger mineral producers, particularly in regard to land and water (Norman, Bakker, and Cook, 2012). The artisanal small-scale gold mining sector has also been turned into an area of conflict through effected policies proposed by the government affecting the livelihood of the involved masses (Spiegel, 2009).

The Mazowe Catchment contains several of Zimbabwe’s largest mining operations, particularly in gold and nickel. It is a densely populated area and facilitates a large number of agricultural activities (Ravengai et al. 2005). The occurrence of large commercial mines in the area has led it to being a hotspot for artisanal miners due to the presence of extensive gold reserves. Mining and commercial agriculture are the major water and land users, while urban areas such as Bindura, Marondera and Mutoko draw water from the catchment (Lupankwa et al. 2006). As a result, it is important to regulate different classes of mining and mineral processing operations within the Mazowe Catchment so as to manage the environment quality and avoid conflicts over sharing and control of natural resources.

The method used to process ore throughout the Mazowe catchment mostly involves crushing of ore which is followed by amalgamation with mercury by artisanal miners and gold mills. Mercury is mostly utilized as it simplifies the gold recovery process, is an affordable chemical agent and provides high recovery rates (Maponga and Ngorima, 2003). Mercury is lost in the tailings after repetitive washes and is eventually washed away into river systems. Water quality problems are commonly associated with ASM, with mercury contamination having fatal consequences for aquatic fauna and flora species. Mercury discharged into the environment becomes transformed into forms that are readily bioavailable and accumulates in the food chain
Cyanide is used by registered gold processing mills to extract fine gold from low grade ores though the process requires more expertise and investment compared to mercury amalgamation (Bridge, 2004). Cyanadation has higher yields of gold recovery and the gold is extracted from a gold-cyanide complex through precipitation. Chemical pollution is detrimental on human health with use of cyanide and mercury being linked to death, depression, exaggerated emotional response and dysfunction of the urinary tract (Hinton et al., 2003).

Conflict often arises between farmers and miners over access to land and water resources, this being related to the total amount of land and water used, particularly when areas have limited natural resources (Mishra and Pujari, 2008). Mining and mineral extraction usually involves powerful actors who gain control over local water arrangements (TNI, 2013b). This can bring about direct or indirect restrictions on the access to land and water for previous users or marginalized groups by negative transformations on both the landscape and waterscape such as water pollution and depletion (TNI, 2013a). Conflict can be avoided by enforcing environmental legislation requiring the assessment of potential environmental impacts likely to result from mining activities (Mishra and Pujari, 2008). However, artisanal small-scale gold mining is viewed as illegal and occurs in areas where large-scale mining takes place. Artisanal small-scale gold mining operates without following environmental procedures leading to unregulated pollution (Mishra and Pujari, 2008).

2.5. Environmental governance within the mining sector

Globally, issues concerning water scarcity and a shift to natural resources management paradigm has helped to push environmental issues onto the priority list of development agencies (Chikozho, 2008). This aims to improve governance of the environmental sector and to introduce equitable access to natural resources. Governance generally refers to how power and decision-
making is shared amongst different actors and groups in society (Chikozho 2008). Environmental governance has been defined as “how societies organize themselves to manage their environments and deal with fundamental environmental problems” (Salih, 2002). Lemos and Agrawal (2006) refer to environmental governance as a “set of regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes.” Conflicting interests are accommodated, with stakeholder engagement being included to ensure a sustainable and responsible use of natural resources (UNDP, 1997). Balancing effective environmental governance with the extraction of mineral resources is a critical challenge faced by government, regulatory authorities and local communities. Mining activities often bring together a diversity of actors whose interests are often opposed. Environmental governance intervenes the conflicting interests and allows interaction among actors to reach favourable environmental outcomes for those involved. When groups of individuals share water resources as a common property, they are connected to each other in a socio-political, economic and ecological manner. Misuse of a water resource by one individual affects the other users (Chikozho, 2008).

The operational needs of mining and human rights of local people intersect in complex and conflicting ways as access to water and land tends to become restricted (Kemp et al. 2011). The artisanal mining industry utilizes water for processing and transport of ore and waste, mineral separation, removal of dust particles, washing of equipment and human consumption (Kemp et al. 2011). Extraction of water from surface and groundwater directly affects ecosystems, resulting in competition for water access with other users particularly where alternate industries are present. Dewatering occurs whereby naturally occurring recharging is not enough to replace the water utilized in mining activities when the water is extracted from underground pits (Mudd
This devastates the local water resources upon which local communities are reliant upon. ASM is plagued by environmental governance issues as the trade is mostly associated with unregulated operations with manual workers engaged in the sector being generally ignorant when it comes to understanding of the importance of protecting the environment and their resources against making a profit (Jonsson and Bryceson 2009).

Polluted water and land have implications on the right to health and the ability for an individual to secure a livelihood if the water and land have been contaminated such that they cannot be used for agricultural or domestic purposes (Kemp et al. 2011). Community involvement in environmental governance improves efficiency, access and sustainability of available natural resources, especially when local community actors have a more significant role in environmental management compared to when it is headed by government (Rogers and Hall 2003). There is a need for closer attention to be paid to the interrelationships that exist between power and environmental governance.

Artisanal small-scale mining results in significant social, economic and environmental changes which are not necessarily positive. Mining operations that are usually carried out within rural areas are often accompanied by irreversible changes in how water and land are controlled and managed within an area (Rogers and Hall, 2003). Different actors at different levels respond to the environmental and social challenges brought by artisanal mining using different approaches to mitigate the impacts. These approaches include environmental impact assessments and environmental taxes. Local communities rely on customary systems in regulating the use of land and water in an area (Kasanga and Kotey, 2001).

Conflicts between artisanal small-scale miners and regulatory authorities occur within connected cycles of cause and effect (Noetstaller, 1987). For the artisanal miners, the use of inadequate
mining and extraction methods leads to low returns and low metal recovery. This limits their ability to acquire funds for appropriate equipment and to formally register their trade. Regulatory authorities are often unable to enforce laws due to a lack of operational resources leading to corruption, illegal operations, poor environmental health and a loss of monetary revenues (Noetstaller, 1987).

Environmental conflicts are a clash of interests over the allocation, use and distribution of a natural resource (Kemp et al. 2011). Zimbabwe is a developing country where the local natural resources available conditions are insufficient to satisfy the increasing demands. Conflicts for land and water resources arise easily when there is a competing demand for the same resources. Conflict for natural resources has also been attributed to the frequent and severe droughts that have been faced in recent years thereby making the resources, particularly water and arable land scarce (UNEP, 2015). The scarcity of water and arable land has been worsened by small-scale miners who clear extensive areas of forests for mining, panning dishes and infrastructural constructs (Shoko, 2002). The deforestation is directly involved in the rapid loss of soil moisture and topsoil which disrupts the balance of the climate, accelerating deforestation.

Conflicts between artisanal small-scale miners and regulatory authorities occur within connected cycles of cause and effect (Noetstaller, 1987). For the artisanal miners, the use of inadequate mining and extraction methods leads to low returns and low metal recovery. This limits their ability to acquire funds for appropriate equipment and to formally register their trade. Regulatory authorities are often unable to enforce laws due to a lack of operational resources leading to corruption, illegal operations, poor environmental health and a loss of monetary revenues (Noetstaller, 1987). There is also an association of environmental conflict between small-scale mining companies and the communities in which they work in. These companies often belong to
a single individual and have limited resources, limiting their ability to cultivate relationships with the community (Bebbington, 2008). Communities are not involved in giving permission as to whether exploration and extraction of minerals should take place on their lands. Regulatory authorities often have a conflict of interest in the promotion of mineral extraction and fail to protect the environment of the community from the effects of mining (Bebbington and Williams, 2008).

To resolve conflicts surrounding natural resources within the Mazowe Catchment and other mining areas, rural district councils and other regulatory authorities have been empowered to train artisanal small-scale miners to protect water and land so as to reduce environmental pollution and conflicts (Shoko, 2002).

**2.6. Zimbabwean legislation on environmental governance**

The legislature of Zimbabwe has certain guidelines to ensure a more equitable distribution and stakeholder involvement in the management of available natural resources. The legislation serves to avoid pollution and environmental conflict. However, it appears that most of the legislation that has been proposed and approved is biased towards urban residents compared to the majority of the population which is located within the rural areas.


This is based on the principle that every human being has a right to access clean water and that water cannot be privately owned. Pollution of water is restricted and is considered an offense, with the stakeholder responsible being liable. Regarding water and land management, local authorities are able to make regulations for the administration of the area they are in. The act is executed under the Ministry of Environment, Water and Climate (Government of Zimbabwe, 2015).
2.6.2. Environmental Management Act of 2002 (20:27)
The act states that every person has a right to protect the environment for the benefit of present and future generations. It ensures ecological sustainable management and use of natural resources. As a result, it serves to protect against water resources and land degradation. The act allows for environmental management and makes allowance for the formulation of environmental quality standards such as air, water, effluents and hazardous substances. The act requires that EIAs be undertaken for specific projects and lists procedures to be followed for the implementation of the EIA process. The act is executed under the Ministry of Environment, Water and Climate (Government of Zimbabwe, 2015).

2.6.3. The Rural District Councils Act of 1989 (29:13)
Rural district councils should try to ensure adequate supplies of water in an area for all people and activities, with councillors being responsible of rural governance of natural resources. The act is executed under the Ministry of Local Government, Public Works and National Housing (Government of Zimbabwe, 2015).

2.6.4. The Forest Act of 1949 (19:05)
The act allows for the recognition and demarcation of forests and natural reserves, the conservation of timber resources and the regulation of the burning of vegetation. The act is implemented under the Ministry of Environment, Water and Climate (Government of Zimbabwe, 2015).

2.6.5. The Mines and Minerals Act of 1961 (21:05)
The act manages the processes of obtaining mining rights, prospecting and extraction of mineral resources, as well as the closure of mining works. The act is implemented by the Ministry of Mines and Mining Development (Government of Zimbabwe, 2015).
CHAPTER THREE: METHODOLOGY

3.1. Introduction
This section provides an overview of the geography of the Mazowe Catchment area and the research methods and analysis used to meet the objectives of the research. An outline of limitations and challenges experienced throughout the research period concludes the chapter.

3.2. Aims and related methods
The aim of the research is to determine the effects of artisanal small scale mining and gold processing mills on environmental governance within the Mazowe Catchment. To complete this aim, four objectives were established. These were to explore the use of participatory mapping and GIS to identify land changes due to artisanal mining and gold processing mills; to analyze the factors surrounding environmental conflicts among different actors; to identify and explain existing land and water resource use and access among actors, and to determine how ASM is contributing to water pollution in the Mazowe Catchment. Table 3.1 shows a summary of the methods used to collect data and the techniques applied in analyzing data related to these objectives:

<table>
<thead>
<tr>
<th>OBJECTIVE</th>
<th>METHOD</th>
<th>DATA ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To explore how participatory mapping and GIS can be used to identify artisanal mining and gold processing mills.</td>
<td>Primary data: mental mapping by participants&lt;br&gt;Secondary data: use of Landsat imagery</td>
<td>Quantitative and qualitative Use of GIS software&lt;br&gt;Mapping of Land use/land cover changes</td>
</tr>
<tr>
<td>2. To analyze the factors surrounding environmental conflicts among different actors within the Mazowe Catchment in relation</td>
<td>Primary data: use of questionnaire, key informant interviews, focus group discussions, field observations&lt;br&gt;Secondary data: literature review</td>
<td>Quantitative and qualitative Observations made through transect walks&lt;br&gt;Review of previous studies</td>
</tr>
</tbody>
</table>
3. To identify and explain existing land and water resource use and access amongst ASM miners, other land users and main key actors within the Mazowe Catchment.

<table>
<thead>
<tr>
<th>3. To identify and explain existing land and water resource use and access amongst ASM miners, other land users and main key actors within the Mazowe Catchment.</th>
<th>Primary data: use of questionnaire, key informant interviews, focus group discussions and field observations</th>
<th>Quantitative and qualitative Content analysis Remote sensing and GIS Mapping of land use/land cover changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. To determine how artisanal small scale gold mining is contributing to water pollution in the Mazowe catchment.</td>
<td>Primary data: water sampling and quality testing Secondary data: use of digital elevation models, comparison with local and global water guidelines</td>
<td>Quantitative Laboratory analysis Remote sensing and GIS analysis</td>
</tr>
</tbody>
</table>

3.3. Research design

A mixed-method approach was used to achieve the objectives of this research. This approach involved the use of a variety of data sources that generated qualitative and quantitative data. The research used a mix of techniques which included the use of a structured questionnaire survey, key informant interviews, FGDs, field observations, water quality testing and GI Science techniques to map areas where the land use changes occurred due to ASM activities. The mixed methods approach is useful when undertaking complex research questions with qualitative data providing a thorough understanding of survey questions, and qualitative data allowing for statistical analysis which provides an accurate overview of the data (Driscoll et al. 2007).

The methodology that was chosen was based on the phenomena under study that required the views of people in the study area. Qualitative methods place a lot of emphasis and focus on the perceptions, attitudes, views and belief systems of people (Creswell, 2013). These are measured by descriptions of the respondents under study, as the same events may have different meanings to different people. Qualitative approaches have been criticized due to subjectivity and a
perceived lack of scientific rigor in comparison to quantitative methods which focus on exact statistical measurements (Kothari, 2004). Thus this research combined both qualitative and quantitative methods, which allow for the process of methodological triangulation of data for scientific validity and for the provision of a clear and comprehensive picture of issues pertaining to environmental governance. For example, maps drawn by several actors in the Mazowe catchment were validated through the use of LULC and a strong correlation was observed between the two sets of maps as discussed in Chapter Four. Participatory mapping was validated through land use/land cover mapping using GIS and remote sensing techniques.

Quantitative methods were utilized in the research with reference to spatial data and water quality testing in the laboratory. The methods utilized were remote sensing and parametric water quality testing. Figure 3.1 shows a schematic representation of the methodology carried out during the research:
A single case study approach was employed as it provided a complete observation of the community under study, with efforts being made to study every aspect and minute detail of the situation under investigation (Kothari, 2004). The case study approach allows for a phenomenon to be studied in depth and within a real-life perspective (Yin, 2009). A case study when combined with qualitative and quantitative data, allows for an in-depth appreciation (Crowe et al. 2011) of the environmental conflicts in the area.

3.4. Study area
The Mazowe catchment is situated in the north eastern region of Zimbabwe. The catchment consists of ten sub-catchments with the study location being located in the Upper Mazowe sub-catchment. The Upper Mazowe sub-catchment is located at 17°31’18”S and 30°59’19”E. The area comprises of several land tenures which are commercial mines, communal areas and
commercial farms. The soils within the sub-catchment are mostly fertile, alluvial soils and experience a relatively high rainfall ranging from 800-1000mm. The mean annual temperature ranges from a minimum of 9ºC to a maximum of 28ºC. the economic activities found within the Mazowe catchment are based on mining and agriculture. Gold is the most important mineral in the catchment and is extracted at both commercial and individual levels, which rely on it for employment and income. Commercial farming within the catchment consists of growing citrus fruits, groundnuts, with the main cash crops being maize and tobacco. The area was previously dominated by white commercial farmers but is now owned by mostly black, powerful elite individuals following the land re-distribution program. This has been followed by a decline in commercial farming in the area with some of the land being converted into a wildlife sanctuary and processing plant for milk products. The Mazowe Dam providing water for surrounding areas such as Bindura, Marondera and Shamva (Lupankwa et al. 2006). As a result, it is important to regulate and govern the different classes of mining and mineral processing operations within the Mazowe Catchment, as well as their effect on the environment so as to minimize conflicts over sharing and control of natural resources among different actors.

The site of the study was selected through purposive sampling which does not rely on probability. During the process of site selection, personal judgment and extensive literature on ASM activities was used to select Mazowe Catchment as it is representative of the significant land uses (ASM activities and farming) which are of interest to the study and highlight environmental conflicts among the different land and water users. The conditions within the Mazowe Catchment best serve the objectives of the research as the situation in Mazowe Catchment represents other similar cases within mining areas in Zimbabwe.
3.5 Primary data collection

3.5.1 Quantitative data

Quantitative primary data collection comprised of both spatial and non-spatial data. The methods utilized in the research consisted of a structured household survey with close-ended questions, and integration of GIS methods and physico-chemical analysis of water samples.

3.5.1.1 Questionnaire survey

A closed ended questionnaire was administered to 32 artisanal miners. Gold millers were not included in the sample group due to their unwillingness to cooperate, though they participated in the use of interviews and focus group discussions. The use of close-ended questions was adopted
as it is amenable to statistical analysis and graphical representation. The questionnaire administered consisted of two sections: the first section consisted of the demographic profile of the sample group and the second section had questions that focused on mining activities, their impacts and resulting conflicts as shown in Appendix 1. The questionnaire was used to obtain information based on the artisanal small-scale gold mining trade and to assess the presence of conflicts in the area. Convenience sampling was used to select artisanal miners to interview based on their proximity to where ASM activities occurred. Dornyei (2007) defined convenience sampling as a method where a sample of a target population is selected based on certain criteria such as expenses on the researcher, geographical proximity, accessibility and availability at a certain time. This method was utilized for research based to the nomadic nature of artisanal miners and their willingness to volunteer to the study.

The artisanal miners interviewed were chosen through systematic random sampling techniques which allow a researcher to have a wider coverage of an area and opinions by skipping the next miner after interviewing one.

3.5.1.1. Questionnaire survey analysis

Survey data was imported into SPSS v22.0, which was used to analyze questionnaire content. SPSS allows for the coding of questionnaire responses and produce graphical illustrations and charts.

3.5.1.2. Remote sensing and GIS

A hand-held GPS receiver was used to record locations where interviews and artisanal and small-scale gold mining activities were occurring within the Mazowe Catchment. The locations were

Comment [EC5]: One/two sentences explaining convenience sampling an why it was used
used to ground truth spatial locations mentioned by respondents and illustrated during mental mapping. The locations recorded were also used to create maps using GIS software to reflect the areas where artisanal mining and conflict were prominent. Location data for small-scale gold processing mills was obtained from EMA as the gold mills were not accessible to the researcher.

Cloudless Landsat 4 and Landsat 7 images covering for the Upper Mazowe sub-catchment for the years 2001, 2006 and 2015 were obtained from the GLOVIS website (www.glovis.usgs.gov). The time series used for analysis was obtained from discussions whereby respondents gave time frames for when conflict started and ASM activities became prominent in the area. The Upper Mazowe catchment region was covered under two adjacent images which were mosaicked together in QGIS 2.14 Essen to produce one overall image for each year. The images were imported into ArcGIS where they were pre-processed and classification was done using the maximum likelihood classification where pixels with similar spectral signatures are grouped by use of training samples. The images were used to verify land use changes noted by respondents. The river hydrology of the Upper Mazowe catchment was determined by the use of digital elevation models (DEMs) obtained from SRTM digital elevation data which was inputted into ILWIS 3.3 to generate flow accumulation and flow direction maps for the sub-catchment. This was done in order to determine extent of possible pollution of the Mazowe River from surrounding artisanal mining and gold processing sites.

3.5.1.2.1. Remote sensing and GIS analysis

Land use land cover maps showing different land classes such as dryland farming, irrigated farming, settlements, and vegetation were produced. The percentage change in the land area occupied by each land use was calculated using the years 2001 and 2015. River hydrology data
produced flow accumulation and flow direction maps which highlight the direction in which pollutants from ASM activities are likely to be concentrated.

3.5.1.3. Water quality sampling and testing

Water samples from each artisanal small-scale mining site were collected in 500ml polythene bottles rinsed thoroughly with distilled water. The physical parameters that were tested in-situ were temperature, pH, dissolved oxygen and electrical conductivity. The water samples were stored in a cooler box with ice and transported to the laboratory where further analysis was carried out within 24 hours of sampling to maintain the integrity of the water samples. The chemical parameters that were analyzed in the laboratory were total nitrogen, nitrates, total phosphates, phosphates, turbidity, presence of E.coli and mercury. The quantity of nitrates and total nitrogen was determined using the cadmium-reduction method (Adams, 1989). Phosphates and total phosphorus were analyzed by use of the ascorbic acid method (Adams, 1989). Turbidity was determined from the samples by use of a HACH DR/2010 Portable Spectrophotometer at a wavelength reading of 860nm. The amount of mercury in the samples was determined by use of atomic absorption spectrophotometry (AWWA, 1999). E.coli presence was determined by the growth of colonies on 2% brilliant green lactose bile broth (Cairns, 1979) which supports the growth of that specific bacterium. Parametric water quality testing was carried out so as to determine the effect of ASM activities on water quality within the catchment.

3.5.1.3.1. Water quality data analysis

Results obtained from water quality testing by the Department of Biological Sciences and Tobacco Research Board (TRB) were compared with the standards set by the World Health Organization (W.H.O) and Environmental Management Agency (EMA).
3.5.2. Qualitative data

A combination of qualitative tools was used in data gathering and these included direct observation of activities occurring, key informant interviews and focus group discussions.

3.5.2.1. Focus group discussions

Focus group discussions (FGDs) are informal dialogues involving a group of 6-8 respondents where an issue of common interest is discussed and information is obtained in a short amount of time (Kothari, 2004). Three FGDs were held at each of the mining sites sampled by the researcher and were differentiated as follows: men, women and youth. Each FGD comprised of 6 respondents. The age group of the men FGD ranged from 18-42 years. The women FGD had participants aged from 24-37 years old, with the youth FGD ranging from 17-25 years old. The youth FGD comprised of males only as young, unmarried females within the study area did not participate in ASM and were not willing to participate. Three FGDs were done so as to gain different perspectives on artisanal gold mining within the Mazowe catchment, the conflicts associated with artisanal small-scale gold mining and to determine how environmental governance was being implemented in the area. The participants included small-scale farmworkers, artisanal miners and local villagers. The discussions assisted the researcher to gain insight on the conflicts that surround the trade of artisanal gold mining and how it has affected other livelihoods in the area. The respondents also engaged in participatory mapping whereby respondents showed an understanding of their area and the changes that occurred over time due to the upsurge of artisanal small-scale gold mining in the catchment. The sketch images drawn were verified through the use of satellite images due to validate the land use changes confirmed by the participants.
3.5.2.1. Focus group discussion analysis

Analysis of data from FGDs was carried out by transcribing the discussions and through content analysis by selecting issues that were discussed and emphasized the most by respondents. This was supplemented by observational data made by the researcher to interpret statements made during the discussions.

3.5.2.2. Key informant interviews

Key informant interviews are formal conversations in which specific questions are posed to the interviewee by the interviewer (Creswell, 2013). A total of six key informant interviews were conducted during the research. Three of the interviews were carried out with officers representing regulatory authorities involved in natural resource management in the study area: EMA, ZINWA and Mazowe sub-catchment council. The other key informant interviews were carried out with a local farmworker, an artisanal miner and a worker at a gold processing mill. The interviews were conducted with workers in farms and gold mills as the farm and gold mill owners were not accessible to the researcher. The guides used for the interviews are shown in Appendices 2 and 3.

3.5.2.2.1. Key informant interview analysis

Content analysis was used to determine the cause and the nature of conflicts within the Mazowe Catchment that could be attributed to the occurrence of artisanal mining. Content analysis is a technique utilized for making data inferences by compressing text into fewer concept categories (Stenler, 2001). This was done through identification of issues and patterns that were continuously raised during interviews.

3.6. Limitations and challenges faced during research and data collection
Some of the challenges faced during data collection were that the respondents were initially unwilling to cooperate with the researcher as they feared that the information exchanged would lead to arrests and raids by police and EMA. Some of the miners also had been part of previous studies carried out in the area and felt that they had not benefitted from cooperating with researchers in the past. They were of the opinion that research carried out in the area only served to benefit the environment and regulation authorities, who used the information to curb ASM in the area and thereby curtailing an important source of economic livelihood for miners. The gender of the researcher proved to be an obstacle in engaging participants as the majority of respondents were male and not willing to communicate to a female, with females not being welcome in areas where rift mining was being practiced. The researcher was also accused of being an undercover agent for police or EMA, as the police and EMA had used such strategies in the past to arrest unsuspecting artisanal miners and unregistered gold stamp millers under the pretense of research. In order to gain access to and information from the mining community, a male research assistant was used in the data collection process. Furthermore, a community gatekeeper (a notable miner in the area) assisted the researcher and assistant in gaining access to two mining sites where reef and stream bank panning were taking place. The gatekeeper gave the researcher legitimacy as a student researcher which allowed for access to people in the upper catchment area. Areas where the artisanal miners carried out their activities were fiercely guarded by the miners who feared arrest and the researcher was restricted from taking photographs in some instances that showed the residences of the miners.
CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Introduction
This chapter focuses on the presentation of results and data analysis of the three artisanal small scale mining sites sampled during the study. Miners from these sites were found within the Upper Mazowe sub-catchment of the Mazowe area.

4.2. Summary of the artisanal small scale miners and mining activities

![Graph showing demographic profile of artisanal miners]

Figure 4.1: Demographic profile of artisanal miners

From the graph, Figure 4.1 the total of male artisanal miners who responded is 68.8% and that of their female counterparts is 31.3%. The dominance of males in the sample suggests that males are capable of coping with the physical demands required by artisanal small-scale gold mining, with females having to engage in intensive domestic responsibilities within their households (Eftimie et al. 2012). The dominant age groups of the artisanal miners sampled were 18-24 years and 25-34 years for both males and females which is related to the age groups that are recognized as economically active and contributing to the growth of the country (Mtetwa and
Artisanal miners aged 45-54 years were few, with most of them resorting to less laborious livelihoods such as farming. Figure 4.2 shows the profile of artisanal miners and reflects the highest level of education attained, the amount of time they have practiced the activity of gold panning and the nature of their engagement in the activity. The percentages shown in the figure are a function of the total number of artisanal miners interviewed which is 32. 50% of the artisanal small scale miners in the sample group attained a secondary level of education with gold panning offering full-time employment. This contradicts previous studies carried out before by Marongwe (1995) and Shoko (2002) which stated that the educational levels of artisanal miners are low. This can be attributed to the decline of the economy and the high levels of unemployment which therefore attract individuals from different educational backgrounds to pursue artisanal small scale gold mining as a livelihood.

Two types of artisanal small-scale gold mining were established to be occurring within the Upper Mazowe sub-catchment and these were reef and alluvial mining. Reef mining was only practiced by males (43.8%) , while alluvial mining which is less laborious was carried out by all of the female respondents (31.2%) with fewer males (25%) being engaged in alluvial mining.
The main drivers for engaging in artisanal small-scale gold mining were lack of employment and a need to increase income from selling the mineral. Lack of employment can be categorized as a push factor which affected 53.1% of male respondents with females being less affected by the push factor. The need to increase income acted as a pull factor which attracted 28.1% of the female respondents and 15.6% to the trade. Lack of employment and increased poverty levels have risen in Zimbabwe due to the economy which declined with a cumulative rate of 54.8% between 1999 and 2009 (Mawowa, 2013), and has faced a 9.8% decline from 2013 to 2015 (Mhlanga, 2016). Women required more income to supplement their husbands’ income and to oversee the daily running of their households. This trend has been enabled by the lack of formal employment which has been brought about by the closure of underperforming industries and an increase in retrenchments over the past decade (Spiegel, 2009).
Figure 4.3: Driving factors of artisanal gold mining

4.3. Spatial distribution of artisanal miners and small-scale gold mills
The researcher established three sites within the Upper Mazowe sub-catchment where artisanal small-scale gold mining activities were prominent. Artisanal miners were found operating near Jumbo Mine, which is approximately 10km north east of Mazowe and on two farms which are Bhuka and Lowdale Farm, with the farms being located nearly 8.7km and 14.6km north-west of Mazowe respectively. Reef mining was being practiced at the site near Jumbo Mine, while alluvial mining was more prominent than reef mining at Bhuka and Lowdale farms. Figure 4.4 shows the areas where artisanal miners carry out their livelihood activity and at times reside. The red dots represent the spatial location of small-scale gold processing mills that are used by artisanal miners within the Upper Mazowe sub-catchment. The blue dots represent the location of artisanal gold miners.
Figure 4.4: Spatial distribution of artisanal miners and small-scale gold stamp mills
(source: Google Earth, Vimbi Chandiwana)

4.4. Impact of artisanal small scale gold mining on environmental conflicts
From the key-informant interviews and focus group discussions, it was deduced that the environmental conflicts occurring were intra-community, involving different land users in the same community and village areas within the Upper Mazowe sub-catchment. Environmental conflicts were due to the following factors:

- Land and forest-related conflicts
4.4.1. Land related conflicts
In all the three artisanal gold mining and small-scale gold processing sites, it was found that land conflicts were prominent among different land users with the most affected groups being farmers, the local community and artisanal miners. Farmers and farm workers complained over the encroachment of artisanal mining activities into their farming lands. Artisanal miners were taking over the arable land which they converted into pits and they dug wells in those areas to acquire water for their mining activities. This reduced the productivity of the land as the land became less suitable for irrigation activities. Pits left exposed by artisanal miners contributed to injuries among local residents and livestock, though most of these incidences were not recorded or reported. These findings acknowledge work done by Mabhena (2012) where conflicts arise as a result of gold panners destroying the environment through unsafe depositing of mercury, forest clearing and lack of rehabilitation of dug pits. It also highlights issues of environmental governance whereby those affected by artisanal mining activities negatively cannot direct their complaints due to lack of influential power within the area. Incidences are rarely investigated if reported to the police or relevant stakeholders due to the influential powers of elite individuals involved indirectly in the artisanal mining sector. Farmers also noted a decrease in the fertility of their soils which they attributed on the use of mercury which is used for gold extraction by those practicing alluvial gold mining within their fields. Alluvial mining also contributed to the loosening of the top soil which became readily washed and blown away during the rainy season. The decrease in soil fertility can be attributed to soil contamination by mercury which alters the chemical composition of the soil thus affecting the metabolic system of plants and eradicating soil microorganisms necessary for growth. Both of these factors have been linked to a reduction
in crop yields (Xu et al. 2015). Plate 1 shows artisanal mining occurring in a field belonging to ZRP near Lowdale Farm which is no longer arable due to land degradation and land which has been exposed to possible soil contamination:

Plate 1: Land degradation caused by artisanal gold mining (source: V. Chandiwana, 20th April 2016)

Most artisanal miners claimed that they had no option in invading some of the farms as some of the gold claims were situated within the farm areas. Invading farm areas where the occurrence of gold claims was certain made their work less laborious and it yielded greater profits for them as they would be able to mine larger quantities of gold in a shorter period of time. In some cases, some resettled farmers and farmworkers noticed that it was lucrative to allow the artisanal miners to mine on their land and the miners would have to pay bribes or handover some of their gold to the farm owners and workers to avoid being reported. This highlights a mutualistic relationship between farmers and artisanal miners. This has resulted in different land uses on the same land, where alluvial and reef mining occur on one side of the farm and farming activities are carried
out on another portion of the land. The resettled farmers also engage in ASM within their own farms to gain funds for agricultural inputs, which is consistent with findings by Hilson (2016). This is considered illegal in Zimbabwe as all land is owned by the government, with underutilization of the land resulting in revenue loss for the state and food insecurity (Sithole, 2002 and Masiiwa, 2004).

The proliferation of artisanal small-scale mining activities in small-scale farms and large-scale commercial farms is evident and has been researched in Kwekwe (Moyo, 2011) where both conflicts and cooperation were apparent between miners and farmers. The factors underlying conflicts and cooperation between farmers and artisanal miners range from scarcity of arable land, as well as the competing needs of artisanal mining and agriculture for land, with different value being placed on land by different users (University of Manchester, 2009). Such conflicts and mutualistic relationships have reshaped land use patterns.

Artisanal miners also reside in the settlement areas of the farm reserved for farmworkers which is a sign of cooperation between the two parties. Most of the farm areas in the Upper Mazowe sub-catchment belong to prominent and politically-connected individuals who cannot report artisanal mining activities due to wanting a low profile in the area and involvement in artisanal mining syndicates. As a result, they allow artisanal miners to mine for gold in their farms as part of a syndicate which belongs to those individuals in exchange for their silence. The involvement of high profile figures in the artisanal mining industry shows that the activity is no longer just a survival strategy for the poor but a lucrative industry for wealthy and politically connected individuals involved (Mawowa, 2013). Plate 2 illustrates land conflict where artisanal gold mining is occurring opposite a field of sorghum in Bhuka Farm.
Land conflicts were also noted among the artisanal miners themselves. The artisanal miners had disagreements and violent clashes in areas where gold claims were discovered. They frequently invaded reef and alluvial mining pits dug by other individuals or groups to obtain the gold. According to the artisanal miners, it is easier to invade and extract gold from areas that have been explored by others as it is less time consuming and does not require much labour compared to prospecting for gold in a new area. An area where deposits are known to be in existence means that they do not have to utilize time and resources exploring for deposits on their own. This saves time and effort.

4.4.1.1. Forest-related conflicts
Local villagers expressed concerns over the depletion of vegetation, particularly forests. They attributed this to the upsurge of artisanal mining within the catchment. Artisanal miners would
clear forested areas as they prospected for new mining sites. The environmental damage left after exhausting an area of gold would be extensive, making it difficult for the vegetation to recover. Deforestation was also attributed to an increase in population over the years due to an increase in artisanal mining activities which led to an increased demand for timber to allow for the construction of new settlements. These settlements would be leased to artisanal miners in the area mostly on a short-term basis due to their nomadic nature. Most of the settlements that accommodate artisanal miners lack electricity and there is also an increased need for wood for activities such as cooking and lighting. The decrease in vegetation and forest cover was validated through participatory mapping and remote sensing data where there was a 45.2% decrease in vegetation cover from 2001 to 2015.

4.4.1.2. Changes in land use due to ASM and environmental conflict

From the focus group discussions and participatory mapping carried out by participants from different demographic characteristics and livelihood backgrounds, it was deduced that there had been changes in the land use of the Upper Mazowe sub-catchment since 2002 when artisanal gold mining became prominent in the area. Figures 4.5 and 4.6 illustrate the drawings from participants illustrating the changes in land use comparing the landscape using the years 2002 and 2016.

Jumbo Farm land use changes

The drawings that were illustrated by locals during FGDs in the Jumbo Farm area show that since 2002, there has been a decrease in forest and vegetation cover in the area. The population in the area has increased leading to the construction of a secondary school and more settlements.
A new Jumbo mine plant was opened and this resulted in an increase in the number of artisanal gold miners in the area. This has resulted in the number of gold processing mills in the area increasing from one to three, with two of the mills being informal.
Figure 4.5: Participatory drawing of land use changes between 2002 and 2016 (Jumbo)

Bhuka’ Farm land use changes
Participatory mapping by Bhuka farm residents showed that since 2002, there has been depletion in vegetation and forest cover. Some of the forest was cleared to allow for construction of settlements in the area due to the proliferation of reef mining. Vegetation was cleared in mountainous areas to allow for alluvial mining. The presence of mining activities in the area has led to an upsurge in population with the farm settlement area increasing in size.
4.4.1.3. Land use changes based on Landsat imagery

Figures 4.7 and 4.8 reflect changes in the land use/land cover patterns due to artisanal gold mining within the Upper Mazowe sub-catchment as observed by Landsat imagery.
Figure 4.7: Land-use patterns in Upper Mazowe sub-catchment in 2001
Figure 4.8: Land-use patterns in the Upper Mazowe sub-catchment in 2006 and 2015
Below is Table 4.1 showing the percentage changes in land cover since 2001 before artisanal small-scale mining became widely practiced within the Upper Mazowe sub-catchment:

<table>
<thead>
<tr>
<th>Area in 2001 (ha)</th>
<th>Area in 2015 (ha)</th>
<th>Percentage change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare soil and rock</td>
<td>57127.76</td>
<td>56338.97</td>
</tr>
<tr>
<td>Dry land farming</td>
<td>184040.66</td>
<td>228884.62</td>
</tr>
<tr>
<td>Irrigated land</td>
<td>19454.90</td>
<td>2797.63</td>
</tr>
<tr>
<td>Settlements</td>
<td>3148.73</td>
<td>16951.98</td>
</tr>
<tr>
<td>Vegetation(trees)</td>
<td>88436.00</td>
<td>48430.51</td>
</tr>
<tr>
<td>Water</td>
<td>3070.67</td>
<td>1911.83</td>
</tr>
</tbody>
</table>

Participatory mapping was used to verify areas within the Upper Mazowe sub-catchment that had undergone land use/land cover changes due to artisanal small scale mining activities as detected by GIS and remote sensing. Participatory mapping has been essential in mapping land use/land cover changes as local knowledge of the area is included in input data. As a result, information produced is able to reflect reality on the ground. Locals have the capacity to know more about the factors influencing land cover/land use patterns than experts who often are foreigners to the area (Mapedza et al., 2003). This conclusion was determined by Mapedza et al., (2003) where participatory mapping and GIS were used to determine factors underlying land use changes in Mafungutsi Forest.

There was a decrease in the amount of land occupied by irrigated crops within the area. This was attributed partially due to the conversion of arable land to mining areas where gold claims are present by both farmers and artisanal miners and due to the scarcity of water during the perennial droughts. An increase in settlements was observed and this corresponded with the increase in population and frequent migration to the area due to artisanal gold mining being a lucrative livelihood for locals. A new mine plant was also opened in Jumbo between 2001 and 2015 and
research shows that the number of artisanal miners in an area increases with an increase in commercial large-scale mines as panners operate in close proximity to mining corporations. A decrease in vegetation was also noted and this was due to deforestation by artisanal miners as they clear the land to prospect for new mining sites and land was cleared to enable construction of settlements as can be observed between the years 2006 and 2015. An overall decrease in the area covered by water can be explained by decrease in rainfall and increased frequency of droughts with water bodies not being replenished often. An increase in population within the area also places water resources under pressure as there is an increased demand

4.4.2. Water-related conflicts
The majority of the artisanal miners (84.4%) acknowledge that there were no water conflicts among users within the catchment. This was attributed to the use of different water sources for different purposes. Artisanal miners practicing alluvial mining dig wells near their mining sites where they obtain water to wash away dust particles and extract free gold. The water used for washing and gold extraction processes was discarded in deep pits to avoid effluent runoff into tributaries that feed into the Mazowe River. The wells dug by artisanal miners are used exclusively for mining purposes, with other water sources such as taps and boreholes providing water to be used for domestic purposes. Most of the artisanal miners desisted from carrying out alluvial mining within the Mazowe River as they avoided clashes with regulatory authorities such as EMA and police. However, ZINWA and the sub-catchment council highlighted that there were conflict over water resources as disposal of mining effluent contributed to groundwater pollution by passing through aquifers. The artisanal small scale miners interviewed displayed a lack of understanding of groundwater pollution and were unaware that groundwater and surface waters were interlinked.
Of the artisanal miners interviewed, 87.5% were also aware of the ecological implications of alluvial mining and mercury pollution on the river water as a community and were committed to protecting their natural resources. The fewer artisanal miners who acknowledged the presence of water conflicts attributed them to other artisanal miners who were ignorant about the environment and proceeded to carry out alluvial mining within tributaries leading to the Mazowe river. The miners did not use mercury which prevents chemical pollution but relied on James tables and cloth to free the gold from the soil particles. This left the river water turbid and contributed to siltation within the streams used.
Figure 4.9: Respondents’ views presence of water conflicts

Farmworkers that formed part of the focus group discussions responded that conflicts over water within the area were non-existent as farmers relied on dams and canals to irrigate their crops with water. Some of the crops were also rain-fed thereby there were no clashes over the water sources used for farming and artisanal mining. Small-scale gold stamps relied on their own wells and taps to obtain water for the washing of gold and they disposed of polluted water into storage containers and gulleys on their sites. The disposal of effluent into gulleys also contributes to soil contamination as well as groundwater pollution hence EMA carries out inspector visits to minimize the extent of pollution into groundwater and to ensure soil remediation practices by the gold stamp companies. Local villagers relied on the use of boreholes and taps within their community to obtain clean water for their domestic uses.

4.4.2.1. Determination of extent of water pollution in Mazowe River

Participants from FGDs responded that artisanal miners and the small-scale gold processing mills they use to extract gold were responsible for the pollution of the Mazowe River. To determine the extent of pollution by artisanal miners, water samples were collected from the artisanal mining sites and the mills frequented by the panners for gold extraction were mapped with the river hydrology of the Upper Mazowe sub-catchment. Table 4.3 shows the water quality parameters obtained from the mining effluents.

Table 4.2: Water quality parameters of artisanal gold mining effluent

<table>
<thead>
<tr>
<th>Place</th>
<th>Jumbo mine</th>
<th>Bhuka Farm</th>
<th>Lowdale Farm</th>
<th>W.H.O guidelines for drinking water</th>
<th>Zimbabwe effluent standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
<td>Site 1</td>
<td>Site 2</td>
<td>Site 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>6.66</td>
<td>6.93</td>
<td>6.51</td>
<td>6.5-8.5</td>
<td>6-9</td>
</tr>
<tr>
<td>DO (mg/l)</td>
<td>2.7</td>
<td>5.0</td>
<td>5.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Conductivity(μS)</td>
<td>287</td>
<td>62.1</td>
<td>428</td>
<td>-</td>
<td>≤1000</td>
</tr>
<tr>
<td>===============</td>
<td>-----</td>
<td>------</td>
<td>-----</td>
<td>---</td>
<td>-------</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>3</td>
<td>32</td>
<td>39</td>
<td>5</td>
<td>≤5</td>
</tr>
<tr>
<td>Nitrate (mg/l)</td>
<td>0.001</td>
<td>0.027</td>
<td>0.063</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>TN (mg/l)</td>
<td>0.032</td>
<td>0.700</td>
<td>2.592</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phosphates (mg/l)</td>
<td>0.032</td>
<td>0.057</td>
<td>0.019</td>
<td>-</td>
<td>≤0.5</td>
</tr>
<tr>
<td>TP (mg/l)</td>
<td>0.153</td>
<td>0.356</td>
<td>0.072</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E.coli</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Mercury (mg/l)</td>
<td>0.0000287</td>
<td>0.00042</td>
<td>0.000294</td>
<td>0.001</td>
<td>≤0.01</td>
</tr>
</tbody>
</table>

All of the water samples collected from the artisanal mining sites were compared with drinking water guidelines set by W.H.O and effluent discharge levels for Zimbabwe according to EMA (Effluent and Solid Waste Disposal Regulations Statutory Instrument 6/2007). Mercury was present from effluent sampled from the artisanal mining sites indicating that mercury is used as an extracting gold agent by artisanal miners in-situ. In comparison with W.H.O guidelines for drinking water, if the Mazowe River is polluted with the effluent it cannot be used for domestic purposes such as drinking and cooking due to the high turbidity which is indicative of high solute concentration. Turbidity is a measure of water clarity, and if not eliminated it can act as a source of food and shelter to potential pathogens that would have contaminated the water (W.H.O 2006).

The presence of *E.coli* in the samples is reflective of the presence of fecal matter contamination as some artisanal miners reside at the mining sites where they use the same water source for their needs and mining activities. The effluent is not considered to be an environmental danger when compared with the effluent standards set by EMA and has to be released into the Mazowe River and its tributaries in high volumes to be considered a threat to the ecosystem.
Figure 4.9 shows the river hydrology of the Mazowe River and its tributaries within the Upper Mazowe sub-catchment. The artisanal mining sites sampled during research and small processing gold mills found within the area are mapped to determine the extent of pollution if effluent is released. Figure 4.10 shows the flow direction of the Mazowe River and tributaries in the Upper Mazowe Sub-catchment and shows the directions within the sub-catchment where dispersal of pollutants is most probable to occur.

Figure 4.9: Flow accumulation map of Upper Mazowe sub-catchment
Figure 4.10: Flow direction map of Upper Mazowe sub-catchment

Based on the figures above which show the flow accumulation and flow direction, if effluents are released either on the surface or underground, they are likely to flow into tributaries in a NW direction. Most of the tributaries do not flow directly into the Mazowe River as the flow within the catchment follows a NW direction, with an eastern flow direction being required for pollution within the Mazowe River to occur. Based on the spatial location of artisanal mining sites sampled and the small-scale gold processing mills within the Upper Mazowe sub-catchment, pollution in the Mazowe River is unlikely and occurs on a lesser extent. Water conflicts based on the pollution of the Mazowe River are probably due to chemical pollution by large-scale commercial mines, commercial farms and other artisanal mining sites within the
Mazowe catchment, these factors which were recognized by stakeholders active in the sub-catchment.

4.4.3. Authority-related conflicts
Of the respondents, 96.9% recognized EMA as the main regulatory board in the Mazowe catchment with regard to environmental management. As a result, artisanal miners encounter most of their conflicts with EMA as it moves to reduce environmental degradation within the area. Raids by EMA were frequent within the catchment area and this makes artisanal mining a risky activity for those involved as they risk being fined heavily or arrested. The raids carried out by EMA are assisted by the police. The artisanal miners complained that the police were corrupt, demanding bribes ranging from $5-$20USD for them not to be arrested. Some of the police officers were said to have formed syndicates with groups of artisanal miners and they arrested artisanal miners who competed with their syndicates for gold buyers. Crimes associated with illegal gold mining have an incarceration period of 2-5 years, depending on the amount of gold recovered from the miners thereby most miners feel obliged to pay bribes to the police. To resolve these conflicts, artisanal miners were of the opinion that their trade should be formalized and that levies paid to obtain licenses had to be reduced as they were too exorbitant ranging from $500-$6000 USD. The artisanal miners and workers of gold stamp mills did not give recognition to the catchment council as a regulatory board as it rarely carried out raids or carried out awareness programmes.
4.5. Challenges faced by stakeholders in effecting good environmental management

Through key informant interviews, the main environmental regulatory board identified within the Upper Mazowe sub-catchment was EMA. EMA forms partnerships with other stakeholders within the area such as ZINWA and the Mazowe Catchment Council (MCC). These three stakeholders are involved in resources management within the catchment, with ZINWA being more aligned to water management than the other stakeholders. EMA is more involved with environmental management and prevails over other laws when there are environmental conflicts. The strategies employed by the stakeholders include the implementation of fines for both commercial mines and artisanal miners if they violate environmental legislation and recommendations. The fines range from $5USD to $5000USD for environmental crimes such as water, soil and noise pollution (Langa, 2015). The regulatory authorities acknowledged that there has been an improvement in conflict involving land degradation and water pollution specifically in relation to the Mazowe River due to the implementation of penalty fines. This was also credited to the formation of committees in the catchment where the stakeholders are able to
engage with locals and make them recognize the need to protect their natural resources to allow for environmental sustainability. The committees are comprised of members of the local community and environmental officers who work together and hold workshops that serve to inform environmental management within the area. The role of the committees is to disseminate information on the environment, sustainable development and to raise awareness particularly to those involved in farming and artisanal small scale gold mining. The challenge associated with the formation of committees is that artisanal miners and small-scale gold mills are generally reluctant to participate, fearing arrest and this makes it difficult to resolve environmental conflicts.

Raids are carried out in the area by EMA in conjunction with the state police to apprehend illegal miners and to infiltrate syndicates involved in gold trading. However, this has been a tedious effort as some police officials are corrupt and involved in the gold-trading syndicates and it is difficult to apprehend those involved. The syndicates are inclusive of high-profile individuals such as government ministers and they can manipulate the justice system in their favour to prevent investigations and arrest. Most of the gold buyers in the Mazowe catchment are foreigners who travel from South Africa and their movements and financial dealings are difficult to trace.

Stakeholders acknowledged that conflicts involving farmers within the area were difficult in resolving and these had low success rates. Most of the farmers are involved in tobacco production and this leads to disputes over water quantity usage and quality with phosphorus and nitrates being leached from the soils. The farmers also illegally converted their lands into mining areas without consulting or seeking approval from the necessary authorities. The farmers tend to have political connections and resist penalties set by the stakeholders. In such events,
stakeholders refer the cases to courts and due to the influence of the farmers; the cases are often unresolved, with no justice for other actors being negatively affected. This is evident of Marxist traditions where powerful actors control resources, affecting other parties negatively and conflicts involving such actors cannot be resolved due to their influence in society (Blackie and Brookfield, 1987). Corruption within the stakeholder organizations also contributes to environmental conflicts as some small-scale mine owners and gold stamp owners pay bribes to officers in the organizations, enabling them to bypass environmental procedures such as the acquisition of an EIA (environmental impact assessment) license whereby stakeholders suggest recommendations so as to preserve the environment and promote resource sustainability.

Operating licenses for small-scale mines and gold processing mills are granted by the Ministry of Mines and it is difficult for EMA to intervene when the mining operations have an adverse on the environment and surrounding local communities.

Stakeholder organizations also lack resources to fully pursue environmental management and they are unable to monitor for water pollution and land degradation within the catchment as expected. As a consequence, site visits and quality control and assurance are limited. In some cases such as with ZINWA, water quality monitoring is not carried out regularly and the organization has engaged in promoting firefighting and prevention as it requires less resources than water sampling and monitoring. The catchment council has limited resources which affects their ability in conducting workshops and pursuing the investigation of environmental conflicts within the area.
4.6. Conclusion

ASM activities within the Mazowe catchment are not being properly managed due to the occurrence of environmental conflicts. Differing influential powers of actors within the catchment contribute to conflicts, with the more powerful actors having more control over ASM activities and resources. These factors, paired with lack of resources for regulatory authorities affect the manner in which environmental governance is implemented. EMA was recognized as the most effective regulatory authority in managing conflicts, with the Mazowe catchment council being the least effective.
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction
This chapter relates the conclusions of the study in accordance with the research objectives. It suggests recommendations that may be applied to achieve effective environmental governance towards artisanal small-scale gold mining activities in the Mazowe Catchment.

5.2. Conclusions
The results from the study show that artisanal small-scale gold mining is the main livelihood activity in the Mazowe catchment, with fewer people being involved solely in agricultural practices due to frequent droughts. The persistent occurrence of droughts results in unreliable yields and income. As long as artisanal small-scale gold mining is occurring within the Mazowe catchment, environmental conflicts are unavoidable due to the use of natural resources by different users, with artisanal mining affecting them in some manner.
Environmental conflicts within the Mazowe catchment are prominent among the following groups of actors:

- artisanal gold miners and farmers
- artisanal gold miners and regulatory authorities
- artisanal gold miners and local villagers
- farmers and regulatory authorities

Artisanal gold mining activities have resulted in changes in the land use patterns in the Upper Mazowe sub-catchment, with more changes expected to be found if the entire land cover for the Mazowe catchment is to be analyzed. This has limited access to resources mainly use of arable land, forests and clean water to other users. The conflicts between artisanal miners and regulatory authorities are based on a lack of engagement between the two parties to work together towards a solution that maintains artisanal mining as a livelihood in the catchment, while preserving natural resources and abiding by environmental policies thereby minimizing the extents of conflicts likely to be encountered. The reduction of conflicts in the catchment among different actors in the catchment will reflect effective environmental governance where the needs of every party are taken into consideration and sustainable management of natural resources is possible. The following characteristics of artisanal gold miners within the Mazowe catchment are attributed to being factors in the conflicts occurring:

- They destroy large areas of land in pursuit of small quantities of gold
- They use outdated mining technologies which are detrimental to the environment
- They utilize mercury for gold extraction
- Artisanal miners lack capital to formalize their trade
They value outcome of their livelihood more than the environment

They are unwilling to engage with other members of the community and key stakeholders

The artisanal small-scale gold mining sector has also been invaded by prominent figures who influence the extent of the trade and are able to undermine the laws and policies effected by regulatory authorities. By taking into account the factors that contribute towards environmental conflicts within the Mazowe Catchment, it is possible to prescribe recommendations that seek to implement good environmental governance practices within the Mazowe Catchment and other areas where artisanal mining is prominent in Zimbabwe.

5.3. Recommendations

Artisanal gold mining is an important livelihood activity in the Mazowe Catchment providing full-time employment for those involved and an additional income for those who engage in it part-time or seasonally. However, if not regulated properly it has adverse effects on the environment and limited natural resources which trigger tensions among users within the catchment. The emphasis should be on ensuring that the community benefits from artisanal gold mining without negatively affecting other livelihoods that utilize the same resources as artisanal gold mining activities. The relationship among artisanal gold miners, gold stamp millers and regulatory authorities should be strengthened to ensure good environmental governance and sustainable development. The following recommendations should be implemented to ensure effective environmental governance:

- **Formalization and legalization of artisanal gold mining activities**

  Under the current legislation, artisanal gold mining is identified as an illegal and criminal activity. It is not recognized as a livelihood and a source of income for most people.
Formalizing artisanal mining in the country allows authorities to have accurate figures of those involved in the trade and can prevent artisanal mining from occurring within river banks thereby reducing the negative impacts of the activity on the environment. This improves the manner in which environmental governance is implemented by stakeholder organizations if they have population numbers of artisanal miners and control over the areas where artisanal mining can be practiced. The formalization of artisanal mining provides the government with revenue to be earned from taxes and royalties. It also protects the artisanal miners from raids and arrests by the police thereby minimizing the conflicts that occur between miners and regulatory authorities.

- **Educating artisanal small-scale miners on the importance of a clean and preserved environment**
  
The research showed that while some artisanal miners have no regard for the environment and carry out alluvial mining in river banks, most of them have realized the effects of mining on the environment. They and their communities have adopted laws to safeguard their natural resources particularly water. There is still a need to continue educating artisanal miners over the adverse effects of protecting the environment especially with regards to soil contamination and underground water pollution, as they are under the impression that disposal of mercury and effluent into dug pits does not harm the environment. Stakeholders should continue carrying out campaigns on the effects of using mercury on human health and the environment by suggesting other alternative methods such as using cloths with fine particles to extract gold. Gold can also be precipitated as a powder from ore by the use of hydrochloric acid combined with
potassium hypochlorite and oxalic acid. These chemicals are less hazardous than mercury and have fewer impacts on the environment and human health if used properly.

- **Attempts to introduce environmentally friendly mining technologies**

  Stakeholders can introduce environmentally friendly mining technologies to those involved in the artisanal gold mining sector. However, for this to be realistic, the equipment must also benefit the artisanal miner for it to be utilized. The technologies and methods must be less labour intensive, less time consuming, affordable and should offer high yields of gold extracted from ore. If this can be proven to the artisanal miners, it is easier to gauge their interest and have them practice the new methods of mining that are friendly to the environment.

- **Strengthening of the authorities in charge of monitoring the environment**

  Regulatory authorities that have been tasked with environmental monitoring and the execution of environmental governance in the catchment face challenges in doing so. They have a lack of resources, are understaffed and have corrupt elements within their systems. Increased support from government and interested donors through funding enables the authorities to carry out environmental monitoring more frequently and workshops to educate locals or artisanal miners. Increased awareness should be raised particularly to groundwater pollution and ways of safely disposing effluent from artisanal small scale miners and gold stamps should be proposed. Funding and re-structuring of these organizations also eliminates corruption and raises the morale of environmental officers who will carry out their duties more effectively. It also lessens interference from
prominent figures and allows fair treatment of all the parties that are involved in environmental conflict.

- **Reduction of registration levies and taxes**
  Artisanal miners are not eager to register formally due to the high levies and taxes associated with being recognized formally. The levies and taxes should be lessened in a manner that encourages artisanal miners to register as most of them earn low incomes from the trade. Due to fear of being taxed heavily, artisanal gold miners and millers shun the registration process and risk making profit at the cost of being arrested.

- **Promotion of other alternative livelihoods**
  The government should embark on promoting other livelihoods in areas where artisanal gold mining activities occur such as fishing, farming and weaving of baskets. This benefits vulnerable groups such as women and children who are forced to participate in artisanal mining to have a source of income for their households. By doing this, the number of artisanal miners in the Mazowe Catchment can be reduced which minimizes the negative impacts to the environment. The government should provide start-up capital and look for markets that are easily accessible to the locals in the Mazowe Catchment for the alternative livelihoods.

- **Offering better prices for purchase of gold**
  Legislation requires registered small-scale miners to sell their gold to Fidelity Printers and Refineries. Artisanal miners are of the opinion that prices offered for gold are low,
with informal traders mostly from South Africa offering better prices for the gold. Fidelity Printers and Refineries also buy a minimum of five grams from gold, with artisanal small-scale miners unable to achieve that goal at times. Foreign buyers are willing to purchase any amount of gold and they also receive money instantly with no taxes. The government should attempt to offer competing prices with those of the foreign buyers and should eliminate the minimum acceptance threshold of five grams to encourage small-scale miners to sell their gold.

- **Form a collaborative association for artisanal gold miners and millers**
  Those involved in the artisanal small-scale mining sector should find form a trade union which is able to engage formally with the government and regulatory authorities. Being represented by a trade union represents the interests of those involved in the artisanal small-scale mining sector enabling them to have better recognition among stakeholders with regards to decision-making processes.

- **Revision of the Mines and Minerals Act**
  Legislation should be revised so as to recognize artisanal mining and include it in national development policies. The recognition of artisanal mining as a formal activity reduces environmental conflicts as legislation will demarcate areas where artisanal mining can be practiced and reduces degradation of the environment. Previously this was implemented by the Mining Alluvial Gold Regulation which was a statutory instrument passed in 1991 that recognized gold panning. The instrument passed guidelines as to how artisanal gold mining should be practiced. However, the instrument was revoked and
if current legislation is revised to accommodate artisanal mining, it promotes environmental governance with sustainable natural resource management being possible. In general, the legislation and regulatory authorities focus more on environmental degradation and neglect recognizing artisanal small-scale mining activities as livelihood activities. Improving the conditions under which artisanal gold mining activities occur minimizes environmental conflicts which are poorly addressed and ensures the implementation of good environmental governance.
References


APPENDIX 1: QUESTIONNAIRE SURVEY

QUESTIONNAIRE FOR MINERS AND GOLD MILLERS

Questionnaire number……..

Date……………. Start time……………. End time…………..

Introduction

My name is Vimbai Chandiwana, a student at the University of Zimbabwe doing a Master’s Degree in Geography and Environmental Science. I am currently carrying out research on water governance and conflicts in relation to artisanal mining in the Mazowe Catchment. You are invited to be part of this research by providing your views. The information you provide will only be used strictly for academic purposes. Participation in this research is voluntary and no names will be published. If at any point, you are uncomfortable with the questions, the questionnaire can be stopped at any moment.

BACKGROUND INFORMATION

1. Gender: 1. Male □  2. Female □

2. Age group: 1. Below 18 years □  2. 18-24yrs □  3. 25-34yrs □
   4. 35-44 yrs □  5. 45-54yrs □  6. 55-64yrs □
   7. 65-74yrs □  8. 75+ □

3. Highest level of education (completed, that is for which one has a certificate to prove they attained it)
   1. No formal schooling □  2. Primary level □
   3. Secondary level □  4. Tertiary level □

4. Marital status
   1. Never married □  2. Married □
   6. Cohabiting □

5. Main sources of income for household
   1. Agriculture □
   2. Salary/Wages □
   3. Social grants □
   4. Pension □
   5. Remittances from relatives □
   6. ASM □
   7. Other □

If other, specify………………………………
RESEARCH QUESTIONS

1. Where is your home area? .................................................................

2. How long have you been involved in artisanal and small-scale mining in this area?
   1. 0-5 yrs □  2. 6-10 yrs □  3. 11-15 yrs □
   4. 16-20yrs □  5. 21yrs+ □

3. Which type of artisanal mining are you involved in/ or process gold for?
   1. Reef mining □  2. Alluvial mining □

4. What is your role in artisanal and small-scale mining?
   1. Panner/miner □  2. Miller □
   3. Both □  4. Other □
      If other, (specify).............................

5. What made you be involved in artisanal and small-scale mining?
   1. Lack of employment □  2. More income □
   3. Drought □  4. Other □
      If other, (specify).............................

6. How often do you engage in artisanal and small-scale mining?
   1. Full-time □  2. Part-time □  3. Occasionally □
   4. Seasonally □  5. Other □
      If other, (specify).............................

7. Are you registered as a miner/ gold stamp miller?
   1. Yes □  2. No □

8. If not, why are you not registered?
   1. Registration is not enforced in this area □
   2. The process is expensive □
   3. The process is difficult □
   4. Process is corrupt (e.g. needs bribes) □
   5. Avoiding taxes and monitoring □
   6. Did not know about registration/don’t know how to do it □
   7. Other □  Specify reason:.................................................................
9. Which chemicals do you use for gold extraction?
1. Mercury ☐ 2. Cyanide ☐ 3. Other ☐
   State quantity………………

10. Are any of these chemicals recovered or recycled from gold extraction?
1. Yes ☐ 2. No ☐
   State quantity……………… Amount of gold extracted…………………………

11. How do you dispose of the chemicals that you use during gold panning?
1. Dumping of effluent into river and water systems ☐
2. Disposal into pits/ gulleys ☐
3. Disposed of in storage containers ☐
4. Other ☐ If other, specify…………………………

12. How do you use water in your mining activities?
1. Metal recovery ☐
2. Control of dust ☐
3. To meet the needs of the gold panners on site ☐
4. All of the above ☐
5. None of the above ☐
6. Other ☐ If other, specify…………………………

13. Are you aware of the potential impact of your mining activities on the water resource that you use?
1. Yes ☐ 2. No ☐

14. Do you think your mining activities are detrimental to water quality and access?
1. Yes ☐ 2. No ☐

14. Have your activities resulted in changes to the water you use?
1. Yes ☐ 2. No ☐ 3. Don’t know ☐

15. Which changes associated with the water have you noticed?
1. Less water volume ☐
2. Siltation of water source ☐
3. Change in water colour ☐
4. Death of aquatic life  
5. All of the above  
6. None of the above  
7. Other  
If other, specify…………………………………………

16. Are there conflicts over water resources and pollution in this area?
1. Yes  
2. No  >> end of interview

17. What is the cause of these conflicts?
1. Restricted access to water  
2. Water scarcity  
3. Pollution of water sources  
4. Ownership of water sources by elites  
5. All of the above reasons  
6. None of the above reasons  
7. Other  
If other, specify reason:……………………………………

18. When do most of these conflicts among water users occur?
1. Dry season  
2. Rainy season  
3. All year round  
4. Other  
If other, specify…………………………………………

19. What has been the impact of these water conflicts?
1. Violent clashes  
2. Fish kills  
3. Livestock deaths  
4. Reduced yields  
5. Less agricultural activity  
6. Human illness  
7. Reduced pastures  
8. Food shortages  
9. Loss of livelihood  
10. Other  
If other, specify……………………………………

20. Have there been any changes in land uses over time due to water conflicts?
1. Yes  
2. No

[Ask for simple diagrams illustrating land use changes over time]

21. Who is blamed for the pollution of water sources in the catchment?
1. Artisanal miners □  2. Gold stamp millers □
3. Commercial mines □  4. Farmers □
5. Fishermen □  6. Locals □
7. All of the above □  8. None of the above □
9. Others □ If others, specify…………………………

22. Is a basic right to water demonstrated in the area?
   1. Yes □  2. No □

23. How is water allocated within the catchment?
   1. Equal access to water □
   2. According to needs of person/project □
   3. To those who pay for water usage □
   4. Based on a first come/first serve basis □
   5. Based on connections to ministry/council □
   6. Other □
   If other, specify………………………………………………

24. Who is in charge of water issues and environmental regulation in the area? [multiple response]
   1. Municipality □
   2. EMA □
   3. ZINWA □
   4. Rural district council □
   5. River basin organisations (catchment council) □
   6. Other □
   If other, specify……………………………………………………

25. Is there a facility within the area where complaints and conflicts over water can be reported?
   1. Yes □  2. No □

26. Where are complaints over water conflicts directed?
   1. Police □  2. Chief □
   3. Headman □  4. Councilor □
   5. Rural district council □  6. Other □
   If other, specify………………………………………………
27. Do you have water meetings in your area to resolve conflicts?
   1. Yes □  2. No □ Q26

28. How many times have you been invited/represented to attend a water meeting annually?
   1. 1-2 □  2. 3-5 □
   3. 6-10 □  4. 11+ □

29. Which institutions have held these meetings?
   1. NGOs □
   2. RDCs □
   3. Community □
   4. Women’s groups □
   5. Men’s groups □
   6. ZINWA □
   7. Catchment council □
   8. Sub-catchment council □
   9. Other □
   If other, specify………………………………………………

30. Which topics are crucial at your meetings?
   1. Water shortage □
   2. Water pollution □
   3. Water conservation □
   4. Other □
   If other, specify…………………………………………………………

31. Are you involved in the proposal, implementation and regulation of policies regarding water?
   1. Yes □  2. No □

32. How effective are institutions in resolving conflict over water and other resources?
   1. Not effective □
   2. Little effectiveness □
   3. Moderate effectiveness □
   4. Very effective □
   5. Extreme effectiveness □

Thank you for your time and responses

APPENDIX 2: FOCUS GROUP DISCUSSION QUESTIONS
FOCUS GROUP QUESTIONS

(Applicable to all locals including miners, gold stamp millers, fishermen and farmers)

List name of all participants, age, marital status, level of education and source of income.

1. What are the different types of livelihood activities that are occur within this area?
2. Who carries out and is involved in artisanal and small-scale mining in the area? For how long has artisanal and small-scale mining been practiced in the area?
3. What are the reasons that have led people being involved in artisanal mining in this area?
4. Has artisanal and small-scale mining interfered with other livelihood activities in the area? If yes, how has this occurred? Which livelihood activities have been affected the most and how?
5. Has there been a difference in the water (especially river water) and land that you use over time? If yes, which changes have you observed and what do you attribute these changes to?
6. Are there any conflicts that occur over water access (and pollution) and land use? What are the causes of these conflicts? Is there a particular set of water users amongst which the conflicts are prominent?
7. Is there a particular season or time of the year that water and land conflicts mostly arise, with access to water and fertile land being limited?
8. How are land and water resources distributed among users in the catchment? Is there a group of water users that have more access or control of water within the area?
9. Which institutions are responsible for resolving conflicts over water? How do they resolve conflicts? Have these institutions had success in resolving these conflicts amicably?
10. Are there any other conflicts in this area based on ASM among different groups of people in this area?
11. Have water conflicts and access resulted in land use changes, particularly in relation with artisanal and small-scale mining? Ask for sketches highlighting changes from a few individuals.
12. Are locals invited or represented at water meetings? Who attends these meetings?
13. Which organization/s is /are responsible for these meetings? How often are the water meetings held?
14. Has the community been involved in the implementation of decisions involving water resources? If yes, how has the community contributed and have any of the ideas been implemented?

APPENDIX 3: STAKEHOLDER KEY INFORMANT INTERVIEW
KEY INFORMANT INTERVIEW WITH STAKEHOLDERS
(Target groups: ZINWA, RDC, EMA, Catchment council)

INTRODUCTION
My name is Vimbai Chandiwana, a student at the University of Zimbabwe doing a Masters Degree in Geography and Environmental Science. I am currently carrying out research on water governance and conflicts in relation to artisanal mining in the Mazowe Catchment. You are invited to be part of this research by providing your views. The information you provide will only be used strictly for academic purposes. Participation in this interview is voluntary and no names will be published. If at any point, you are uncomfortable with the questions, the interview can be stopped at any moment.

BACKGROUND DETAILS
Organization:
Designation of respondent:
Name of respondent:

WATER GOVERNANCE AND CONFLICT INTERVIEW QUESTIONS
1. What is the role of this organization within the catchment? What responsibilities do you carry out within this organization?
2. What role do you play in water resources management?
3. In which areas of the Mazowe catchment are artisanal and small-scale gold mining taking place? How often do you monitor this activity?
4. How many miners and gold millers do you estimate to be involved in artisanal and small-scale mining activities? (ask for exact numbers or estimates of both registered and unregistered miners and millers)
5. What are your views as an organization towards artisanal and small-scale gold mining?
6. Has ASM had any consequences to the environment? If so, can you detail the effect of ASM on the environment?
7. Is water pollution a problem, and if yes, what do you attribute it to? Have you done any water quality tests or monitoring? (Ask what conclusions can be drawn from the results).
8. Which group of water users is largely responsible for pollution within the area and has the highest access to water?
9. Are there any conflicts that you have noted arising from gold panning? What have the conflicts been centered upon? Who are the main actors involved in the conflict?
10. What role has this organization played in resolving these conflicts? Is there a noticeable trend to these conflicts?
11. Which other actors are involved in water resources management and how do you work together?
12. Do you keep records of water conflicts or conflicts over other natural resources in the catchment?
13. Are the legislations that have been passed for water governance being implemented accordingly? Have there been any challenges faced in executing them?
14. Are there any other conflicts in the Mazowe Catchment that are associated with artisanal gold mining and if so, what is their nature?
APPENDIX 4: LOCATIONS OF ARTISANAL SMALL SCALE GOLD MINERS

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## APPENDIX 5: LOCATIONS OF GOLD STAMP MILLS IN UPPER MAZOWE

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