ENHANCING PARTICIPATORY DEVELOPMENT IN MOROCCO: ANALYZING THE SKETCH MAPPING BEHAVIOR OF MEN AND WOMEN AND INTEGRATING PAPER AND DIGITAL PARTICIPATORY MAPPING ENVIRONMENTS

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Enhancing Participatory Development in Morocco: Analyzing the Sketch Mapping Behavior of Men and Women and Integrating Paper and Digital Participatory Mapping Environments

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DEDICATION

This is dedicated to the long and hard work done by the High Atlas Foundation and the community of El Ksabi, Morocco for making me part of your community for eighteen months.

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I would like to thank the many friends, relatives, and supporters who have made this happen. My parents, Peace Corps friends, frisbee gals, and middle school gang got me through the past year of Covid-19. I would like to thank the High Atlas Foundation for the incredible work they do in Morocco and for working with me so closely on this project. I would also like to thank the community members of Ighil, Taghrit, Alhadyane, El Mellah, Boghrar, Idganoudane, and Lakliaa who mapped their communities. I unfortunately did not have the chance to meet any of you, but your efforts made this thesis possible. I thank Hassan Mansouri and Kawthar Messaoudi for working so hard to provide excellent translations. Finally, Drs. Rice, Rosenfeld, Croitoru, and Komwa were of invaluable help.

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LIST OF ABBREVIATIONS

High Atlas Foundation.....HAF
Participatory Mapping .....PM
Volunteered Geographic Information..... VGI
Participatory Rural Appraisal .....PRA
Geographic Information Science .....GIS
Public Participation Geographic Information Systems.....PPGIS

ABSTRACT

ENHANCING PARTICIPATORY DEVELOPMENT IN MOROCCO: ANALYZING THE SKETCH MAPPING BEHAVIOR OF MEN AND WOMEN AND INTEGRATING PAPER AND DIGITAL PARTICIPATORY MAPPING ENVIRONMENTS

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Twelve participatory paper maps by separate groups of men and women were facilitated by the High Atlas Foundation in six communities in Morocco between 2010-2020 as part of their process of participatory development. In this thesis research, these sketch maps are analyzed for the first time. History and methods of participatory mapping are discussed in the context of gender dynamics and sustainable development in the postcolonial setting of Morocco. Spatial webs, gazetteers, and gender trends in sketch map content creation, positional accuracy, and OpenStreetMap contributions are also discussed. The twelve participatory paper maps underwent a gender-focused content frequency analysis. Seven communities were located using OpenStreetMap and Google Maps by a High Atlas Foundation expert. It was found that men contributed more overall geographic elements and written Arabic commentary than women, which could indicate a

higher level of familiarity with their community and comfortability communicating their opinions in writing. It was also found that there are many barriers to adding data from the sketch maps to OpenStreetMap due to language, loss of institutional memory, and inconsistencies between the sketch maps and satellite imagery.

CHAPTER ONE

Introduction

1.1 The Background

Morocco is a developing country, ranking 121 out of 189 countries in 2018 according to the United Nations Development Programme. In the last two decades, there has been significant poverty reduction, but the urban-rural gap remains wide. Development in urban areas has outpaced rural areas, though 40% of Moroccans live in rural areas (World Bank, 2018). 75% of impoverished Moroccans live in rural areas, where the poverty rate is close to five times the national rate. There is evident social discontent resulting from chronic poverty, which has erupted into demonstrations and labor strikes in recent years, especially in the north of Morocco (Ben-Meir, 2019, p. 195). A rural region of Morocco is the High Atlas Mountains, which is home to the Amazigh, the indigenous people of Morocco. Illiteracy rates in this region for women and girls are as high as 90%. According to the World Bank, a mere 26% of girls enroll in secondary school (The Guardian, 2016).

The High Atlas Foundation (HAF) has worked in the High Atlas Mountain region of Morocco since 2000 to combat poverty and foster sustainable development. A cornerstone of HAF's philosophy is participatory methods for development, which according to HAF's President Yossef Ben-Meir (2010), "values local knowledge and

engages entire communities in dialogue as they conduct their own investigation and analysis toward the creation of an action plan that reflects local development priorities." Participatory methods are "essential for sustainability because such projects are more often able to generate benefits- including economic, educational, and health- that directly address the priority needs of the local communities managing them" (p. 67).

HAF utilizes participatory mapping (PM) exercises as part of this approach by asking participants to draw sketch maps of their communities that identify the most important places in their lives. Mapping is a powerful tool for collecting knowledge and making informed decisions. In contrast to the traditional "top-down" method of cartography, PM provides a "bottom-up" form of mapmaking. This method enables communities to be involved in the mapmaking process and benefit collectively by fostering internal empowerment. PM is "a process that attempts to gather information about a community's lands and make it visible to outsiders by using the language of cartography" (Corbett & Keller, 2005, p. 92). Essentially, PM is the creation, visualization, analysis, and dissemination of spatial information created by a community. PM is an integral part of the sustainable development process in developing countries like Morocco because it provides information necessary to understand the local context and pathways toward the most impactful local development. According to HAF, creating a community map (their name for a paper participatory map) is a way to document and start communication about a community, not only about its physical layout, but also the activities that compose community life. Community maps can be used to identify resources frequented by the people mapping. The setting and the group composition

determine the scope and variations in the community maps, which can be used to identify community issues and provide a visual record of the community to be revisited in the future (Thompson, 2010, p. 27).

After paper mapping, HAF facilitators lead the community group in doing a needs assessment and priority ranking of community needs. Facilitators use the map as a catalyst to discuss what participants wish to change in their community, their future needs, and community knowledge (Kramarski, 2018). HAF uses the process of sketch mapping as a tool in a larger participatory development process but has never analyzed the data on the maps specifically. Sketch maps of approximately 90 villages collected by HAF between 2010-2020 have been unused and stored in the HAF office in Marrakesh since they were taken from the communities. This research will take 12 of these maps and analyze them for the first time.

1.2 Research Questions and Objectives

This research thesis is a study focusing on Morocco that addresses sketch map creation and analysis. Secondly, it considers paper and digital participatory mapping and the interoperability of participatory methods as it relates to open-source mapping and sustainable development. The literature suggests sketch mapping can be an accurate and fruitful portrayal of a community and the process of participatory mapping is important to sustainable development. HAF uses sketch mapping in their participatory development process, but no specific analysis of the sketch maps has been done. These sketch maps are important because they were done in rural, relatively unmapped communities in Morocco and capture many unique elements in these communities. The detailed data

contained in these sketch maps contrast with the lack of information available in digital mapping platforms. Exploring the relationship between local knowledge production and digital mapping platforms addresses research gaps detailed in Chapter 2. The following questions were crafted to form the basis for this study:

1. What do participatory paper maps indicate about the geographical knowledge of local communities in Morocco and how can this knowledge be used to enhance participatory development initiatives?
2. Is there a difference in the sketch mapping behavior of men and women in terms of content and positional accuracy and if so, what factors may account for this?
3. What are the enablers and inhibitions to data integration from paper to digital participatory mapping platforms? What implications does this have for open-source mapping in developing countries?

1.3 Significance of this Research

This research was designed to address the following gaps in understanding as highlighted below and in Chapter 2:

1. There is significant research about PM in developing countries. There is also significant research about sketch map accuracy and content, mostly done in developed countries. However, these two bodies are fairly separate. This research seeks to investigate sketch map accuracy and content from an under-addressed population.

2. This research aims to support the inclusion of nontraditional data sources that better address the needs of a local community, rather than relying on digital mapping and satellite imagery to build a complete map of the world. The research process investigates bridging the gap between paper and digital PM by taking data from the sketch maps and working with HAF to add them to OpenStreetMap (OSM). This documentation will serve future researchers and provide HAF with a guide for their future mapping efforts.
3. This research explores sketch map accuracy and content from maps that were developed not in an academic, research setting, but rather in the field with an operational development organization utilizing PM to work with poor, rural peoples in the developing country of Morocco. The results will serve to better the operations of the High Atlas Foundation by providing them with further insight into the sketch mapping behavior of men and women.

The end result of this research will be an improved understanding of geographical knowledge of local communities in Morocco and the benefits and limitations of integrating paper and digital mapping environments.

1.3.1 Research Motivation

This thesis research addresses sketch map creation and analysis, and the interoperability of participatory mapping methods as it relates to open-source mapping and sustainable development. The thesis researcher worked with HAF to add the locations and all identifiable geographic elements from the sketch maps to OSM. This aspect of the research was requested by HAF to support their work and provide the

resource to community members. Adding data to OSM improves the open-source community's map of Morocco and benefits all organizations that rely on this base map. The process of adding data to OSM and recording the related barriers contributes to the general understanding of data integration as it relates to PM, spatial webs, and geographic data in developing countries. Better understanding of data integration between paper and digital PM supports the push to establish a more equitable, open-source map of the world. Finally, a better understanding of the limits of digital PM and OSM assist all in addressing the specific needs of rural, nonwestern, developing countries.

Ideally, local development organizations should map familiar areas in collaboration with local communities, rather than outsiders attempting to map using satellite imagery. Local development organizations are an indispensable resource of knowledge and should be included in the effort to map the world to make open-source maps more complete. However, this effort should also service them as part of their development process. Because paper PM is important to HAF's participatory development process, a better understanding of integrating data from sketch maps with digital platforms could address this problem and improve the open-source map of Morocco while also supporting HAF's community development initiatives.

The research motivation for analyzing the content of male and female made sketch maps is to investigate how men and women relate to their community, represent their idea of where they live, and make meaning of their surroundings on a sketch map. If distinct gender trends are discovered, it will help HAF tailor their development process to elicit the most useful and complete information from community members at the onset of

their relationship. Additionally, it can provide HAF with deeper perspective about their past and current development initiatives and if they address the needs of both men and women.

Surfacing gender distinctions is important because it can offer insight into if and how men and women relate to their space differently. HAF splits the community into gender groups, rather than other socioeconomic distinctions, such as age, income, mobility level, educational status, etc. If significant gender distinctions are found, it will support HAF's procedure of dividing the community by gender. If no or slight gender distinctions are found, it will offer HAF an opportunity to review this practice and potentially decide to alter their procedures to elicit better data for their work. Investigating distinctions can also challenge preconceived assumptions about the lived experience of different genders in Morocco, especially if results are different than hypotheses based on traditional gender roles. Hypotheses are outlined in the following section and discussed in Chapters 4 and 5.

1.3.2 Research Setting

This research focused on seven villages in the High Atlas Mountains of Morocco in which paper participatory maps were completed between 2010-2020 by HAF. The villages are Alhadyane, Taghrit, El Mellah in Marrakesh, Lakliaa, Idganoudane, Boughrar, and Ighil. A regional map showing the approximate location of these seven communities is below:

Figure 1 Map of the 7 Villages (My Maps, Google)

The villages of Idganoudane, Ighil, and Taghrit are small villages located in the High Atlas Mountains. Boughrar is located on the southern foothills of the High Atlas with an unknown population. Lakliaa is a mid-sized city on the outskirts of the city Agadir with a population of approximately 80,000 (“Lqliâa,” 2021). El Mellah is a neighborhood in Marrakesh, a city with a population of about 900,000 (“Marrakesh,” 2021). Alhadyane is a small town with an unknown population north of Marrakesh in the plains.

Two maps were done in each community: one each by a group of women and men. Expected findings were that geospatial data are in the sketch maps that does not exist in digital platforms, including OSM and Google Maps. In terms of positional accuracy, the thesis researcher expected that men would be more accurate because men generally spend more time outside the home than women, which increases their familiarity of place, mobility, and gives men more practice experiencing distance between places. She expected that men would be more positionally accurate in drawing items further away from the center of town. In terms of content frequency, the researcher expected that men drew more overall items and a higher proportion of agricultural parcels, road segments, and natural landmarks. The researcher expected that women drew more manmade landmarks and less overall items. Finally, the researcher expected that she would be able to add multiple geographical elements from the sketch maps into OSM for each village.

The thesis researcher received 25 total sketch maps from HAF. Seven of these maps were pictures and the resolution was not adequate to do a content frequency analysis. Also, the location and gender of these sketch maps were unknown. Two of the sketch maps were not representations of a specific location, but rather representations of necessary inputs to related projects whose purpose was to get crops to organic markets. They were not included in the analysis. Finally, HAF sent five sketch maps from Boghrar. It was unknown which of these maps were done by adults and which by children, so none of the Boghrar sketch maps were included in the content frequency

analysis. However, Boghrar was included in the location identification process, covered in section 3.4.

12 maps compose the final set for the content frequency portion of the thesis research. This is both a limitation and a strength. These 12 maps from six villages were chosen specifically by HAF because of their importance to HAF's work. As such, the results from these maps will be immediately applicable to HAF. However, the relatively small data set is a limitation, because unknown variants such as the makeup of the participant groups, time of day, time of year, process of map facilitation, and more is unknown. These unknowns are an important part of this thesis research and explored in Chapters 3 and 5. They are not necessarily seen only as limitations because this research sought to explore the process of working with sketch maps made by an operational development organization with the hopes of drawing wider implications about the use of sketch maps in participatory development. There are a number of additional sketch maps in HAF's possession, as many as 180 maps from 90 villages that were done between 2010-2020. A future area for this research is to extend this study to include a wider variety of sketch maps.

1.4 Structure of the Thesis

The remainder of this thesis is structured as follows: Chapter 2 will review the pertinent literature. Chapter 3 will outline the range of methods employed in this research. A gender-based content frequency analysis was done on 12 sketch maps. The thesis researcher worked with Amina El Hajjami, Director of Projects at HAF, to find the locations of seven communities in which sketch maps were done. The process of finding

these communities on digital platforms was recorded. A topographic analysis of map elements was done and the process of adding data from the sketch maps to OSM recorded. Finally, an analysis of scale, distortion, relative positioning, and orientation of map elements was done. Results are presented in Chapter 4. Finally, Chapter 5 reflects on the findings, places them in the context of the literature, and proposes future research.

CHAPTER TWO

Literature Review

2.1 History of Participatory Mapping

Traditionally, mapmaking was elite and exclusive, with roots in imperialism. Cartography was called the 'science of princes' because elites, with access to knowledge and tools to create maps, did so to occupy land, extract resources, and subjugate indigenous peoples. Colonizing countries, such as France in the case of Morocco, were able to codify their power onto maps. This history is important because the process of mapmaking reflects the power dynamics of a society, which has shaped the way mapmaking has evolved over time and has led to a rise in PM as a way to democratize the mapmaking process (Pánek, 2016).

Lynch (1960), Gould, and White (1986) first introduced the idea of mental maps, which put individuals at the center of information gathering and research. Mental maps were used to study boundaries, urban movement, and knowledge of geographical areas by recording a representation of a place on paper. However, rather than being the creators of the maps themselves, the participants were only asked to contribute information to the researcher (Pánek, 2016, p. 304).

Nelson (2019) writes that in the 1980's, the spread of personal computers led to a proliferation of Geographic Information Science (GIS) among the public, but the primary

users of GIS were governments and universities. More people began owning computers, which led companies to introduce mapping application software. At the same time, there began a shift in the opinions of development professionals, who started to move away from a top-down development approach to one that involved more dialogue with communities (Nelson, 2019, p. 12). These projects were known as Participatory Rural Appraisal (PRA) projects, which saw the first instances of mapping done by outsiders in developing countries (Chambers, 2006). Chambers (2006) notes the ignorance of researchers at this time, who did not believe local people could do mapping. Mapping experts were fixed on ideas of traditional cartography and did not realize that local people could make maps that were useful.

In the 1990s, the digital revolution spread around the globe and people started to contribute to information online (Pánek, 2016). This decade saw the first acknowledgement of a digital divide between those who had access to the internet and computers and those who did not. Pánek (2016) states that in the literature, there was recognition that GIS was part of imperialist geography. GIS was criticized for being a tool to manipulate data to adjust to the reality the mapmaker wanted, underrepresenting people marginalized from society, and being affected by unequal power differentials.

The term "public participation geographic information systems" (PPGIS) was introduced in 1996 at meetings of the National Center for Geographic Information and Analysis. PPGIS describes an approach where GIS technology is used in support of public participation and decision making. PPGIS takes power dynamics into

consideration and specifically attempts to increase inclusion of less privileged groups and move GIS away from being a form of imperialist geography (Sieber, 2006).

The related term "participatory GIS" emerged from participatory approaches to development in the global south (Brown & Kytta, 2014, p. 2). There was a movement to analyze the impact of GIS and identify areas for improvement and research. GIS began to be more broadly used and accessible to the public, leading to a rise in participatory methods. However, the early uses of PM were mainly focused on gathering data from participants, not including them at all stages of the development process (Nelson, 2019, p. 13).

Goodchild (2007) discusses the spread of GIS among the public in his seminal work that introduces the term volunteered geographic information (VGI), referring to the development of tools to create, assemble, and disseminate geographic data provided by untrained individuals who act voluntarily. He also discusses the digital divide as a result of the spread of public GIS, and states that there is an apparent openness of GIS, but it depends on who has access to the internet. Citizens in developed countries have access, but it is unavailable to the majority of the world's population.

Goodchild (2007) describes enabling VGI technologies, including OpenStreetMap (OSM), where the user can use satellite imagery to create digital records of streets, houses, and other features by digitizing visually on the screen. OSM is one of the most used, analyzed, and cited VGI platforms (Pánek, 2016, p. 303). Morocco is a highly mapped place in OSM for a developing country, but the High Atlas Mountain region is very remote and relatively unmapped in OSM. There are also little data available on

Google Maps. The lack of available data, and especially open-source data, makes the sketch maps facilitated by HAF potentially the only record of geospatial data in certain rural villages. Goodchild does not specifically address the digital divide in developing countries and how to combat it using PM methods.

PM has expanded rapidly since 2007 due to public contributions of data to open-source maps. This has led to a greater interaction of GIS and society because people other than mapmakers have access to mapping tools and methods, which gives various stakeholders data about locations in the world and the people who live there. The participants of VGI are often not GIS experts, which has led to the inclusion of subjective data that are deemed important to the mapper, resulting in a more humanized map of the world (Pánek, 2016, p. 303). Overall, there has been a trend away from using locals as research objects to participants and creators of their own maps. PM methods have moved locals from subjects of research to equals in participation, shifting power away from governments and research elites to the community (Pánek, 2016, p. 304). The literature related to PM has expanded rapidly since 2007, but a majority of the research in developing countries is related to digital PM, not paper PM. This thesis research is significant because it fills in a gap in PM methods by discussing paper PM in a developing country. Also, the research addressees the process of integrating data from paper to digital PM and the implications of doing so with VGI from a developing country, especially considering gender issues related to the digital divide, covered in section 2.5.

2.2 Participatory Mapping and Sustainable Development

Participatory mapping (PM) is an integral part of the sustainable development process because it provides crucial information necessary to understand the local context. Sustainable development prioritized local engagement and indigenous communities from the beginning. The United Nations Conference on Environment and Development was held in Rio de Janeiro, Brazil in June 1992 and resulted in the Agenda 21 document. Chapter 26 of this document deals with recognizing and strengthening the role of indigenous people and their communities. The document states that indigenous people have unique knowledge of their lands, natural resources, and environment. Historically, their ability to participate in the process of sustainable development has been constrained due to economic, social, and historic factors. Agenda 21 says that in the future, efforts should be made at the local, national, and international levels to "recognize, accommodate, promote, and strengthen" indigenous peoples and communities and engage them fully in the sustainable development process (*Agenda 21,* 1992, p. 280).

In 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development. This document aims to guide sustainable development until 2030 by setting out 17 Sustainable Development Goals and 169 targets. These goals are built upon core principles, including "leave no one behind" (*Stakeholder Engagement & The 2030 Agenda*, 2020, p. 18). The Agenda identifies indigenous peoples as a marginalized group to include in the sustainable development process. Another principle is to be "open, inclusive, and participatory" by engaging all stakeholders in all levels of

the process. Participation is emphasized in the 2030 Agenda, more so than any prior sustainable development document. Specific targets related to participation include:

- 5.5 Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and public life.
- 6.b Support and strengthen the participation of local communities in improving water and sanitation management.
- 11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory integrated and sustainable human settlement planning and management in all countries.
- 16.7 Ensure responsive, inclusive, participatory, and representative decision-making at all levels.
- 17.17 Encourage and promote effective public, public-private, and civil society partnerships, building on the experience and resourcing strategies of partnerships.

(*Stakeholder Engagement & The 2030 Agenda*, 2020, p. 26).

The inclusion of participatory approaches in local data collection enables researchers to understand where and how people live. Understanding how people live requires a participatory approach to ask local peoples directly about their way of life. This is particularly important in remote places of developing countries that have been systematically overlooked by official government mapping projects. PM is a necessary step to reach marginalized groups and bring them into the sustainable development process by providing an approach that draws on people's local knowledge about their

own space, revealing not just where people live, but important social and economic factors of their lives.

Pánek (2016) and Vajhalla (2005) discuss the rise in participatory methods, including PM, in developing countries as part of the sustainable development process to combat the digital divide. It is only recently that PM methods have been used in developing countries like Morocco to fight the top-down methods of development and the digital divide. In Morocco, the French colonial government stripped power away from rural, indigenous communities in the High Atlas Mountains, leading to poverty and a lack of infrastructure. The digital divide is very pronounced in Morocco between urban and rural areas. This proposed thesis is significant because the paper participatory maps facilitated by HAF addresses the digital divide and the resulting data gap.

Vajjhala (2005) argues that effective development depends on equitable information access and global knowledge sharing. Development practices and priorities have been transformed, which has drawn attention to the different information and communication technologies and their potential to help with participatory development. Development decisions are inherently grounded in physical locations of people, resources, and issues, meaning GIS is central to decision making. However, GIS is complex, leading to maps that are incomprehensible and inaccessible to the communities the technology initially meant to serve due to the community's lack of access to and familiarity of technology. Vajjhala (2005) argues that participatory GIS needs to move past representing where people live to describing the dynamics of how people live (p. 2).

Vajjhala (2005) argues that to do effective development, actual and perceived spatial relationships must be disaggregated by gender, age, and income, to understand and address the different impacts of development among diverse populations. PM can fill in this gap by capturing a person's or group's perceptions of local issues. The maps created by HAF by the female and male groups in six villages address this concern because they disaggregate the population by gender. However, they do not do so by age, income, education, or other socioeconomic factors, which will be considered in the analysis and discussed in Chapter 5.

Vajjhala (2005) argues there are three dimensions of mapping:

1. social vs. spatial
2. accurate vs. precise
3. representative vs. comprehensive

Accuracy refers to the correctness of information, while precision is the resolution of the representation. Most paper participatory maps record accurate social information, but with varying degrees of spatial precision. The second dimension is especially relevant because attribute, completeness, and positional accuracy will be analyzed in this study. These aspects of accuracy are specified by the Federal Geographic Data Committee (2020), which establishes standards for geospatial data in the United States in their data quality standards. Attribute accuracy assesses the accuracy of the identification of entities and assignment of attribute values in the data set. Completeness assesses the information about omissions, selection criteria, generalization, definitions used, and other rules used

to derive the data set. Finally, positional accuracy assesses the horizontal and vertical accuracy of the positions of spatial objects.

2.3 Methods of Participatory Mapping: Paper and Digital

This thesis discusses the process of taking data from paper participatory maps and adding them to OSM, a digital, open-source PM platform. It is important to understand the differences between these two methods of PM and their advantages and disadvantages to the local community and the general public. There are essential differences between paper and digital PM both in terms of mapping product and ethical considerations. Especially when the mapmaking process is important, one should not automatically believe digital PM is the best method because in many cases, especially when working with a local community, the process of mapping is as vital as the mapping result (Pánek, 2016, p. 304). Chambers (2006) writes that "the medium and means of mapping, whether ground, paper or GIS and the style and mode of facilitation, influence who takes part, the nature of outcomes and power relationships" (p. 1).

Chambers (2006) discusses the advantages and disadvantages of paper participatory maps over other methods. Paper mapping is done using a large sheet of paper with a writing utensil (HAF uses large white sheets of paper and blue, black, green, and red pens). Paper mapping is process-focused, which helps facilitate local people to work collaboratively, think critically about their community, and share and document local knowledge. Paper maps are relatively permanent; they can be used for monitoring and evaluation, and with government and NGO officials. They also allow for meaningful discussions to happen while people draw about one thing at a time (Raftree, 2013).

Symbols can be drawn to represent assets, which removes the necessity for participants to be literate (Mascarenhas & Kumar, 1991, p. 2).

However, paper PM is unfamiliar to many participants, hard to alter and add to, and uses outside materials. It is more exclusive because only one or a few people hold writing utensils and participants are limited to those that can fit around the paper. The limited paper size also does not allow for a high level of detail up to the household. It is also vulnerable to data extraction, as is the case in the sketch maps facilitated by HAF, who took the maps from the community with them back to their offices in Marrakesh. Finally, paper PM concentrates power and ownership because there is a single map document and whoever possesses the paper at the end of the mapping has the data (Chambers, 2006, p. 5).

Digital PM is the most recent, and fastest growing, method (Brown & Kytta, 2014, p. 126). More so than paper PM, digital PM moves from the process of mapping to the result of the map and extraction of data. There is a noted lack of research and ethics protocols for this kind of data gathering and sharing. It is the least democratic of the methods and requires training, the duration of the mapping is long, and the equipment unfamiliar. Digital PM is the most likely to leave out marginalized groups and see data extracted by outsiders (Chambers, 2006, p. 6). While it is relatively easy to give an illiterate woman a voice in a paper map, it is much harder to do so in a digital map with vast technology and literacy barriers.

It is possible to do digital PM outside the community, such as with satellite imagery in OSM. This increases the potential for engagement across a broad area. Digital

PM has positive potential in terms of widespread use, scalability, and application. However, it removes the necessity of community discussion and collaboration. In this case, it is likely an outside expert would do the actual process of mapping, even while getting input from locals, which eliminates the benefits of the mapping process itself (Raftree, 2013). To do digital PM, the most technical of the methods, participants must have access to a computer or smartphone with an internet or mobile phone network connection, making it inaccessible for communities with limited access to technology, such as is the case in rural Morocco. Digital PM presents as more official than paper PM, especially when done by an outside expert, which might contribute to the impression among locals that if they offer data and local knowledge, government or NGO action will soon follow, even if there is no guarantee (Raftree, 2013).

Considering these advantages and disadvantages, Chambers (2006) discusses ethical issues of digital and paper PM and asks two important questions: "Who is empowered and who disempowered?... who gains and who loses?" (p. 8). In developing countries like Morocco, locals are often the only experts in the areas in which they live. They have lived there for many generations and have the ability to represent their community accurately on a map. Locals can show places of most importance to them, providing outsiders, such as HAF, context into how they think, their priorities, and their reasons for doing or not doing certain things. They are also able to locate very specific details about the community, even to the household level. Locals are empowered by doing paper PM and gain from the process if the resulting data is used effectively in the development process that views locals not only as suppliers of data, but as equal partners.

Chambers (2006) discusses an additional ethical issue of PM: taking people's time (p. 6). The method of mapping done in each community will affect the results of the maps. For example, taking people's time could affect men and women differently. The mapping activity might have taken place during harvest when men did not have the time to participate, so the subset of men who participated were older or wealthier. If the mapping took places after dark, married or older women might have participated more than young, unmarried women. Differences in gender and time affect the results of the maps and are discussed further in this chapter in section 2.5.

2.4 Gender Differences in Sketch Map Creation

An important body of literature for this thesis relates to gender differences in mental cognition and sketch map creation. Much of the research about mental cognition and sketch mapping builds on the work of Lynch (1960), who writes that mental maps contain five elements: paths, edges, nodes, districts, and landmarks. Lynch (1960) sparked research in content frequency analysis in sketch maps, where researchers count the frequency of objects drawn within pre-set categories (Hátlová & Hanus, 2020). Lynch (1960) also notes the uniquely personal nature of cognitive maps. He writes that different groups form very different cognitive images of the same reality and individuals interpret and organize their surroundings uniquely. Different things matter to different people and that affects what is seen, thus affecting individual's cognitive maps.

Appleyard (1970) analyzes content frequency in male and female sketch mapping in a developing country, namely the city of Guayana in Venezuela. Following Lynch's approach, Appleyard (1970) divides the maps drawn by residents into sequential elements

(roads) or spatial elements (buildings, landmarks, districts). Approximately 75% of the maps were more sequential maps, and 25% were more spatial maps. Females relied 70% on spatial structuring of their local space as opposed to 59% of males. Appleyard (1970) posits this difference is due to women's tendency for security and containment and low mobility. The least accurate maps were drawn by women who were housewives, also explained by their low mobility.

Coluccia and Louse (2004) review the literature about gender differences in spatial orientation from 1983-2003 and find that for the spatial orientation tasks of pointing, wayfinding, and distance estimation, males performed better than females. However, for the task of map drawing, 22.22% of cases showed females performing more accurately than males, and 55.56% of cases saw no gender difference. Most of the cases in which females performed better than males concerned map sketching involving landmarks and map elements.

McGuinness and Sparks (1983) address gender differences in map representations of participants' familiar areas. They find that men draw more routes and connectors and are more spatially accurate in placing landmarks. Women have a more accurate sense of distance and include more landmarks. McGuinness and Sparks (1983) write that women have a greater sense of grouping and proximity, meaning they organize their space by what lies before, behind, or next to each other, rather than an overall geometric pattern. Women organize maps starting with individual parts and then connect them together into a whole. Men begin their maps with patterns of roads and connectors to create a geometric framework and then move to fill in landmarks.

Montello et al. (1999) study gender differences for a wide range of tasks related to spatial ability, including map learning, short- and long-term spatial knowledge, object-location memory, and self-reporting on spatial competence. They review the literature and find that studies have found only small differences between men and women on their knowledge of distances and directions related to their local, home environments. Females performed better at static object-location memory, while males performed better on tasks of short-term spatial knowledge. There was no difference in performance on long-term spatial knowledge, like the knowledge developed about a place over a long period of time.

Huynh et al. (2010) discuss gender differences in sketch map creation and focus on the process of creating a sketch map by analyzing the sequence of elements drawn. Huynh et al. (2010) find that throughout all steps of the map sketching process, women tend to draw more landmarks and men tend to draw paths. Based on a survey of the literature, the authors find that men tend to draw maps based on an orientation and survey strategy of drawing paths to serve as connectors to landmarks to create a geometric framework that relies on a coordinate system. Women tend to follow a route strategy where landmarks and sites of importance are favored. Huynh et al. (2010) also examine the gender differences in the total number of map elements drawn in the manner specified by Lynch (1960). The authors find that women drew more landmarks than men and men drew more paths than women. Women drew more total elements than men. The HAF maps have already been created, so the thesis researcher did not analyze the sequence of map creation but focused on the final map products.

Hátlová and Hanus (2020) review the existing literature since 1960 about sketch map quality and aim to identify and describe the factors that affect quality from 90 studies. They write that mental maps and subsequent sketch maps are influenced by many factors including biological, psychological, and sociocultural factors. The authors identify 22 studies that address the influence of gender in the content frequency of sketch maps. They find no provable gender effect for content frequency in sketch maps: an approximately equal number of studies find that men drew more elements in their sketch maps than women and that men and women drew the same amount of content. When analyzing content frequency in the manner defined by Lynch (1960), they find that the studies have inconsistent conclusions. Some authors find women draw more roads than men, some find the opposite, and some find that gender has no effect (Hátlová & Hanus, 2020, p. 14). In reviewing notable literature about gender differences in content frequency in sketch map creation, there seems to be a pervasive belief that women draw more landmarks and men draw more paths. However, it is evident from the work of Hátlová and Hanus (2020) that this belief should be challenged, and more comparative research is needed.

Hátlová and Hanus (2020) find there is a confirmed influence of mobility in the quality of a sketch map in studies of participants in developed countries (p. 11). Increased mobility has a positive correlation to positional accuracy and higher content levels, although most of the studies they site have participants sketch entire continents or the world. Only one study focused on mobility in a developing country in which participants drew their local area. This study, by Karan and Bladen (1982), focuses on mobility in the

Katmandu-Patan metropolitan area in Nepal. They find that higher levels of mobility as indicated by distance between residence and workplace and amount of travel in the previous week have a positive correlation to the comprehensiveness of identifiable locations drawn on the map of the city.

Another study that focused on mobility in a local area is by Jenkins and Walmsley (1993), who studied sketch maps done by tourists in Coffs Harbour of New South Wales. This study is obviously limited in that all of the participants were tourists who did not live in Coffs Harbour. The study finds that tourists who stayed in resorts and with relatives drew poorer quality maps than tourists who stayed in motels and caravan parks. Jenkins and Walmsley (1993) conclude those in resorts and with relatives had lower mobility than the tourists at motels and caravan parks. They cited this difference in levels of mobility as directly affecting the quality of the sketch maps.

Murray and Spencer (1978) study the effect of mobility on an individual's quality of mental imagery, graphic ability, and cognitive mapping skills. They divide participants into high mobility (domestic airline pilots), medium mobility (community college students), and low mobility (local miners) groups and ask them to draw their immediate local community, town, route map between home and work, region, and world. They find that people with high mobility drew complex, organized maps with many features, medium mobility people drew less organized, complex, elaborate maps, and low mobility people drew the least organized, complex, and elaborate maps, regardless of map scale. High mobility airline pilots drew better maps of their community and town than did low mobility people who spend all their time there, which suggests that mobility affects

sketch map quality more than familiarity of place. Mobility is important to consider in this research because the population lives in a relatively conservative Moroccan culture, especially the rural villages of Ighil, Idganoudane, and Taghrit. Women tend to travel less and spend their time inside the home, and men tend to spend time outside of the home and travel to other places for work or market access. Moroccan gender dynamics are further discussed in section 2.5 of this chapter.

Pocock (1975) studies familiarity of place by comparing sketch maps done of Durham, North Carolina by residents, visitors, and summer tourists. He follows Appleyard's (1970) method of dividing the maps into spatial (buildings, landmarks, districts) or sequential (roads) maps. Pocock (1975) finds that participants with higher familiar of place use more sequential elements, and participants with lower familiarity of place use more spatial elements. Low familiarity of place residents also drew the least sophisticated maps overall. Pocock (1975) finds that women over all three categories tended to map sequentially rather than spatially, which differs from Appleyard's (1970) findings.

In their overall survey of the literature, Hátlová and Hanus (2020) find that familiarity of place is proven to affect sketch map quality. They find that the better the participants know the space, the more elements they draw and the higher their positional accuracy. One study by Evans et al. (1981) finds that the number of nodes and paths increases the better participants know the place, even if the number of landmarks stays the same. It is highly probable that the participants in HAF's mapping exercises are all residents of the village and have been their whole lives. However, if the female

participants spend the majority of their time in the home, they might have a lower familiarity of place than do male participants who spend much more time outside the home. The gender difference in sketch mapping has less to do with biological brain differences than how gender manifests in people's lived experience in terms of their mobility, familiarity of place, mapping ability, etc. If a female participant has never been to school, never held a writing implement, rarely leaves home, and has never seen a map, they will likely struggle more in sketch mapping their community.

2.5 Moroccan Gender Dynamics

It is important to understand gender dynamics in Moroccan society and culture, especially in rural regions, as gender is investigated specifically in this thesis research. Much has been written about gender in Muslim-majority countries (Morocco is 99% Muslim) as it relates to Islam (U.S. Department of State, 2019). It is undeniable that patterns in society are influenced by Islam in Morocco. However, the effects of religion on gender in Morocco are complicated and cannot be separated from other societal influences. It is important that the reader does not inaccurately attribute these inequalities solely to Islam (see extensive works by Fatima Mernissi and Fatima Sadiqi for more information about gender and Islam in Morocco). With that said, the state of gender in Morocco, and especially that of women, is discussed to provide the necessary context for this thesis research. Alongside other factors, mobility and educational level has been proven by Hátlová and Hanus (2020) to affect sketch map positional accuracy and content frequency. It is essential to understand Moroccan's access to public and private spaces and differences in educational levels as it relates to gender.

2.5.1 Moroccan Cultural Gender Roles

Many factors including resource access, mobility, education, socioeconomic status, and the digital divide relate to Moroccan cultural gender roles. Sadiqi (2011) examines linguistic expressions of stereotypes regarding women in Morocco as a way to reveal underlying cultural beliefs relating to gender. Most stereotypes about women in Morocco are negative and reflect underlying patriarchal values that structure gender relations in the Moroccan culture. Sadiqi (2011) writes that in Morocco, stereotypes are significant because Moroccan culture regulates men's and women's lives in a strict manner and creates a common cultural mindset that is translated into sociolinguistic patterns of thought and behavior.

Sadiqi (2011) defines culture as a system of practices, rituals, beliefs, values, and ways of meaning in a community. Cultures differ in the degree of control they impose on the behaviors of their members, but Moroccan culture strongly restricts the behavior of men and women through a space-based patriarchy, space being physical, linguistic, or symbolic. Men are culturally associated with the public space of power and women are associated with the private space of obedience and conformity. This control derives from powerful social institutions, including historical heritage and tradition, orality, multilingualism, and social organization.

Sadiqi (2011) investigates Moroccan historical heritage and tradition as it relates to gender and concludes that it has been officially recorded by men, resulting in the presentation of women from a male point of view. Women's subordination has been constructed in this way over the years, which is characteristic of a postcolonial society.

Official, written history is seen as a venerated institution, which has exacerbated a rigid gender dichotomy because it is prized above oral history. While Modern Standard Arabic and French are written, Moroccan Arabic and indigenous Moroccan languages are oral. Rural women, such as those living in Ighil, Alhadyane, Idganoudane, and Taghrit, overwhelmingly speak Moroccan Arabic and indigenous languages, such as Tamazight and Tashlehit, and are illiterate (Sadiqi, 2011, p. 10).

Sadiqi (2011) writes that orality is especially important to the experience of illiterate women. These women perceive the written word as alien and do not identify with Modern Standard Arabic and French (p. 6). This assumption will be tested in this thesis research by counting the number of labels on each map and comparing the amount of written language between male and female maps. Sadiqi (2011) writes that in rural areas of Morocco, the *lkelma d rrajel*, or the "oral word of a man," has authority, and has traditionally been binding as marriage and business contract and last wills (p. 7). Monolingual indigenous women usually live in remote rural villages, like those in the High Atlas Mountains. However, Sadiqi (2011) writes that although these women are perceived as the most disadvantaged portion of society, they can be very successful in their local communities, working both inside their homes and outside in the fields to support their families, and moving easily between local villages (p. 10).

Social organization has the strongest impact on gender perception and gender construction. Moroccan society is built on clear gender role assignments that guarantee the structure of the society. These roles are created, fostered, and perpetuated in the family unit of Moroccan society, which is typically patriarchal both legally and

functionally. This patriarchal system is built on the exclusion of women from public spaces of power. Women guard the social organization by focusing on the family, meaning running a household and raising children. Explicit stereotypical expressions reinforce the relationship between women and the home and look negatively upon an association of women with the public sphere (Sadiqi, 2011). Stereotypically, women's language is disfavored in Moroccan culture. This is significant because HAF specifically asks for women's beliefs, opinions, and view of their space by having women create their own community maps in a women-only group.

Chafai (2017) discusses the phenomena of street harassment against Moroccan women in public spaces, which might have effects on the mobility of women versus men. Street sexual harassment is defined as any kind of verbal or physical violence committed against girls and women in public areas by men unknown to them. Chafai (2017) writes that in Morocco, gender-based violence is a widespread phenomenon that challenges Moroccan women. In 2010, 63% of women ages 18-65 reported experiencing physical, psychological, sexual, or economic violence. In 2015, Morocco was ranked 139th out of 145 countries in the Global Gender Gap Index by the World Economic Forum, which combines health, economic, educational, and political indicators (Chafai, 2017, p. 822).

Chafai (2017) notes that street sexual harassment is not given high significance when compared to other types of gender-based violence, but it has dramatic consequences on the health, safety, and mobility of Moroccan women (p. 822). There is a dichotomous relationship between private and public space in Morocco and women are frequently subjected to sexual harassment in public places that are hostile to women.

Chafai (2017) proposes that gender inequalities, the legitimization of these inequalities, and the stereotypical conservative perception of women foster street sexual harassment in public spaces (p. 825). The ubiquity of street sexual harassment against women can be seen as a symptom of men's dominance of public spaces, which likely has effects on women's levels of mobility.

Chafai (2017) writes that Morocco is dominated by traditional, conservative, and patriarchal ideologies that legitimate male dominance. In the 1990's, Morocco tended towards conservatism, particularly in the rise of Islamic fundamentalism. The rise of religious, conservative norms and values influences everyday life for Moroccan women. There is a phenomenon of rural to urban migration, where men move from the countryside to cities, such as Marrakesh and Lakliaa, for better economic opportunities. These men tend to have conservative values of disapproving of women in the public sphere, which clashes with working women in public spaces. Chafai (2017) notes the importance of chastity and virginity in Moroccan culture to maintain family honor, which leads to the desire to control women's sexuality and limit women's freedoms and mobility (p. 828). These factors culminate in a societal understanding that the public sphere is a male space where women are unwelcome, and women's space is in the home (Chafai, 2017, p. 830).

2.5.2 The Digital Divide in Morocco

Davis (2008) investigates the state of the internet in rural Morocco and if and how access to the internet empowers, both individually and collectively, illiterate craftswomen. Davis (2008) addresses the urban-rural cultural divide and states that a

middle-class, young, urban woman would have more choice in choosing her future spouse than a rural woman, and a rural woman would dress more conservatively than an urban woman (p. 17). Davis (2008) writes that stereotypes about the subservience of Muslim women derives from observations from male outsiders, who interacted with Muslim women in public spaces and perceived their actions as utter submission to men. However, there is now a more realistic and richer picture of Muslim women's roles and their power in various domains from Muslim women themselves (p. 17).

Davis (2008) worked with women weavers in N'kob, a village of 700 in southern Morocco, and Ben Smim, a village of 1,300 in the Middle Atlas in the north. Neither of these villages are in the High Atlas Mountains, but the experiences of rural women in other places in Morocco can be useful to understanding the situation of rural women in the High Atlas. The women in Ben Smim speak both Moroccan Arabic and the indigenous dialect of Tamazight and the village had regular electricity and mobile phone coverage as of 2008. The women of N'kob spoke only the indigenous language Tashlehit, there is no telephone line, mobile phones work at one spot in the village, but electricity has become available since 2005. In N'kob, people travel to another town to access the internet at cybercafes. Due to cultural constraints disallowing women from being seen at cybercafes and the burden of being away from the home for traveling, the women weavers do not leave N'kob frequently.

Davis' project, Women Weavers OnLine, attempts to connect women weavers in these villages with buyers abroad using the internet, cutting out the middlemen who buy products and sell them for much higher prices to tourists in cities. Davis (2008) writes

that her main problem is the illiteracy of women and their lack of digital competency. In both places, Davis had to find a community representative with education, French and English language skills, and the ability to use a phone and the internet to organize with the women and send Davis the information necessary to sell to foreign buyers. The weavers, being illiterate, cannot use mobile phones, but control things such as the price, the craft design, and get income by relying on community representatives. Davis (2008) notes that in informal interviews, many women reported increased empowerment in their households from earning their own income and increased prestige in the community.

Davis (2008) reveals important information about the lived experience of rural, illiterate women. Although these villages are not in the High Atlas Mountains, the experience of rural women in Morocco can be generalized to a degree and relates to the experience of women in this research study. The disconnect between women and the internet must be considered in this thesis research because it is clear that illiterate women do not access the internet, meaning that any data about villages added to OSM would not be seen by the women who volunteered data on the sketch maps to HAF if they are illiterate. Even if the women are literate, if they do not have mobile phones, access to mobile phone cell networks, or access to the internet in other ways, the data added to OSM will be similarly unseen and unutilized. However, it is still possible that the information volunteered by these women could benefit them if, for example, the location of an artisan cooperative is noted in OSM that attracts outside tourism and provides income directly to women.

Dodson et al. (2013) investigate cultural, technical, and gender-based barriers to mobile phone use among illiterate and low-literate women in indigenous communities of Southwestern Morocco. This study is relevant to the thesis research because rural people's access and ability to use smartphones to add, look at, or change information on OSM will affect the process of transferring information from paper sketch maps to digital participatory maps. Also, lack of smartphone usage lowers the chance a person might have seen maps before, thus affecting their familiarity and ability to do a sketch map. Dodson et al. (2013) first note that Morocco has relatively widespread mobile phone connectivity and high levels of ownership. However, 90% of rural Moroccan women are illiterate, and the ratio of male-to female school enrollment is one of the lowest in the world. This is not just a problem for older women; less than 15% of rural girls are enrolled in secondary school and 60% of girls aged 15-24 are illiterate. These factors need to be understood to quantify the utility gap beneath women's mobile phone usage (Dodson et al., 2013, p. 38).

Dodson et al. (2013) investigate technical, linguistic, and cultural challenges to mobile phone usage in an Argan Oil Cooperative in the Tiznit Province in southwestern Morocco. They survey 40 women from the cooperative and four surrounding villages. The women all identified as illiterate or low literate. The women used their mobile phones for personal communication, rather than instrumental communication, meaning they used mobile phones to maintain contacts with friends and family, and occasionally for work. 85% of the women said they could not write, read, or send an SMS message, and stated they were not "qualified" to use SMS due to their lack of education. Husbands,

sons, and brothers often have priority over more sophisticated mobile devices, including smartphones. Only two of the women in the study owned a smartphone (Dodson et al., 2013, p. 85). As 90% of rural women are illiterate, it is likely that the circumstances described above are similar to conditions in the rural villages in which HAF works. As such, it is probable that data added to OSM will be inaccessible to many villagers, but especially women.

2.5.3 Moroccan Migration Trends

Haas and Rooij (2010) discuss the impact of male migration on women left behind in rural Morocco, specifically the Todgha region located on the southern slopes of the High Atlas Mountains in southern Morocco. In Todgha, migration is a common phenomenon. Almost half of the men surveyed by Haas and Rooij (2010) were involved in migration (33% international and 15% internal). Only 34.5% of the households reported having no household member involved in migration. The phenomenon of migration is high because households see that migration leads to more wealth: the average income of households involved in international migration is more than double that of non-migrant and internal migrant households. Mobility and migration are issues that must be understood in this thesis because, as covered previously in this chapter, they have been found to affect sketch mapping by other authors.

Haas and Rooij (2010) assert that gender relations in Morocco are based on strong patriarchal values that includes spatial separation, where women's lives are in the domestic domain, and men's lives exist more in the public domain. However, the reality of life in Todgha does not strictly conform to these gender roles. Women are outside to

fetch and carry water and fetch wood if needed. Women also engage in agriculture by collecting fruits and crops like wheat and barley, cutting alfalfa for livestock, weeding, and collecting wood, leaves, and twigs. Among the women surveyed regarding education, 90% of the women between the ages of 35-39 had never attended school, compared to only 20% of men in the same age group. As of 2010, 87.7% of girls aged 7-12 were enrolled in school, and 31% of girls aged 13-18 were enrolled in school (Haas & Rooij, 2010).

Haas and Rooij (2010) found that progressively more households in Todgha are headed by women. Migration and higher divorce rates are seen as the major causes of female-headed households. 10.4% of all households surveyed reported being female headed, however, the authors assert that the majority of migrant households are *de facto* female headed households. In many cases, an eldest son was identified to the researchers as being the head of the household, but the migrant's wife held the true household responsibilities. With this addition, Haas and Rooij (2010) conclude that over a third of households surveyed were female headed. It is unknown if the villages where HAF collected sketch maps experience a high level of male migration. However, based on Morocco's general migration trends, it is likely these villages experience some level of male migration to urban areas in Morocco and abroad. If the villages where HAF works have a high level of male migration, it is possible that women may spend more time outside the home, shopping, traveling, engaging in government business, or doing agricultural work that men typically do, which could increase their mobility within the community.

Ennaji (2008) discusses the situation of women in Morocco and their integration in development. She writes that in rural areas, women and men have large inequalities concerning access to resources. Despite increased aid and development programs to combat poverty since the 1990s, poverty has increased in Morocco, and especially among women. Ennaji (2008) writes that despite vast labor and gender divisions in rural areas, rural women contribute considerably to agricultural and rural development. Rural women work in the fields, feed livestock, gather wood and water, engage in artisan activities, manage households, and raise children. Women have growing responsibilities in farming, production, small trade, and services. It is clear that despite gender divisions and conservative gender roles, rural women engage in many activities outside of the home, indicating they likely have mobility within the community. Ennaji (2008) also discusses the phenomena of migration and writes that remittances sent by emigrated males help women and children to live more comfortably, but also leads to emotional suffering and disruption of families, which affects children's development. Overall, Ennaji (2008) writes that women suffer more than men from poverty, which is especially noticeable in rural areas.

2.5.4 Conclusion

The state of gender in Morocco is discussed to discover how gender relates to the various factors that affect sketch map content frequency and accuracy, which include mobility, familiarity of place, education, socioeconomic status, and the digital divide. These factors were investigated in the literature about gender dynamics in rural Morocco, specifically gendered access to public and private spaces, education trends, rural literacy

rates, and mobile phone access. Davis' (2008) and Dodson et al.'s (2013) research into mobile phone usage reveals a vast digital divide among rural women, who are illiterate or low-literate and do not have access to smartphones. This likely is the situation in the villages where HAF works as well, meaning that the data added to OSM is likely to be inaccessible to these women as well as men who are illiterate or without smartphones. Ennaji (2008), Sadiqi (2011), and Chafai (2017) discuss political, historical, and cultural factors and determine that Morocco operates from a patriarchal and conservative system that legitimizes male domination and relegates the public domain to that of men and the private domain to that of women. However, Sadiqi (2011) also notes that in rural villages, women work both inside and outside the home and move between villages. Ennaji (2008) also notes that rural women have growing responsibilities outside the home and are not confined inside. Similarly, Haas and Rooij (2010) in their work on migration, conclude that rural women work both inside and outside the home, especially if the male head of household has left due to migration. It is clear that the state of gender in Morocco is complex. Although traditional gender roles relegate women indoors, the reality of rural life in Morocco is different. It is inaccurate to assume that women do not exist in public spaces in rural villages. As such, the level of mobility for women in the villages where HAF collected sketch maps is unclear and more research is needed to determine women's mobility in these villages.

2.6 Positional Accuracy of Sketch Maps

Regarding positional accuracy, Hátlová and Hanus (2020) find in their survey of the literature that age, mobility, place of residence, use of a map, level of education, and

sex are proven to affect the positional accuracy of sketch maps (p. 9). While they find that content frequency is not proven to be affected by gender, positional accuracy is affected in that men draw sketch maps with greater positional accuracy than women. There are a number of ways researchers have attempted to analyze positional accuracy of sketch maps, including distortion, buffer analysis, point definition, and transparencies using GIS.

2.6.1 Analyzing Positional Accuracy: GIS Buffer Operation

One method used by Okamoto et al. (2005) is GIS buffer operation to distinguish between route-type sketch maps and survey-type sketch maps, following Appleyard's (1970) example. The authors focus on analysis of the areas drawn in reference to actual geographical space and distinction of the forms of sketch maps. They critique previous methods used to measure metric distance and area in sketch maps: the entire road length method and the area method. The entire road length method assumes that the overall area is larger if the total length of road drawn is longer. However, this method does not consider density adequately as the road length could be the same between a map with a single long road and another with a dense network of roads. The area method measures the area within the range where the drawn elements are drawn on the map. The larger the polygon connecting the elements drawn at the edges of the map, the larger the actual geographical space. However, this method requires the elements at the edges of the polygon be identified in actual space. Also, if the sketcher draws one or two elements far away from the core subject of the map, distribution of map elements is impacted, due to non-uniformity of scale.

Okamoto et al. (2005) attempt to combine these two methods by using the buffer operation, which creates a uniform region around a geographical element designated as a point, line, or polygon. The authors focus on the buffer region around drawn roads. They designate route-type maps as those in which the area of the buffered region increases at the same rate as the buffer distance is increased. They designate survey-type maps as the maps for which the area of the buffered regions decreases at some point as the buffer distance increases because the buffer regions will begin to overlap each other. This method also alleviates the problem of outlier geographical elements. The authors test the buffer method on sketch maps drawn by 35 Japanese and 19 Japanese-Brazilian participants. They trace the sketch maps onto a topographical digital map and perform the entire road, area, and buffer method on each. Okamoto et al. (2005) determine the buffer method is effective to distinguish between route-type and survey-type maps and to find the approximate value of area drawn. The authors discuss the effect of length of residence on the type of sketch maps and find that those with fewer years of residence drew more route-type maps, while those with more years of residence drew survey-type maps. In those who drew survey-type maps, area drawn did not increase, but the contents drawn became more elaborate with an increase in length of residence.

2.6.2 Relative Positional Accuracy

Billinghurst and Weghorst (1995) use sketch maps to study cognitive maps of virtual environments. Critically, they study virtual 3-D rather than real world environments, but their analysis of sketch map accuracy, especially positional accuracy, is useful to this thesis research. They write that there are three ways cognitive maps are

created: through an individual's sensory modalities, from symbolic representations such as maps, and from ideas about the environment which are inferred from experiences in other similar spatial locations. Billinghurst and Weghorst (1995) write that an individual's sensory modalities provide direct sources of information and are more effective in forming cognitive maps than indirect sources. In people's situations living in the remote High Atlas Mountains, gender and socioeconomic status might affect how people are able to form cognitive maps. Everyone in the community is able to engage with their space using normal sensory modalities, although in different ways conforming to cultural norms. Forming cognitive maps about the community from symbolic representations such as maps requires access to maps, be it paper or digital. For some of the participants, especially women, they have never been to school or have very limited schooling and are unlikely to have ever engaged with paper maps such as those used in schools. Everyone's access to digital maps relies on access to smartphones or computers, which is limited, especially for women. It is likely that most people do have access to televisions, where they could see maps used for weather or news broadcasting, though not of their local area. Finally, experiences in other similar locations are restricted to those who can travel, which are likely men who travel for work or have disposable income. Many of these assumptions are formed from the thesis researcher's own experience living in rural Morocco with the Peace Corps, hearing from experiences of other volunteers who lived in rural parts of the High Atlas Mountains, and the previous research into gender dynamics in Morocco as seen in section 2.5.

To analyze cognitive maps, Billinghurst and Weghorst (1995) assess the subject's self-reporting and analysis of external representation. They focus on the subject's topological understanding of the virtual environment (where they are and where everything else is), rather than metric knowledge (precise location and distance between objects). The authors rank the maps for goodness from 1-3 for how useful they would be as a navigational tool if taken with them into the virtual environment. They then give the maps a score according to the number of object classes present to measure completeness of the sketch map for the virtual world. Finally, they measure relative positional accuracy by scoring objects if they were accurately positioned to the left or right, above or below, or clockwise or counterclockwise to other objects. The authors give two positioning scores: a total object positioning score, and a significant object positioning score where the five most commonly drawn objects were evaluated. Billinghurst and Weghorst (1995) use the relative object positioning scores to calculate a relative positioning ratio:

Equation 1 Relative Positional Accuracy Ratio

$$Relative\ Positioning\ Ratio = (number\ of\ correctly\ placed\ significant\ objects) /(total\ number\ of\ significant\ objects)$$

This method could be applicable for measuring positional accuracy with the HAF sketch maps if significant landmarks are able to be determined conclusively using satellite imagery, or ground truthing could be done. The ratios could then be compared across sketch maps in multiple locations to establish trends in relative positional accuracy. This will be further expanded upon in Chapter 5.

Wang and Schwering (2015) study spatial information that is preserved in sketch maps, termed invariant spatial information, in sketch maps of urban areas. They write that sketch maps are usually incomplete, distorted, and schematized due to cognitive impacts. Common distortions include distances between near spatial objects are considered relatively farther than distances between distal objects, buildings are judged closer to landmarks than the other way around, routes are judged longer if they contain more turns, intersections, or clutter, and angles tend to be rectangularized and curved features are made straighter. Wang and Schwering (2015) also find in their review of the literature that there are errors of quantity, shape, size, and inconsistent scales in sketch maps. However, sketch maps can still be used to communicate spatial information if distortions are understood in the analysis. The authors write that spatial analysis methods developed for metric maps are not appliable to sketch maps and a new spatial analysis method is needed.

Following the work of Lynch (1960), Wang and Schwering (2015) identify four types of spatial objects as basic elements in sketch maps: landmarks, street segments, junctions, and city blocks. The authors analyze the accuracy of urban sketch maps of participants' familiar areas by comparing them with corresponding metric maps at spatial object (geometric attributes) and spatial scene (spatial relations) levels. For the spatial object level, the authors evaluate the geometric attributes for type, shape, and size. For the spatial scene level, the authors evaluate spatial relations quantitatively by measuring distances and angles, and qualitatively by evaluating topology, orientation, and order. They find that the qualitative spatial relations at the spatial scene level (topology,

orientation, order) provide the best results. At the spatial object level, the authors find geometric attributes distorted and schematized, like street networks, which were incomplete and simplified. Participants drew far fewer landmarks than junctions and street segments. They drew landmarks as blobs or rectangles rather than shapes in reality. The authors also found distance and angle distorted at the spatial scene level. They did not find evidence that relative distances were in proportion to the size of landmarks or lengths of street segments.

Jan et al. (2016) consider map alignment of sketch and georeferenced maps. They write that in the task of aligning drawn objects to underlying spatial datasets, many researchers have used qualitative spatial relation categories such as adjacent, near, and far, rather than numerical distances. Because sketch maps are based on human perception rather than numerical measurements, the information represented is schematized, distorted, and generalized. The authors identify four criteria for the selection of plausible representations to align aspects of sketch maps and georeferenced maps, the first being reference system and scope. Qualitative representations of sketch maps do not require the same reference system as quantitative representations because the sketch maps do not use metrics. Rather, the local frame of reference relies on the qualitative representations of the sketched objects themselves. For example, the relative orientation of landmarks with respect to street segments works better than a metric orientation of north and south (Jan et al., 2016, p. 40).

2.6.3 Distortion and Scale

Waterman and Gordon (1984) measure distortion in mental maps by analyzing sketch maps of Israel drawn by Israeli high school and university students. They develop a pre-GIS technique of measuring distortions in mental maps and find that older subjects drew the most accurate mental maps. They also show that distortion is caused by an overestimation of distances close to the participants' familiar place of residence and an underestimation of distance in less familiar areas. Waterman and Gordon (1984) develop the concept of the box of distortion, which indicates the orientation of maximum and minimum distortion, whether by stretching or compressing. They compare the drawn map to the true-map scale by establishing eight real-world "common points" from the true-scale map.

Peake and Moore (2004) further the findings of Waterman and Gordon (1984) by analyzing distortions in sketch maps using GPS and GIS. They repeat the finding that distortions are apparent the further away participants travel from their familiar environment. Peake and Moore (2004) had participants carry a GPS data collector over seven days to track their movements. At the end of seven days, they had participants draw a mental map of their previous movements. The sketch map was scanned, georeferenced against the GPS data, and digitized using ArcGIS 9. The mental map and GPS data were reduced to a finite number of nodes that could be identified on both maps. The distortion values of absolute distortion, radial distortion, and lateral angle distortion were calculated. Peake and Moore (2004) write that absolute distortion represents the distance between the equivalent GPS and mental map nodes. They write that absolute

distortion does not have a direction. As such, the absolute distortion is a vector that measures magnitude of the distortion, ignoring directionality of the error. Absolute distortion was measured by Peake and Moore (2004) using Pythagoras theorem, as seen in Equation 2:

Equation 2 Magnitude of Distortion (Peake and Moore, 2004)

$$Absolute\ Distortion = \sqrt{\begin{matrix}(x\ coordinate\ of\ mental\ map\ node - x\ coordinate\ of\ GPS\ node)^2 + \\ (y\ coordinate\ of\ mental\ map\ node - y\ coordinate\ of\ GPS\ node)^2\end{matrix}}$$

Peake and Moore (2004) also find that city scale mental maps are "person oriented," meaning based on lived experienced, rather than north oriented. This thesis research will draw from Peake and Moore's (2004) experiment by attempting to identify common nodes that appear on the men's map, women's map, and OSM satellite imagery. GPS data cannot be obtained similarly to Peake and Moore's (2004) example because the sketch maps were done between 2010-2020; it is unlikely the exact groups of participants could be found and would remember the details of their sketch mapping from years before. Also, the thesis researcher is living in the U.S and cannot travel to Morocco at the time of the research.

2.6.4 Conclusion

This thesis research will add to the cannon on gender differences in content frequency and positional accuracy of sketch maps. As examined by Hátlová and Hanus (2020), there are many factors that determine the quality of a sketch map. Gender

specifically will be studied in this thesis research because the community mapping activity done by HAF divided participants into gendered groups. HAF does not have participants do their own individual maps, as is the method followed by all sketch map research surveyed, but rather directs participants to make a group map after being split into groups of men and women. Information about age, socioeconomic status, familiarity of place, level of mobility, educational level, etc. is not known. Therefore, conclusions that will be attributed to gender differences could have more important underlying factors that require further research to fully understand. This will be further discussed in Chapter 5.

The literature reviewed above involves participants who are familiar with the idea of a map; perhaps they have used maps in school or to navigate. It is unclear how familiar some of the HAF participants are with maps at all, if they are uneducated, do not have access to technology, are illiterate, etc. While the literature about sketch mapping is vast, there is a dearth of literature examining sketch mapping with rural, illiterate populations. A potential contribution of this thesis is to educate HAF on factors other than gender that influence sketch map quality that HAF could incorporate and use to collect data for future community maps, including information about the digital divide and map awareness. If results find that there are vast differences between genders in completeness, positional accuracy, and content mapped, the thesis researcher will advise HAF to adapt their process to cater to those differences and obtain the most useful data in the future.

2.7 Gender Differences in OpenStreetMap Contributions

One of the most used, analyzed, and cited VGI platforms is OpenStreetMap. Its main goal is to create a freely available geographic database of the world. The data is matched to a geographic position using georeferenced aerial imagery or GPS locations. To contribute data to the platform, a broadband internet connection and a smartphone or personal computer are needed. Neis and Zielstra (2014) write that two studies focusing on data contributed in 2010 and 2012 indicated that 75% of active OSM contributors were located in Europe, and the remaining 25% were located in North America and Asia (p. 89). Neis et al. (2013) find that the majority of OSM data was collected by external contributors who lived more than 1000 km away from the area in which the data was contributed, indicating the data was added using satellite imagery rather than direct measurement or observation. Prior studies have shown this method of mapping can lead to an overrepresentation in the geometry of a feature and missing feature descriptions such as street names (Neis & Zielstra, 2014, p. 94). As Morocco is located in North Africa, it is likely that the contributors adding information to OSM are not living in Moroccan communities but are adding information using satellite imagery.

Neis and Zielstra (2014) also write that more than 97% of OSM contributors in 2010 and 2012 were male (p. 90). Additionally, over 60% of contributors were between 20 and 40 years old, and 20% of mappers were under 20. Other studies found that 63%-78% of contributors had at least a college degree. About half of those contributors had a degree related to geography, urban planning, or computer/information science, meaning that the OSM community is not overwhelmingly composed of GIS amateurs, as is widely

believed (Neis & Zielstra, 2014, p. 91). These statistics reveal that not only do the OSM contributors of Moroccan data likely not live in Morocco, but they are also very unlikely to be women. The geospatial data from the HAF facilitated sketch maps contains unique data volunteered by underrepresented populations, especially the female volunteered data.

A study by Gardner and Mooney (2018) investigates gender differences in OSM contributions in Malawi. The authors attempt to measure and better understand the impact of participation biases in VGI. They write that male participation bias in OSM contributions has been shown in numerous previous studies, revealing a failure of crowdsourced mapping projects to represent the interests of the wider public. While crowdsourced mapping projects have been hailed as a democratizing force, they omit the interests of many people, especially women. Because crowdsourced maps reflect the geospatial interests of the people that create it, the interests of women are systematically excluded by the process. Gardner and Mooney (2018) investigate gendered mapping behaviors in the specific geographic location of Malawi. They find that men are significantly more active than women in contributing data, both in the number of days active and volume of edits. They also find that men are more likely to create new data; the female contributors did not create a single tagged node. Overall, the results investigating male participation bias at a local level replicate the results at the global level where men are more active than women.

It is apparent in the literature that OSM contributors living in Africa are not typically the ones mapping their spaces and the contributors are unlikely to be women.

This thesis research addresses this geographic and gender participation bias by adding data from local populations of both men and women to OSM. The data pathway of adding data from sketch maps to OSM could be a useful method to address larger issues of participation bias in OSM.

2.8 Spatial Webs and Gazetteers

At the 2004 National Center for Geographic Information and Analysis Specialist Meeting on Spatial Webs, Goodchild et al. explore interoperability and spatial webs. Social media, VGI, and Web 2.0 facilitated the rise of geocrowdsourcing, where a larger community collectively contributes to the collection, mapping, and quality checking of geographic information. In this thesis research, the spatial web that contributed to the mapping of these villages were the thesis researcher, HAF, the translators, and the villagers. All components of the spatial web are in different locations and contributed to this research project over time.

The meeting also discussed the evaluation of geographic ontologies and gazetteers. To have useful and meaningful ontologies, users must be able to understand and map between varying human spatial concepts and consider different human contexts. Geospatial ontologies must include both top-down domain experts and the normal, everyday users of spatial data in a bottom-up approach. Dr. Mark Gahegan, a meeting participant, stated that bottom-up semantics capture aspects of situation or context by building associations between resources, people, times, and places. Bottom-up semantics carry as much meaning as top-down ontologies do. Meaning is a social construct, and human involvement is critical in data creation and data use. Formalizing ontologies

quickly and relying only on government or official points of view do not capture the whole picture and create useful and meaningful ontologies (Goodchild et al., 2004, pg. 12).

Several meeting participants discussed the importance of integrating tools and resources from different information communities to broaden the abilities of spatial webs. Participants considered the integration of various spatial and non-spatial digital communities. A working group concluded that the problem of interoperability cannot be solved by existing mainstream technologies (Goodchild et al., 2004, p. 10). It is also important to consider integrating nondigital sources such as paper sketch maps, especially in places of low technology in developing countries.

Dr. David Mark addresses the difficulties of interoperability and meaning as it relates to language translations. Word-to-word translations between languages are rarely possible without knowing additional contextual information due to inconsistencies in the concepts (Goodchild et al., 2004, p. 9). These obstacles exemplify the difficulties of compiling geospatial data using spatial webs. In this thesis research, translation of the same 12 map documents were done by two individuals. In many cases, the translations were slightly different between the two translators. As ground-truthing is not possible at this time, a certain level of subjectivity exists in the researcher's understanding of the map documents because she relied on non-villagers to provide meaning.

M. Rice et al. (2012) discuss using open-source software that utilizes VGI in tandem with officially sourced infrastructure databases to increase accessibility for blind and visually- impaired people. The authors demonstrate that publicly volunteered

geospatial and crowdsourced data can be quality-checked and tested for consistency using an official gazetteer and informal name variants that are commonly used by the public. Normal gazetteers capture “official” names at small scales. R. Rice et al. (2016) argues the need for an expansion of gazetteer development to also include informal naming structures. The authors demonstrate the need for geographically detailed and specific naming support to include the naming conventions used by the public to describe events and the overall context of their communities.

Helleland (2006) discusses the social and cultural values of geographical names. He writes that geographical names are important for historical documentation, preserving local language and history, and serving as links between individuals and their topographic surroundings as part of a local population’s identity (United Nations Group of Experts on Geographical Names, 2006, p. 126). Helleland (2006) writes that geographical names represent the oldest living part of human cultural heritage because they have been orally passed down from generation to generation for hundreds or thousands of years. In the case of colonized countries, indigenous geographical names preserve potentially extinct languages and cultures (United Nations Group of Experts on Geographical Names, 2006, p. 121).

Kadmon (2006) discusses language and the conversion of geographical names. He defines language as a channel of communication with the help of which members of a linguistic community can transmit conscious thought between individuals (United Nations Group of Experts on Geographical Names, 2006, p. 99). He writes that unwritten languages (also known as illiterate languages) are channels of oral communication for

which no separate or original system of written expression has developed (p. 100). Writing in these languages uses the script of colonizers, such as Arabic and French in the case of Morocco. Unwritten languages are important with regards to geographical names used by locals.

In this thesis research, the local populations in the six villages likely speak one or many of the unwritten languages of Tamazight, Tashlehit, and Darija (Moroccan Arabic). These languages were captured in the sketch maps in Arabic and Latin script, the language of colonizers. Some translation was likely done at the time of mapping if participants were speaking an unwritten language to each other but writing on the maps in Darija, French, and Modern Standard Arabic. Additional translation was done by the Arabic to English translators to provide the thesis researcher with meaning. It is almost certain that with multiple levels of translations amongst various people between several languages, local context and meaning was lost.

2.9 Literature Review Conclusion

Historically, cartography was elite, exclusive, and imperialistic: it was known as the "science of princes." Elites with access to knowledge and the tools to create maps did so to occupy land, subjugate indigenous peoples, and extract resources. Morocco was colonized by France, who codified their power onto maps. In the 1990s, there was the first acknowledgement of a digital divide in GIS. There was a recognition that GIS remained a part of imperialist geography, which led to a rise in participatory mapping in developing countries as part of the sustainable development process. In 2007, Goodchild introduced the concept of volunteered geographic information (VGI) to describe the

development of tools to create, assemble, and disseminate geographic data provided by individuals. Participatory mapping has expanded rapidly since due to the public contributing to their own maps (Pánek, 2016).

PM is an integral part of the sustainable development process because it provides crucial information necessary to understand the local context. In 2015, the United Nations General Assembly introduced the 2030 Agenda for Sustainable Development. This document identifies indigenous peoples as a marginalized group to include in the sustainable development process. Participatory GIS can address this problem by representing not just where people live, but also how people live (Vajjhala, 2005, p. 2). It can reveal crucial information into important social and economic factors that shape their lives. This is particularly important in rural places in developing countries, which have been systematically overlooked by official government mapping projects.

Lynch (1960) was one of the first to introduce the idea of a mental map, which put individuals at the center of information gathering and research. Different things matter to different people, thus affecting what they see and their cognitive maps. He writes that cognitive maps contain five elements: paths, edges, nodes, districts, and landmarks. Future research into sketch map creation reveals mobility affects sketch map content frequency and accuracy. There is a belief that women draw more landmarks and men more paths in sketch map content creation, but there are inconsistent conclusions overall and this topic requires further research. Age, mobility, place of residence, use of a map, education, and gender affect positional accuracy (Hátlová & Hanus, 2020, p. 12). There are many methods to measure positional accuracy, but relative positioning based

on topology is best suited for sketch maps because they are incomplete, distorted, and schematized (Jan et al., 2016). Most studies focus on developed countries in academic settings, which differs from this research.

Ennaji (2008), Sadiqi (2011), and Chafai (2017) address Moroccan gender dynamics and discuss political, historical, and cultural factors. They determine that Morocco operates from a patriarchal and conservative system that legitimizes male domination and relegates the public domain to that of men and the private domain to that of women. However, they also note that in rural villages, women work both inside and outside the home and travel between villages. Due to increased male migration, women have increased responsibilities outside the home. The digital divide affects Moroccan women, especially rural women, who are mostly illiterate or low-literate and do not have access to smartphones.

OpenStreetMap is the most used, analyzed, and cited volunteered geographic information platform. The vast majority of OSM data were collected by external contributors, using satellite imagery, who live more than 1000 km away from the area in which the data were contributed (Neis et al., 2013). Approximately 97% of these contributors were male and the majority of contributors had at least a college degree. (Neis & Zielstra, 2014, p. 89). It is clear that the geospatial data included in the sketch maps in this research are unique data volunteered by an underrepresented population, especially the female-volunteered data. The data pathway of adding data from sketch maps to OSM could be a useful method to address larger issues of participation bias.

Finally, spatial webs and gazetteers are discussed. Social media, VGI, and Web 2.0 facilitated the rise of geocrowdsourcing, where a larger community collectively contributes to the collection, mapping, and quality checking of geographic information (Goodchild et al., 2004). Bottom-up semantics capture aspects of situation and context by building associations between resources, people, times, and places. They carry as much, if not more, meaning than top-down ontologies (Goodchild et al., 2004, p 12). Additionally, there are difficulties of interoperability and meaning as it relates to language translations. Translations between languages are rarely possible without knowing additional contextual information due to inconsistencies in concept. Finally, there is immense social and cultural value in geographical names because they serve as important historical documentation and link individuals and their topographic surroundings to create identity.

CHAPTER THREE

Research Methodology

3.1 Data Collection

The data used in this thesis research come from the High Atlas Foundation. Participatory paper sketch maps were completed between 2010-2020 in approximately 90 villages in Morocco. HAF relies on local associations to gather participants for the meeting in which the community mapping takes place. Time of day, day of the week, time of year, number of participants, and makeup of participants is left to the association to organize, meaning there is little control between the maps as one would find in an academic, research study. HAF does not collect any additional information on participants other than gender when they split them into groups to do community mapping.

As covered previously in sections 2.4 and 2.6, factors such as age, educational level, and mobility affect the quality and accuracy of sketch maps. As this information was not collected, the thesis researcher must be careful in attributing findings to the known factor of gender. There could be many other factors at play more important than gender in sketch map differences. Factors like time of day could have a large impact on the makeup of participants if the meeting were held after dark, when women tend not to leave the home, or during the day in a planting season, when men are occupied with

farming. Women with children are likely to have more available time during the day if their children are in school, but men might have less time if they are working. Unfortunately, these factors are not known. The maps were taken "as is" and findings are contextualized considering these caveats in Chapter 4.

To begin a relationship with the community, HAF first becomes acquainted with community representatives, both formal officials and informal community leaders. HAF meets with these individuals and asks about their goals for the initiative and sets expectations. As much decision-making power and leadership as possible is delegated to the community. HAF asks representatives to identify local community facilitators who are trusted by diverse groups within the community. HAF's ideal role in this process is assisting and training these facilitators. They obtain authorizations from Moroccan officials to work in all communities (Thompson, 2010, p. 9).

After confirmation within the community and from outside officials, HAF organizes an initial meeting with the whole community. In this meeting, HAF explains the purpose of the initiative, how the participatory development process works, and what HAF's role is as facilitators. Ideally, all community members are contacted and invited, and all diverse groups are represented. These invitations are done by local associations. HAF facilitates a discussion of the community's role, introduces the idea of a delegation to a community committee to manage day to day work, facilitates a community decision about the community committee's composition and name, and agrees what will happen next when the community meets again (Thompson, 2010).

In the second meeting, the community mapping, needs assessment, and priority ranking takes place. HAF uses community mapping as a visual tool from Participatory Rural Appraisal (PRA) methods (Thompson, 2010, p. 19). PRA was developed to engage poor, rural communities in group activities to define their own needs and is widely used today. HAF begins with a community mapping exercise. They split the overall community into groups of men and women and provide each with a white, blank, flip chart paper, and several blue, red, black, and green pens (exact number is unknown). Potentially, multiple people work on the map at once in coordination to piece together a sketch map of the community. The facilitators provide a rough guide for mapping, beginning with natural features in green, and roads and buildings in black and blue. HAF facilitators do not allow participants to look at the other group's map or remind participants of things they might have left out. They give them an unlimited amount of time to complete their maps (A. El Hajjami, personal communication, March 31, 2021).

HAF facilitators indicated to the thesis researcher that some of the time, women are unfamiliar and uncomfortable with community mapping. They tend to rely on a member of the group who has higher literacy and education to take control of the process. While this person holds the pen, the other women, especially those uncomfortable with the process, provide verbal directions and additions to the map while pointing at places they think the items should be drawn (A. El Hajjami, personal communication, March 31, 2021).

The last step of the community mapping process is the "dream" step, in which participants use a red pen to add items they wish to see in their community in the future.

In this thesis research, these dream items are coded in a separate category to keep the "real" map and the "dream" map separate. After the community mapping, the community comes back together and a representative from the men's group and the women's group presents the map to the overall community comprised of both men and women (A. El Hajjami, personal communication, March 31, 2021). The maps are discussed for common needs, special needs, and differences to begin the process of community consensus building. An important part of this discussion is resource identification. Men and women, or other categories of people, have different access to resources in a community. The community maps frequently show differences in access to resources and this is discussed in the group to raise awareness of the problem (Thompson, 2010). Additional steps to the meeting include a needs assessment and priority ranking of needs, but these are not discussed in this thesis as they are not applicable to the scope of the research.

3.2 Data Access

Access to the shared google folder is limited to Cora Stern (thesis researcher), the HAF President, Amina El Hajjami (HAF Director of Projects), and the HAF Director of Development. Amina frequently works in the field and facilitated many of the sketch maps included in the analysis. Two translators, Hassan Mansouri and Kawthar Messaoudi, also had access to the Google folder when they were providing translations. The maps are stored in a Google Sheets presentation, with one map per slide. Known information about village name, commune (local administrative unit), province (larger administrative unit), and gender is contained in the presentation notes.

The community maps that were completed between 2010-2020 were removed from the community after the mapping meeting took place and stored in HAF's office in Marrakesh. 18 maps selected by Amina were scanned using a high-resolution scanner in an office and scanning store (mktaba in Moroccan Arabic) and sent to the thesis researcher over email. Two of these maps did not represent a specific location, but rather necessary steps to bring organic produce to market by multiple people living in a larger administrative province. These two maps were not included in the analysis. Four maps from the village of Boughrar were sent to the researcher as well, but it was unclear which of the maps were done by adults and which by children. As this information is no longer known, the maps from Boughrar were not included in the sketch map content and positional accuracy analysis but were included in the location identification aspect of the research. Finally, cell phone pictures of five maps from unknown places were sent to the thesis researcher. These maps were not included in the analysis because the readability was not adequate due to the quality of the picture, and gender and village location are unknown. These unused maps are contained in the shared Google folder to provide HAF with a record of everything sent and keep the digital copies of all maps in one place. The maps have also been saved to the thesis researcher's desktop and put in a shared Dropbox folder with Dr. Rice. The original paper copies of the maps will remain in Morocco at HAF's office.

3.3 Data Translation

For the 12 maps used in the analysis from the villages of Lakliaa, El Mellah in Marrakesh, Idganoudane, Ighil, Alhadyane, and Taghrit., text boxes were inserted on top

of the slides by Hassan Mansouri and Kawthar Messaoudi with English translations from Darija (Moroccan Arabic), Modern Standard Arabic, and French. Hassan and Kawthar previously worked for Peace Corps Morocco as Darija teachers for Peace Corps volunteers, and the thesis researcher met both of them during her time in Morocco with the Peace Corps. Kawthar and Hassan were contacted over WhatsApp and the link to the Google Folder was sent over email. A data issue in this research was language and handwriting. Though the thesis researcher has an advanced proficiency in Darija, she needed the expertise of native speakers to provide high quality translations. The maps with English translations by both Kawthar and Hassan are contained in Appendices B and C, respectively. Table 2 in section 4.1 shows the village names with name variants. After the translations were completed, the shared Google folder permissions were changed to keep the data between the thesis researcher, Amina, the HAF President, and the HAF Director of Projects. The thesis researcher has incredible gratitude towards Hassan and Kawthar for providing such excellent translations and making this research possible.

3.4 Location Identification

For the seven villages including Boughrar, the thesis researcher worked with Amina over Zoom to identify village locations using Google Maps. The thesis researcher proposed finding locations using OSM, but Amina felt more comfortable operating within Google Maps. In subsequent analysis of the available data in OSM and Google Maps, Amina made the correct decision because there is an impressive amount of data in Google Maps, especially in Arabic. The thesis researcher was initially searching for locations in Google Maps using English spellings and variations and coming up short;

Amina revealed the importance of searching in Arabic. This reveals the significance of doing such searching with a native speaker who is from the country, rather than an outsider with an English-language bias. Amina shared her screen with the thesis researcher to show her the strategy of finding each village location and the researcher took notes of the process for each community.

After the communities were located by Amina, the thesis researcher compared the sketch maps to OSM satellite imagery and Google Maps data to investigate which, if any, sketch map elements could be found. First, the thesis researcher checked if the locations Amina identified were in the correct commune and province that were written on the sketch maps. Multiple sketch maps included nearby villages and communes written on the edges of the maps, and the thesis researcher tried to find those nearby locations to support that the found village was in the generally correct area. Results are found in section 4.2.

3.5 Topology of Mapped Elements

The thesis researcher focused on the topology of map elements by looking at the spatial arrangements and patterns of features. Rather than measuring metric distances and angles, the thesis researcher determined that analyzing geometric positioning was a more useful strategy to identify sketch map elements in OSM and Google Maps. To find mosques, which were an included element in most sketch maps, the thesis researcher looked for the shadows of minarets. She also focused on road crossings with other roads and rivers. If any element, such as schools, mosques, or government buildings included formal names, the thesis researcher searched for those elements in both English and

Arabic in OSM and Google Maps. She attempted to match patterns of identifiable features from the sketch maps to OSM and Google Maps data. For example, a mosque between a river and a road, or a cemetery and a mosque with a road in the middle. Results are found in section 4.3.

3.6 Scale, Distortion, Orientation

The thesis researcher attempted to characterize common attributes between frequently mapped sketch map elements. She investigated orientation trends in the style of mapping specific elements. For example, she investigated if certain elements were drawn with an oblique versus overhead view. She did this by looking at the elements drawn on the sketch maps and the map legends drawn on four maps. The thesis researcher also investigated indications of scale by focusing on the relative sizes and distortions of size between map elements. She established trends in the distortions of elements drawn in the center of the maps and at the map edges. The thesis researcher also analyzed the use of symbols and colors to represent map elements. Finally, the thesis researcher identified trends in including formal cartographic map elements and features with distance, areal, and depth measurements. Results are found in Chapter 4.

3.7 Content Frequency Analysis

Content frequency analysis was performed using the qualitative analysis program Dedoose on the 12 sketch maps with the goal of determining trends as related to gender. The coding structure is detailed in Table 1:

Table 1 Codebook [table from Excel file]

Coding categories	Explanation
Dream Element	Elements written or drawn in red ink on the sketch maps that did not exist in reality at the time of the mapping. These elements usually were manmade landmarks (hospitals, schools, wells, women's associations, mosques, soccer fields, etc.) and road segments.
Manmade Landmarks	Included wells, houses, mosques, cemeteries, schools, women's clubs, water towers, markets, government buildings, hospitals, shops, cactus factories, nearby villages, reservoirs, soccer fields, dams, public ovens, guest houses, and city gates.
Natural Landmark	Included trees, forest areas, wasteland areas, mountains, hills, cactuses, rivers, valleys, and rocks.
Agricultural Parcel	In the male map from Idganoudane, the map key had a symbol to indicate *acre*. Coded separately as an agricultural parcel because it is not naturally occurring, but contains natural elements such as crops and trees.
Road Segment	If a road switchbacked back and forth, each switchback was not counted separately, but rather counted overall as one road segment. If a continuous road had a road offshoot, the offshoot was counted as its own road segment. If a straight road forked into multiple roads and no continuous road could be determined, each segment was counted as its own. If two straight roads crossed each other, two road segments were counted, not four.
Written Label	The Arabic next to a geographic element that explained the meaning of that geographic element. Includes dream elements.
Arabic Commentary	Additional Arabic on the map, such as the Arabic in the legends, explanations for types of trees grown, suggestions for village improvements, gender, village name labels, additional information such as shops or mosques being closed, and lists of dream elements not attached to a geographic location.
Map Legends	Four of the sketch maps had legends that explained symbols used on the maps (male and female from both Idganoudane and Alhadyane).

This qualitative analysis employs descriptive codes, or category labels that were expressed through symbols and written labels by mapping participants and information about the facilitation of the sketch maps by Amina. The thesis researcher focused on coding map elements into site categories of natural or manmade elements, road segments,

agricultural parcels, and dream elements. She also coded the elements of map legends, written labels, and Arabic commentary to investigate literacy and formal cartographic map elements.

The thesis researcher began the coding process from the literature, particularly the work of Lynch (1960), who writes that mental maps contain five elements: paths, edges, nodes, districts, and landmarks. However, in conversations with HAF, research ideas centered around the differences in the mapping behavior of men and women, which led to a division of landmarks into natural or manmade features, with the idea the men and women might interact with these categories differently and assign them different levels of importance when drawing map elements. This theoretical framework was based on the availability of data, specifically that the sketch maps were done by groups of men and women. It was also based on a review of the literature about Moroccan gender dynamics and the researcher's experience living in Morocco.

The thesis researcher included road segments as a category based on the literature, especially the work of Lynch (1960), Appleyard (1970), and Huynh et al. (2010), and maintained that category throughout the process. She decided to code dream elements as a separate coding category, with agreement from Amina, after Amina revealed that map elements drawn in red are likely done so due to the process of map facilitation described previously. The researcher divided the written elements on the map into written labels and Arabic commentary after receiving the map document translations from Hassan and Kawthar. After surveying the translations, the thesis researcher saw that many items written on the maps are not simply describing what a spatial element is, but rather are

additional information explaining the broader context of the village, such as ideas for community improvements. She had discussions about illiteracy and the mapping behavior of women with Amina, who stated that women are sometimes more uncomfortable writing on the sketch maps. The written labels and Arabic commentary categories were divided based on this information and a review of the literature into illiteracy and educational levels in Morocco, covered in section 1.1, as well as the effects of education on sketch map quality and accuracy, covered in section 2.6.

The thesis researcher coded agricultural parcels as a separate category after receiving the map translations. She saw that one map from Idganoudane men (Figure 73) indicated a symbol to mean “acre” in their map legend. This is unique because this agricultural parcel indicator is a manmade item, but likely contains natural elements such as crops and trees. Finally, she included map legends as a category after discussions with Dr. Rice as to the unique nature of including formal cartographic map documents on the sketch maps. Evidently, the descriptive codes explained above are iterative. Categories were developed over time as more information about the sketch maps was uncovered through literature review research, conversations with Amina and Dr. Rice, and translations provided by Hassan and Kawthar.

Elements that were not included in the codebook were map labels written in English because they were likely written by a HAF staffer. There were also a few instances of labels not translated by Hassan or Kawthar due to difficulty reading the handwriting and faded ink. These labels were coded as written label, not Arabic commentary, because it is more likely these labels were connected to a nearby geographic

element than were suggestions and commentary on the community. Finally, areas of the map that were shaded with a color were not coded, for example, as seen in the men's and women's maps from Taghrit (Figure 55 and Figure 56) and the map from Ighil men (Figure 63).

The coding structure is distinct from that of Lynch (1960), whose structure does not include labels, written commentary, formal cartographic map elements, dream elements, or the distinction between landmarks into manmade and natural. His categories were important to the subsequent field of sketch map content frequency analysis and serve as a basis for this research, but specific to urban areas of developed countries and established in 1960. This thesis grounded the codebook in Lynch's research, but establishes original processes from a new perspective informed by the evolution of sustainable development, feminist geography, and the specific mission of this research to investigate HAF's questions into the difference in mapping behavior of men and women.

The codebook was created in Dedoose by writing descriptions, explanations, and examples of the coding categories within the program structure, and then replicated from the program into the codebook above (Table 1). The codebook was validated by HAF through ongoing conversations about what HAF wanted investigated in the research. An aspect of the codebook not validated by HAF was the division of written elements into written labels and Arabic commentary. This was done after receiving map translations and research into literacy in rural Morocco. In a future analysis, this aspect of the codebook would be ideally validated by HAF as well.

The analysis is a frequency count framework. This is done because the thesis researcher did not have access to alternative narratives and interviews of the original people who participated in the sketch mapping exercises. She had access to Amina El Hajjami, HAF's Director of Projects, who facilitated some of the sketch maps and could provide descriptions of their process and the sketch map results. Frequency counts best fit the available data. In future research, additional information from interviews and alternative narratives could be obtained if a researcher could be there at the time of mapping or follow-up interviews with original mappers could be done, which could prompt an adaption of the coding structure based on additional information uncovered. Frequency count analysis matches the available data as well as the research questions posed originally by HAF, who requested for this research to better understand the sketch mapping behavior of men and women of what items men and women tend to map.

The content frequency analysis was done to primarily address research questions 1 and 2. Question 1 queries what the sketch maps indicate about the geographical knowledge of local communities in Morocco. The content frequency analysis shows how men and women have knowledge of elements belonging to various categories in their communities. Question 2 explores the gender differences in this geographical knowledge in terms of content, which is studied by analyzing the differences in the frequency of mapped elements into descriptive categories. The subsequent discussion is built upon the assumption that people map more frequently what is important to them. The results of the analysis make space to discuss how sketch mapping might enhance participatory development.

3.8 Ethics

A consent form (Figure 91) from HAF is included in Appendix D, providing the thesis researcher permission to access, analyze, and publish the sketch maps as part of this research thesis. She has incredible gratitude towards HAF for their help and cooperation throughout this process, as well as the sketch map contributors from Ighil, Alhadyane, Boghrar, El Mellah, Lakliaa, Taghrit, and Idganoudane. This research would not been possible without any of you.

CHAPTER FOUR

Results

4.1 Village Naming Conventions

One notable result of this research is realizing how many different current spelling variations there are of village names in Morocco. These variations came from differences in spellings from the sketch maps, in translations by Hassan and Kawthar, from Amina when she originally sent the sketch map documents, from Google Maps, and from OSM. Table 2, containing the village name, commune, and province, approximate GPS coordinates, and spelling variations is below. The GPS coordinates are not authoritative locations of the sketch maps, but rather an educated guess by Amina and the researcher taken from Google Maps after the location identification process was complete.

Table 2 Name Variations

Village Name	GPS Coordinates	Other Name Spellings
Village Name: Lakliaa Commune: Inzgane-Ait Elloul Province: Souss- Massa	30.296992796226, -9.464535953822551	القليعة Lqliaa Dour lqliaa El kliaa
Village Name: Idougnane Commune: Toubkal Province: Taroudant	31.023358903272822, -7.836567971811474	أيكانودين Iguanoudine Idganoudine Idganoudane Idougnane
Village Name: El Mllah El Bahia Mokataa City: Marrakech	31.61969627483495, -7.982740268940625	ملاح El Mellah El Mallah Mlah Lmlah
Village Name: Ighil	30.98399295048489, -8.289026756996776	إيغيل Centre Commune Ighil Morocco مركز جماعة إيغيل
Village Name: Bodghrar Commune: Ait Oussif Province: Tinghir	31.387755952067888, -6.127178842609774	بوتغرار Boutaghrar Boudeghrar Bouteghrar Bou Tharar
Village Name: Alhadyane	Found nearby village Ouled Bouhanda: 32.51988018866121, -8.086107058523636	Alhadyan
Village Name: Taghrit	Found nearby village Ait Othmane: 31.15403627828457, -8.392106626428127	Tefrit

It was a challenge to identify village locations due to the plethora of name variants. In the case of Lakliaa, the village name was not specific enough to narrow down the region adequately. In the case of El Mellah, the neighborhood was easy to identify. However, the sketch maps contained elements outside of that specific neighborhood, so

the village name was similarly inadequate to determine the correct area of the sketch maps in Google Maps or OSM. In the cases of Taghrit and Alhadyane, Amina was unable to find the specific location of the villages in Google Maps, even after trying every name variation included in Table 2. In the cases of Ighil and Idganoudane, Amina and the thesis researcher did successfully identify the village locations. However, the sketch maps included elements outside of the boundaries of the villages. These challenges and various problems of map scale are discussed further in section 4.2, which covers the process the thesis researcher and Amina undertook to identify village locations.

4.2 Location Identification Process

Village locations were identified by Amina over Zoom. Amina shared her screen with the thesis researcher so she could see and record how Amina was searching for each village. Previously to this Zoom meeting, the thesis researcher attempted to find the village locations herself and was not able to identify any locations. Amina started with Boghrar; she stated that she had visited that village and knew the name of a hotel she stayed at. Using Google Maps, she searched for and found *Hotel Boutaghrar valley of roses - Kelaat Mgouna – Morocco*. The town name in Google Maps is not spelled Boutaghrar, but instead Bou Tharar.

Amina found El Mllah El Bahia Mokataa, a specific neighborhood in the city of Marrakesh, quickly. In Google Maps, the neighborhood is named *Mellah الملاح*. Amina then found the city of Lakliaa. Amina searched Google Maps for *Lakliaa* and found a place that is named Lakliaa, but different than the location of the sketch map. She knew the correct location was outside Agadir, so she scrolled south along R105 from Agadir

until she found the city, spelled *Lqliâa* in Google Maps. However, Lakliaa is a city, and it is evident the sketch maps were done in one specific neighborhood. The thesis researcher and Dr. Rice attempted to find the correct neighborhood within Lakliaa but were unable to find enough map elements in the OSM satellite imagery or Google Maps to determine the specific neighborhood mapped. Specifically, the thesis researcher and Dr. Rice tried to find a dam next to a river and a cemetery near a mosque. These identification challenges are further discussed in section 4.3.

Amina then searched for Idganoudane. On the sketch maps (Figure 61 and Figure 62), the Commune of Toubkal and Province of Taroudant is written, so Amina searched near Toubkal mountain on the edge of Taroudant Province. Although spelled *Idganoudane*, *Idougnane*, and *Idganoudine* in the sketch maps, the village is spelled *Iguanoudine* and أيكانودين in Google Maps. Amina found this village by searching within the general region until she saw the village name. In Google Maps, the village name in Arabic is أيكانودين. In Moroccan Arabic, the hard sound "g" exists and is spelled with the letter "gaf," or گ in Arabic script. Gaf is the letter "kaf," or ك in Arabic script, with three dots above. This sound is unique to Darija and indigenous Moroccan languages. In Google Maps, the village name is spelled with a kaf rather than a gaf. A kaf would make the village sound approximately like *Iykanoudeen,* rather than Idganoudine. The thesis researcher believes this village name is misspelled in Arabic in Google Maps. She knows the gaf letter is possible in Google Maps because the separate village of *Tagadirte* is spelled تگادیرت, with the gaf.

Amina then searched for the village of Ighil. She found a nearby commune in Google Maps that she knew is close to Ighil and searched along the river until she found the village. In Google Maps, the village is named *Centre Commune Ighil Morocco*, and مركز جماعة إيغيل in Arabic. Searching *Ighil* in Google Maps reveals at least five different possible locations. The sketch maps did not include additional commune or province information, so it was important that Amina knew the general region of the village and could identify the correct Ighil. On the women's sketch map (Figure 75), the nearby village of *Boulaabaq* is written, and there is a *Boulahebak* village nearby in Google Maps which supports the conclusion that Amina found the correct Ighil.

Amina then searched for the village of Taghrit. Although not written on the sketch maps, Amina knew that Taghrit is in the Al Haouz Province. She looked to the western edge of the province based on her memory of going to the village. From there, she could not find the village location of Taghrit by searching in either Arabic or English with various spellings. After the Zoom session, the thesis researcher searched further in the region for clues from the sketch maps. On the men's sketch map from Taghrit (Figure 68), *Amzmiz Road*, *Assif L'mal Road*, and *Road to Mejjat* are labeled. The thesis researcher found the city of *Majjat*, *Assif El Mal*, and *Amizmiz* in Google Maps. It appears *Assif El Mal* refers to both a village name and the name of a river. On the men's sketch map, there is a village of *Ait Otmane* written in the corner. The thesis researcher looked in this general region and found the village of *Aït Othmane*, or آيت عثمان. She assumes the village of Taghrit is nearby but cannot find the specific village in OSM satellite imagery.

Finally, Amina searched for the village of Alhadyane. In the men's sketch map (Figure 78), the communes of *Sidi Mansour*, *Sidi Ghanem*, *Sidi Abdellah*, *Rahamna,* and *Sokhour* are written on the peripheries of the map. Also, there is a prominent road crossing: a highway connecting *Casablanca* and *Marrakesh* intersects with a road connecting *Soukhour Rehamna* and *Sidi Ghanem*. Amina stated she had never herself been to Alhadyane. She looked at the highway connecting *Casablanca* and *Marrakesh* and found other communes mentioned on the map to get to the correct section of highway. She focused on road junctions in Google Maps, and found the general region, but was not positive about the location of Alhadyane village. She decided upon a village named *Oulad Bou Henda* as being a village likely in the general area of Alhadyane. On the men's sketch map (Figure 78), there is a village named *Ouled Tayebi* written, but the thesis researcher could not find this village within the general region. The thesis researcher could not find a more likely village location after the Zoom session.

There were many challenges in identifying village locations. The process would not have been possible without Amina, a local expert who speaks the native language and has traveled to many of the communities herself. Amina used many different strategies, including using multiple languages and spelling variations. She also relied on her local knowledge of the regions of Morocco where HAF works. This location identification process supports the conclusion that an outside researcher should rely on local experts to provide the necessary skillset and expertise.

The thesis researcher is confident Amina and she correctly identified the locations of Idganoudane, El Mellah, Ighil, and Boughrar. She is confident in the overall location

of Lakliaa but could not find the specific neighborhood. She is confident in the regions where Alhadyane and Taghrit are within, but not the specific village locations. The researcher compared the sketch maps of El Mellah, Idganoudane, Ighil, and Lakliaa to OSM satellite imagery and Google Maps data to investigate the topology of mapped features and attempted to identify sketch map elements and add them to OSM.

4.3 Topology of Mapped Features

Topology refers to the spatial arrangement of adjacent or neighboring mapped features. To analyze relative positioning, the thesis researcher looked at the general arrangement and patterns of mapped features that are nearby, connected, or adjacent. The researcher focused on identifiable features within the sketch maps and attempted to find them in Google Maps and OSM.

4.3.1 Lakliaa

In the women's map of Lakliaa, there is a cemetery and mosque with a road in between. The thesis researcher and Dr. Rice tried to find these elements in a similar geometric pattern in Google Maps and OSM to try to find the specific neighborhood within Lakliaa the sketch mapping took place. The section of the sketch map with the cemetery, mosque, and road is shown in Figure 2:

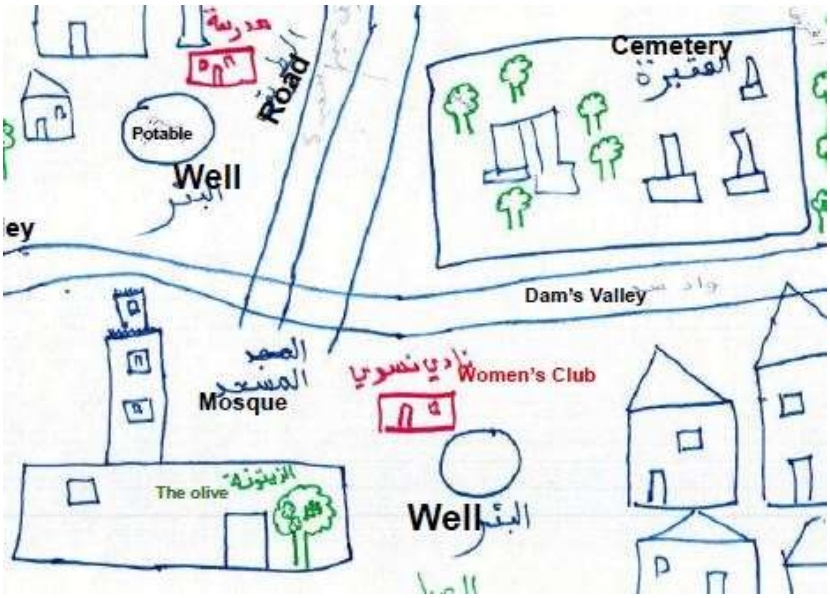

Figure 2 Cemetery, Road, and Mosque, Lakliaa Women

The thesis researcher found the following possibilities of a combination of road, cemetery, and mosque, as seen in Figures 3, 4, 5, and 6:

Figure 3 Mosque, Road, Cemetery in Lakliaa 1

Figure 4 Mosque, Road, Cemetery in Lakliaa 2

Figure 5 Mosque, Road, Cemetery in Lakliaa 3

Figure 6 Mosque, Road, Cemetery in Lakliaa 4

It is apparent there are many instances of road, mosque, and cemetery in the city of Lakliaa. The thesis researcher was unable to find other elements in the Lakliaa sketch maps to identify the correct neighborhood and therefore, the correct instance of mosque, road, and cemetery. The sketch mappers and HAF wrote the city name of Lakliaa on the sketch maps. However, it is evident that to find the correct sketch map location within Lakliaa, further identification is necessary. Discussion related to this challenge of map scale and specificity are further discussed in Chapter 5.

In both the men's (Figure 60) and women's (Figure 59) maps from Lakliaa, a river is featured. In the women's map, a dam is featured near the river. The thesis researcher thought it should be possible to find the dam as there are few dams in the

region. However, the closest dam she could find, named Khemis de Biaoudine, is approximately 65 km away, putting it well outside the city boundaries of Lakliaa and therefore, unlikely to be the correct dam. There are no additional dams in Lakliaa or the surrounding area. Finally, both maps noted a river. In both Google Maps and OSM, there is a river north of Lakliaa, approximately 7.5 km away, named *Oued Sous*. However, this river does not pass through the city of Lakliaa, as both sketch maps show. It is possible that the sketch maps show not the river *Oued Sous*, but rather an irrigation channel that does not appear in the satellite imagery due to lack of resolution or time of year.

4.3.2 El Mellah

The thesis researcher next focused on the El Mellah neighborhood in Marrakesh (Figure 7). This neighborhood is well populated with data in both Google Maps and OSM. The thesis researcher attempted to find the elements of Bab El Mellah, Menchora Street, Mimouna Oum Moumimine School, and the Garden from the male map of El Mellah (Figure 69). She started with Bab El Mellah because it is a location with a formal name. However, Bab El Mellah did not appear in OSM data. When searching Google Maps for “Bab” (ceremonial door), she found ten instances of Bab, none of them named Bab El Mellah, as seen in Figure 7:

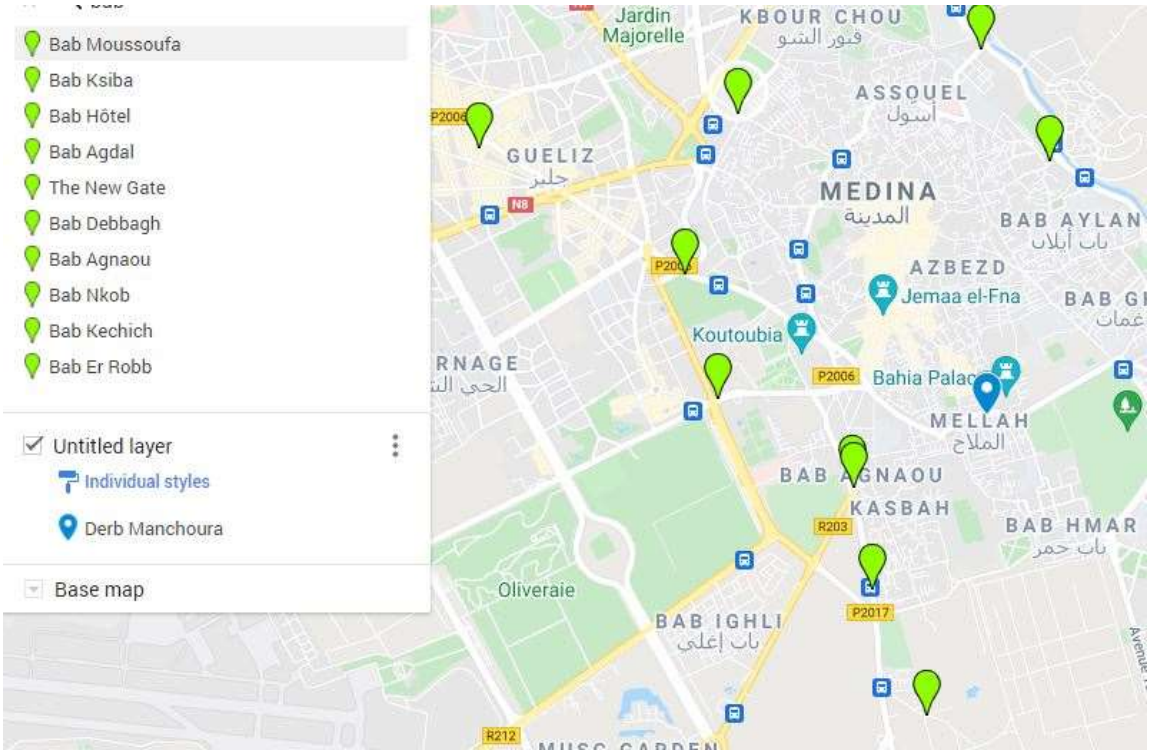

Figure 7 Instances of "Bab" near the El Mellah Neighborhood (My Maps, Google)

The thesis researcher also tried to find the Garden, Oum Moumimine School, and Menchora Street. In Google Maps, she identified Derb Manchoura, Jardin de Rosier, and Ecole El Mouminine, all in the general El Mellah neighborhood. The three identified locations are shown in Figure 8:

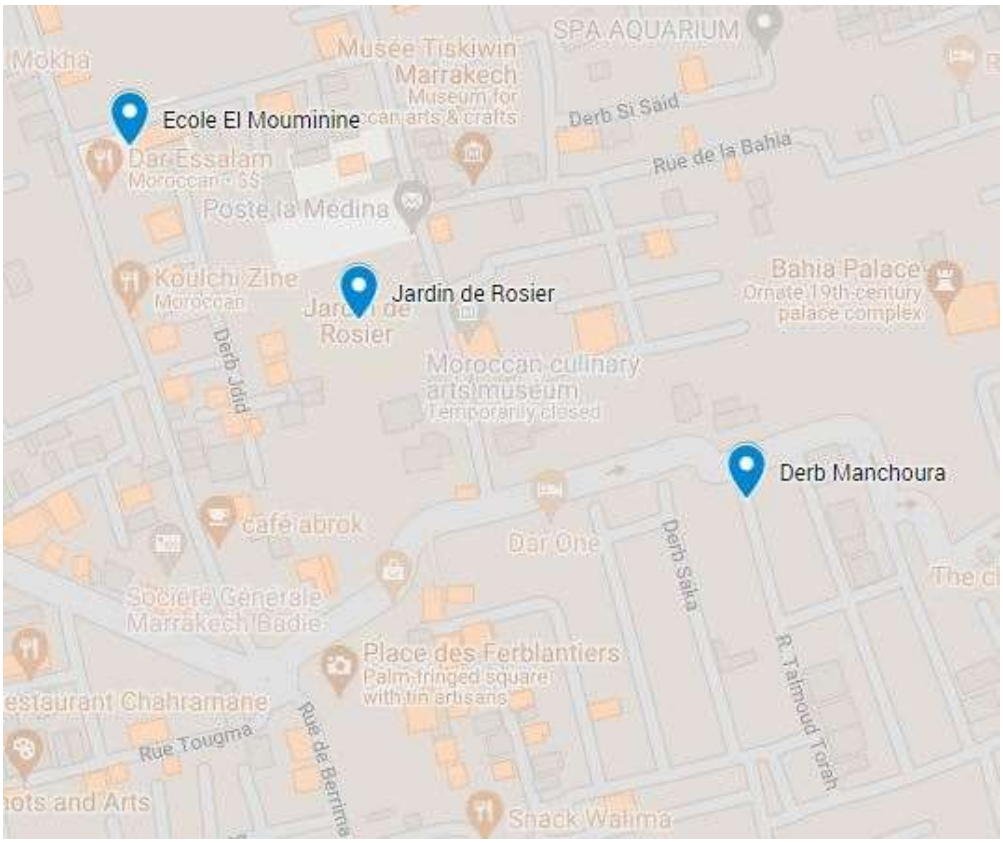

Figure 8 Ecole Mouminine, Jardin de Rosier, and Derb Manchoura (My Maps, Google)

However, the sketch maps show that Oum Moumimine School should be above Derb Manchoura, and the Garden should be located directly below Derb Manchoura, as seen in the male sketch map of Figure 9:

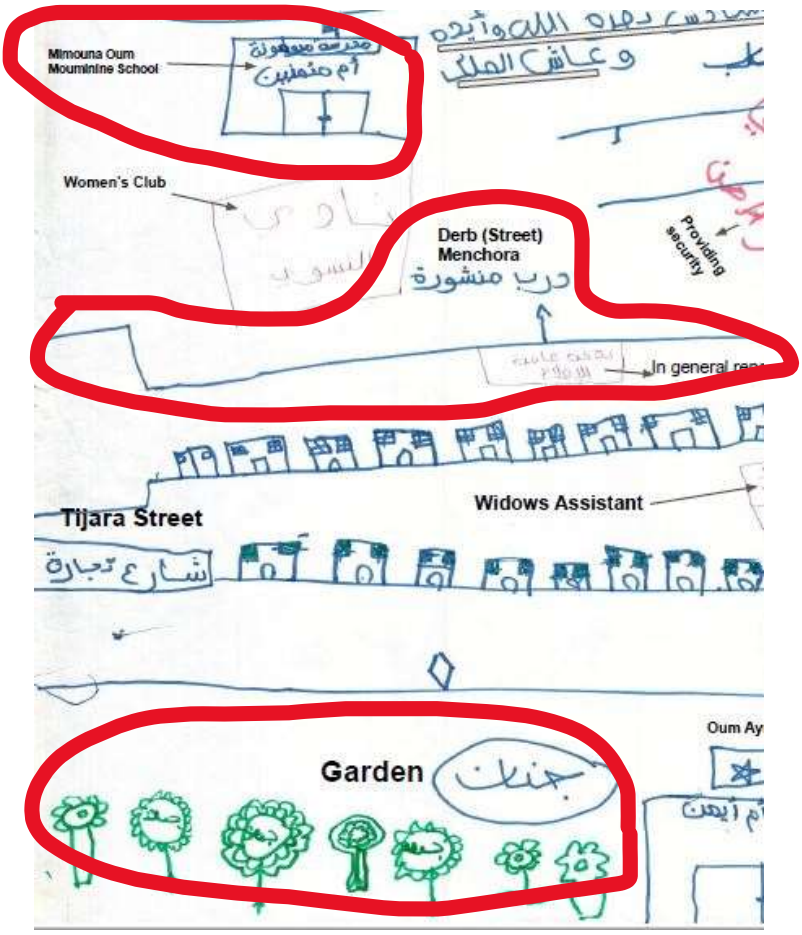

Figure 9 Mimouna Oum Moumimine School, Derb Menchoura, and Garden (El Mellah, Men)

Though the thesis researcher found possible sketch map elements, there is still uncertainty matching the sketch map elements to the Google Maps data. The school names are similar between the sketch map and Google Maps, but not identical. Further, the name of the garden is not included on the sketch map. There are multiple other gardens and green spaces in the general area, meaning the label "garden" was not adequate to authoritatively connect it with one specific garden. Derb (Street) Menchora was the only feature on the sketch maps that the researcher was fully confident she correctly matched with the digital map data.

4.3.3 Ighil

The thesis researcher looked next at Ighil, a small mountain village that Amina confidently identified in Google Maps. Based on the OSM satellite imagery, the thesis researcher identified the likely location of a mosque due to the shadow of the minaret and labeled it as such in OSM, as seen in Figure 10:

Figure 10 Ighil Mosque (Bing Ariel Imagery)

On both Ighil sketch maps, there appears to be a river drawn adjacent to the mosque, as seen in Figure 11:

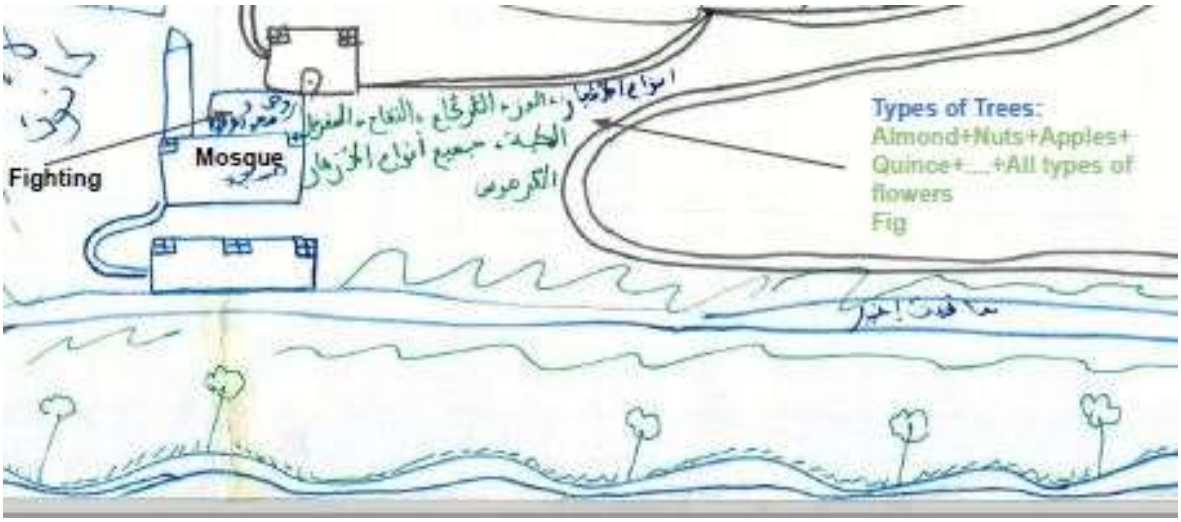

Figure 11 Mosque and River, Ighil Men

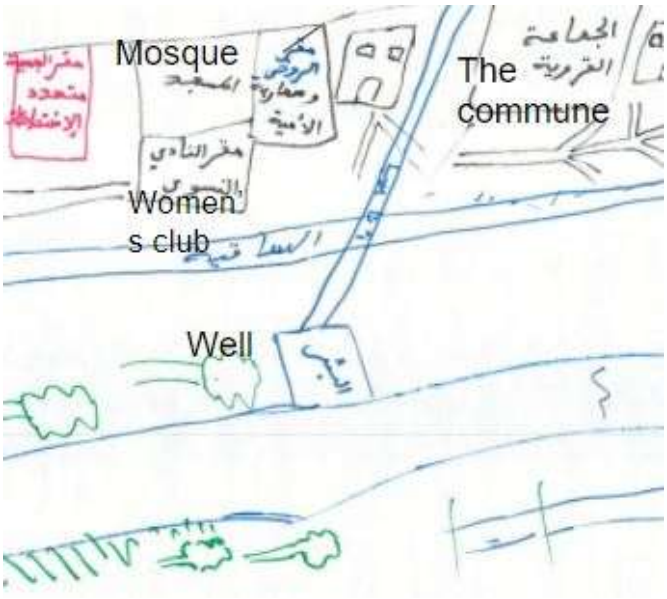

Figure 12 Mosque and River, Ighil Women

In investigating OSM, there appears to be a river by the mosque of Ighil with an area with trees between them, as seen in Figure 13:

Figure 13 Ighil Mosque, River OSM (Bing Ariel Imagery)

On the women's sketch map of Ighil (Figure 75), Boulaabaq village is drawn down the main road from Ighil, between the road and the river. This appears to be the case in Google Maps, as seen in Figure 14:

Figure 14 Ighil and Boulahebak Villages (Google Maps)

The thesis researcher added the village of Boulaabaq to OSM using the spelling from the sketch maps, rather than the Google Maps data. These two village locations allowed the researcher to reorient the sketch map to generally to match the satellite imagery, as seen in Figure 15:

Figure 15 Women's Map Ighil, Reoriented

The researcher then focused on the other side of the river and attempted to find the villages of *Izrane* and *Azerdine*, which are written in the peripheries of the women's sketch map. Interestingly, this zigzag road and additional peripheral villages were absent in the men's sketch map. This could reveal that these villages have some importance to

the women of Ighil that the men do not share. Follow up interviews with the original mapping participants would be needed to research this further. The thesis researcher noted a zigzag shaped road segment in the female map, as seen in Figure 16:

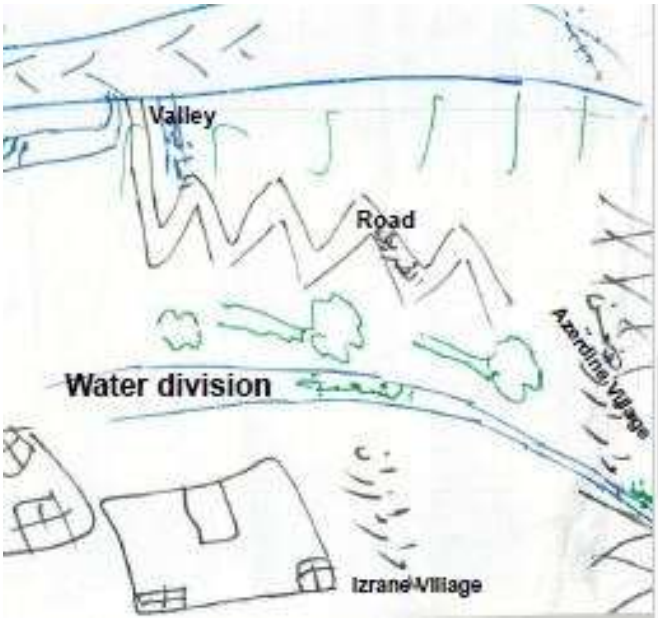

Figure 16 Zigzag Road, Ighil Women

She identified a similar road segment in OSM, across the river from Ighil, as seen in Figure 17:

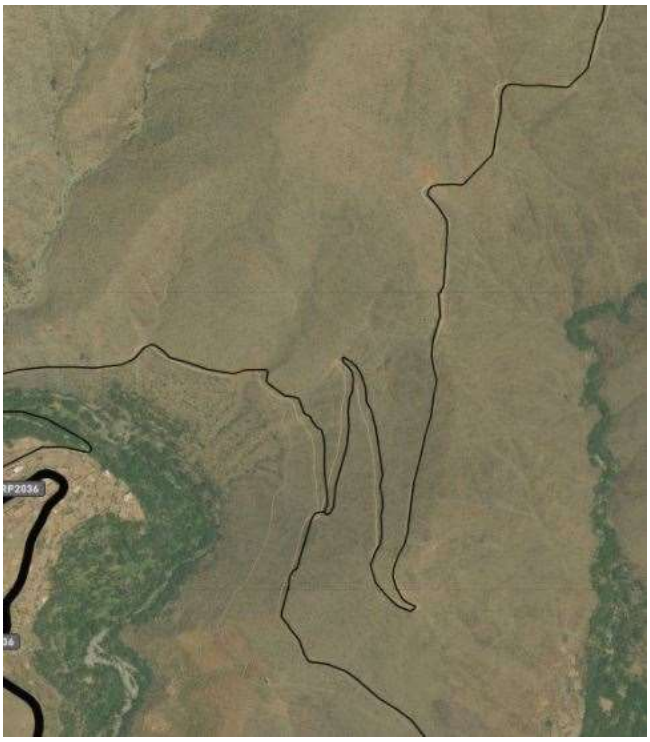

Figure 17 Ighil Road Segment, Google Maps

In the sketch maps, the village of Azerdine appears at the end of the zigzag road. Izrane appears to be to the right of the road. The researcher added Azerdine and Izrane as village point features in OSM; there were already designations of "resident area" in both village locations. The village locations are seen in Figure 18:

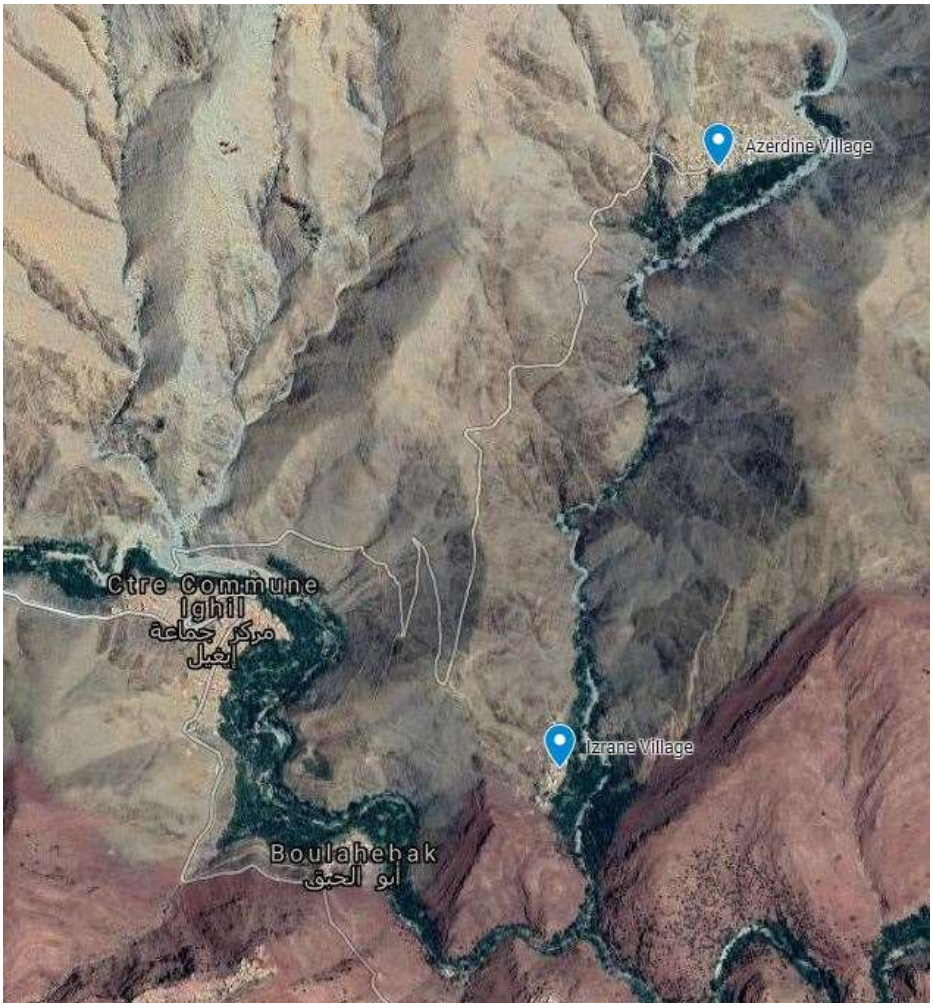

Figure 18 Azerdine and Izrane (My Maps, Google)

The thesis researcher feels relatively confident about the placement of these villages based on the drawing from the women's sketch map. However, she would feel more confident if the men's sketch map also showed the zigzag road, Izrane, and Azerdine. She would only feel fully confident if ground truthing was done, either by herself, another researcher, HAF, or a community member. There is definite subjectivity to matching sketch map elements to OSM data. This is discussed further in section 5.2.3.

The thesis researcher attempted to find additional map elements in Ighil, including the school, market, and hospital. There were variations between the two sketch maps in the relative positions of the hospital, school, and market. The men's map has the hospital, market, and school at the end of two branching roads from the main road, shown in Figure 19:

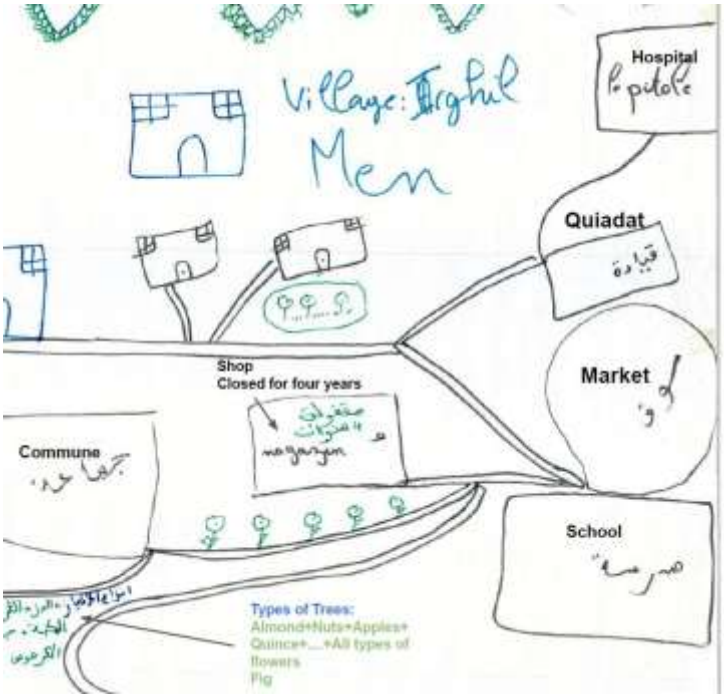

Figure 19 Hospital, Market, School Ighil Men

Ighil women drew the hospital, market, and school adjacent to the main road, as seen in Figure 20:

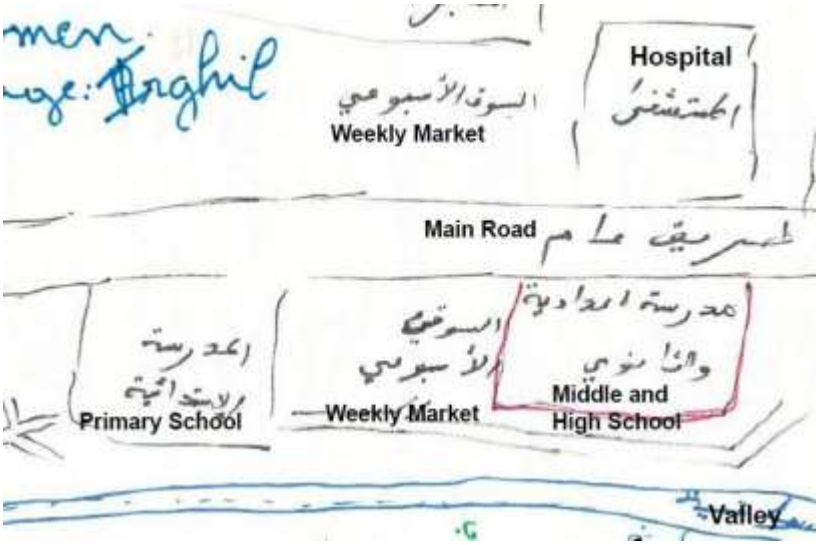

Figure 20 Hospital, Market, School Ighil Women

Due to the differences in the sketch maps, the researcher was unable to authoritatively match these map elements to the satellite imagery and add them to OSM.

4.3.4 Idganoudane

The thesis researcher then focused on the village of Idganoudane. She added the village as a point feature in OSM in the same location Amina identified in Google Maps. A river and a road were already mapped in the village area. In the women's sketch map, there is a notable section where the main road crosses a river, as seen in Figure 21:

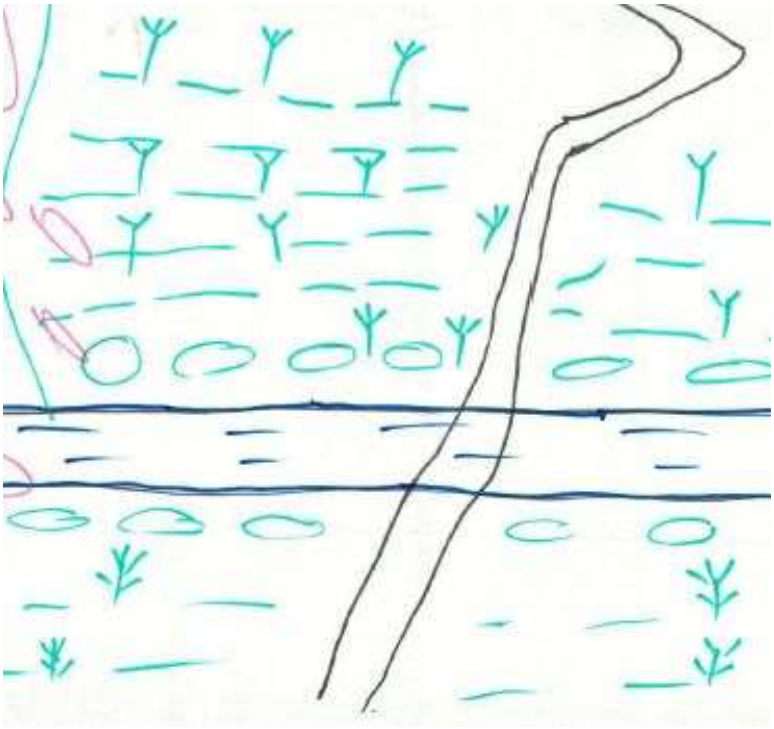

Figure 21 Idganoudane Women, River Crosses Road

In the satellite imagery, the main road appears to run next to the river. There is a road and river crossing in the next village down from Idganoudane, *Amsouzart*, as seen in Figure 22:

Figure 22 Idganoudane River and Road Crossing, OSM (Bing Ariel Imagery)

The river and road in the sketch map appear to be perpendicular to each other, whereas in the satellite imagery, the main river and road are parallel. There are a number of small roads branching off from the main road in the men's map. The thesis researcher attempted to find these roads and other map elements in the satellite imagery, including the mosque and cemetery. She was unable to identify any of the map elements because the village is highly covered by a tree canopy for all satellite imagery layers in OSM.

In the women's sketch map of Idganoudane (Figure 61), there are notable elements drawn with differing translations between Hassan and Kawthar. Kawthar translated a label as *Almgal Village, Commune of Toubkal*, whereas Hassan translated it as *Toubkal Mountain*. For a nearby map element, Kawthar translated it as *reservoir*, whereas Hassan translated it as *public oven*. Due to these translation differences, the meaning of the sketch map elements are unclear. The researcher looked at the location of Toubkal Mountain because Almgal Village is unlabeled in OSM and Google Maps. She noted a reservoir between the mountain and the village. These three locations are seen below in Figure 23:

Figure 23 Toubkal, Reservoir, and Village (My Maps, Google)

These elements could be the ones noted in the women's sketch map, but it is not authoritative due to translation differences. In the men's sketch map (Figure 73), Toubkal Mountain, reservoir, public oven, and Almgal Village are not mapped.

The thesis researcher believed she would be able to identify many features from each sketch map where Amina identified the village location. However, the reality of matching sketch map elements to satellite imagery on OSM and Google Maps proved more difficult than expected. Potential reasons for the challenge include tree canopy cover, differences in sketch map translation, differences between the men's and women's sketch maps, variations in naming conventions, issues determining the scale of the sketch maps, and inaccuracies in the relative positioning of the sketch map elements. These reasons and their broad implications are further discussed in Chapter 5.

4.4 Map Element Orientation- Overhead and Oblique Views

The thesis researcher analyzed the orientation of sketch map elements for whether elements were drawn with an oblique or overhead view. Mosques appear to be mapped almost always from an oblique view with a visible minaret, except in two cases: the women's map of Ighil (Figure 64), and a dream element in the men's map of El Mellah (Figure 57). Additionally, mountains are always mapped using an oblique view where the map reader can see the rise of the mountain with a peak at the top. Trees are also mapped from an oblique view; the trunk of the tree and the top are visible. Elements that appear to be mapped always using an overhead view are roads, cemeteries, wells, soccer fields, and rivers.

Houses appear to be mapped both overhead and obliquely. Houses are mapped with an overhead view in five maps (Figure 67, Figure 72, Figure 74, Figure 77, and Figure 78). In five maps, houses are mapped with an oblique view (Figure 69, Figure 71, Figure 73, Figure 74, and Figure 75). The men's map from Taghrit (Figure 68) shows houses mapped both with an oblique and overhead view. The map of El Mellah women (Figure 70) shows no houses mapped. There are four maps with map legends, and in three of those maps from Idganoudane women (Figure 61), Alhadyane women (Figure 65), and Alhadyane men (Figure 66), houses are mapped with an overhead view. In the last map with a map legend from Idganoudane men (Figure 62), the houses are two-dimensional boxes, which would suggest an overhead view, but there are doors and windows on top, which suggests a 90-degree mental rotation of the houses. Schools are also mapped both overhead and obliquely. In five maps, schools are mapped with an overhead view (Figure 67, Figure 75, Figure 76, Figure 77, and Figure 78). In four maps, schools are mapped with an oblique view (Figure 68, Figure 69, Figure 71, and Figure 74).

4.5 Map Element Scale and Distortion

There are various indications of scale in the maps. The relative size of map elements are distorted. In many cases, map scale is distorted from the center of the maps to the boundaries. Manmade elements, like schools, houses, and mosques, appear to be generally smaller relative to certain natural features. Natural features, such as trees, are significantly larger than houses in many cases. For example, this tree and mosque

(without resizing) appear on the same map of Taghrit men (Figure 56) as shown below in Figures 24 and 25:

Figure 24 Taghrit Men Tree

Figure 25 Taghrit Men Mosque

The same relative sizing appears in this women's map of Alhadyane (Figure 65). The box on the left of the figure contains four houses. The drawing of the trees are significantly larger than the houses, as seen in Figure 26:

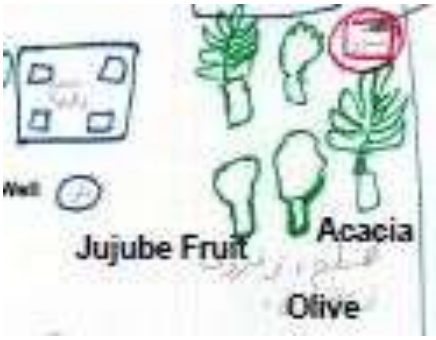

Figure 26 Relative Sizing Trees and Houses, Alhadyane Women

Mountains, if included, are on the peripheries of the sketch maps, and are drawn much smaller than would be possible in reality, as seen in the men's map of Ighil (Figure 63), shown in Figure 27 below:

Figure 27 Relative Sizing House and Mountain, Ighil Men

In many of the maps, nearby villages, communes, and mountains are drawn in the sketch map peripheries. These villages are not placed in terms of metric distance but are included to provide meaning by placing the village's location relative to nearby villages important to the sketch mappers. In Figure 28, the nearby village of *Ait Otmane* is noted in the men's map of Taghrit:

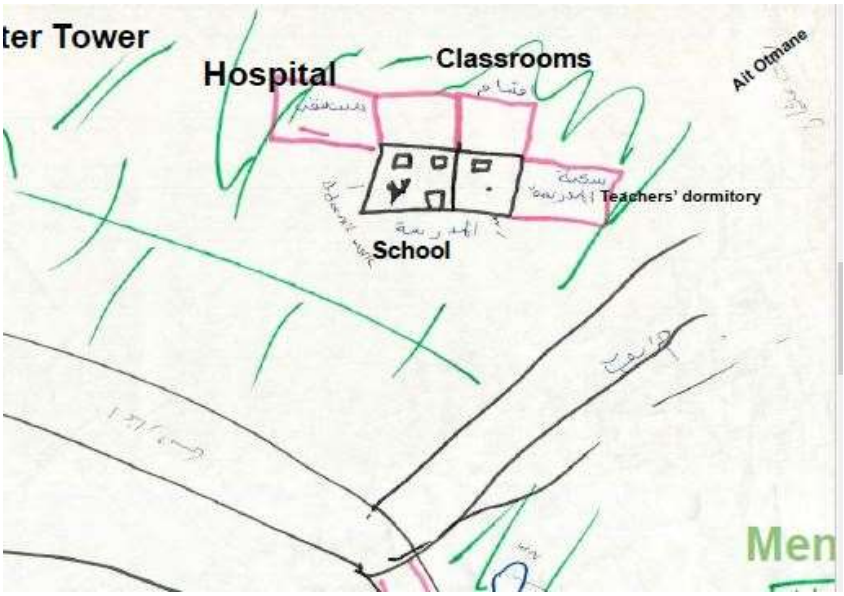

Figure 28 Border Village, Taghrit Men

The outlying village of *Ben Mbarek* village is noted in Figure 29 in the men's map of Lakliaa:

Figure 29 Border Village, Lakliaa Men

And the outlying communes of *Sidi Mansour* and *Sidi Ghanem* are noted in Figure 30 in the men's map from Alhadyane:

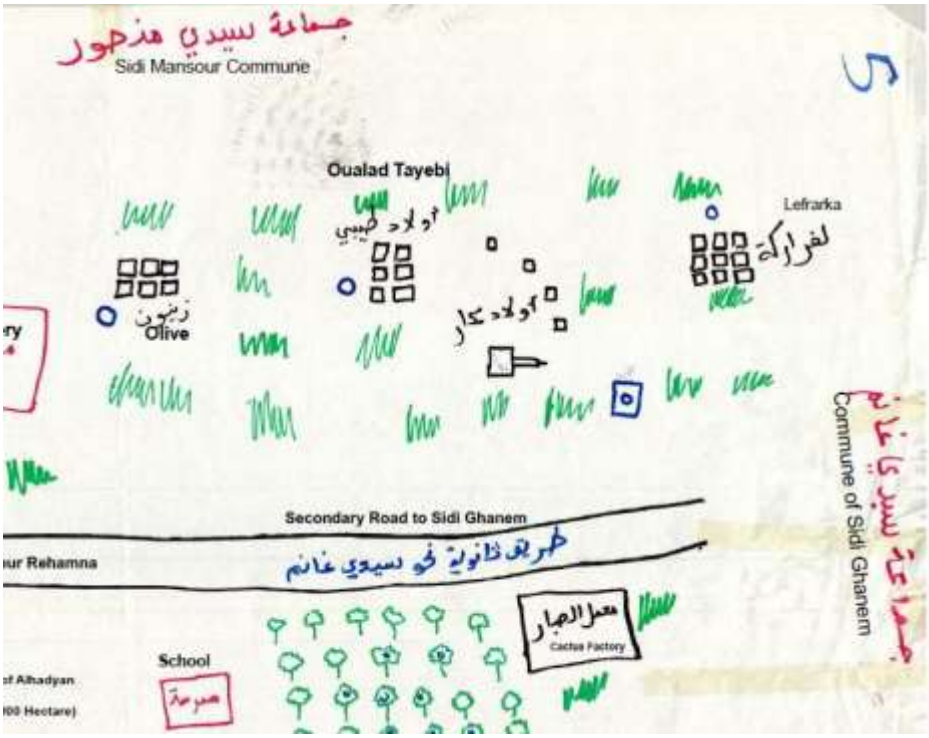

Figure 30 Border Villages, Alhadyane Men

In the men's and women's sketch maps from Idganoudane (Figure 61 and Figure 62), Ighil (Figure 63 and Figure 64), and the women's map from Taghrit (Figure 55), mountains are drawn on the edges of the paper. Sketch mappers could draw peripheral villages and mountains to note their general direction from the sketch map community. These outlying villages and mountains are useful for the orientation of the sketch map documents relative to satellite imagery, as seen in the process of identifying sketch map elements in OSM for Ighil. One scale may be used for the village itself, but another used on the map peripheries to provide a more regional view of the village position relative to other nearby villages and natural features. In the same map document, scale changes in various parts of the paper, presumably to allow the sketch mapper to add more meaning

to the document. This tells the map reader that the sketch contents, including the relative direction of nearby landmarks, was more important to the mappers than scale and positional accuracy. This is discussed further in section 5.2.4.

4.6 Relative Positioning of Map Elements

There are many differences in relative positioning and orientation between the men's and women's sketch maps of the same community. For example, the maps from Idganoudane show striking difference in the relative position of the cemetery relative to the main road and the mosque. The women's map shows the cemetery far away from the main road, to the left and above the mosque, as seen in Figure 31:

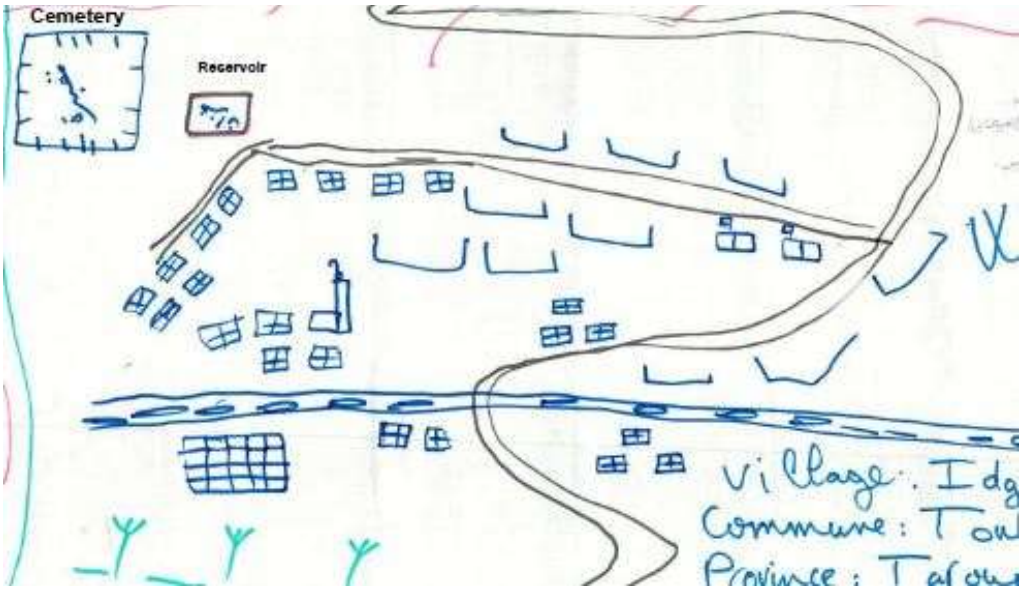

Figure 31 Cemetery, Mosque, Road Idganoudane Women

The map from Idganoudane men shown in Figure 32 shows the cemetery to the right of the main road, neither above nor below the mosque:

Figure 32 Cemetery, Road, Mosque Idganoudane Men

These differences reveal the difficulties of matching map elements from the sketch maps to OSM. Even if the thesis researcher found the likely location of the cemetery in satellite imagery, she would be unlikely to label it due to the discrepancies in the relative positioning. Similar relative positioning differences are found in the mapping of mountains in the Idganoudane sketch maps. The main road in both sketch maps are in similar positions, running from the top of the paper to the bottom. The mountains in the women's map are drawn at the top of this road, stretching along the top edge of the paper, as seen in Figure 33:

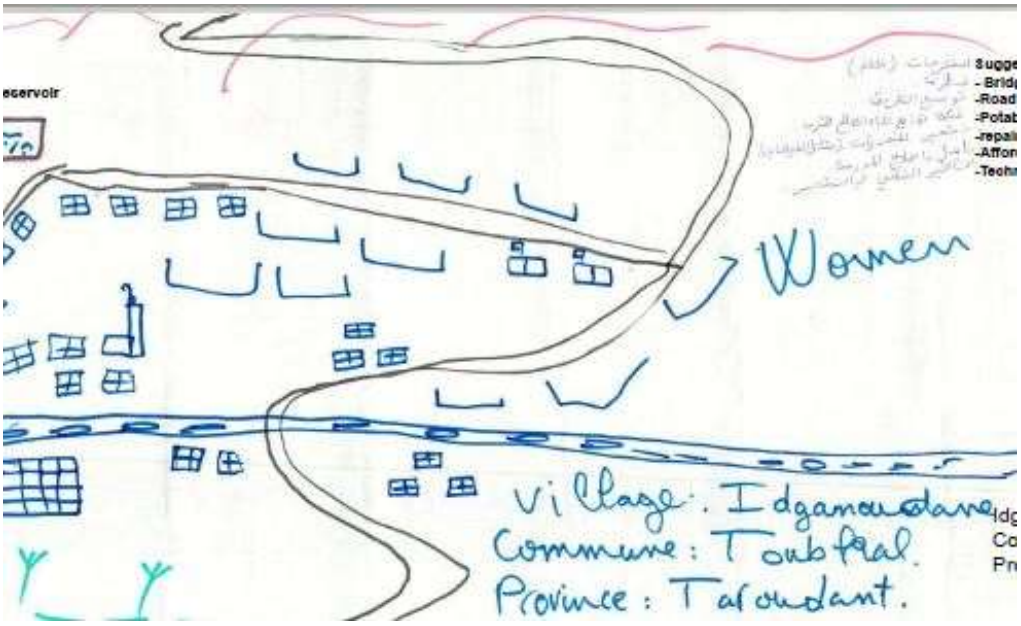

Figure 33 Mountains, Idganoudane Women

The mountains drawn on the men's map are to the right of the main road, stretching along the right side of the paper, as seen in Figure 34:

Figure 34 Mountains, Idganoudane Men

The mappers could have been drawing completely different ranges of mountains, both omitting the mountains the other group chose to draw. Perhaps one range of mountains is important to men, while the other range is important to women. Perhaps the men and women drew the same mountains but had different ideas of where those mountains are located relative to the road and other map elements.

Similar relative positioning discrepancies were addressed previously in the relative positioning of the hospital, market, and school relative to the main road of Ighil. Men drew the hospital, market, and school in a vertical line to the right of the main road

at the end of two road branches (Figure 19). Women drew the hospital, market, and school adjacent to the main road, with the hospital above the road, the market both above and below the main road, and the school below the road (Figure 20).

In the sketch maps of Lakliaa, men and women drew different relative positions of the road, river, and mosque. Men drew the river above the road, with their positioning generally parallel, with the mosque in between, as seen in Figure 35:

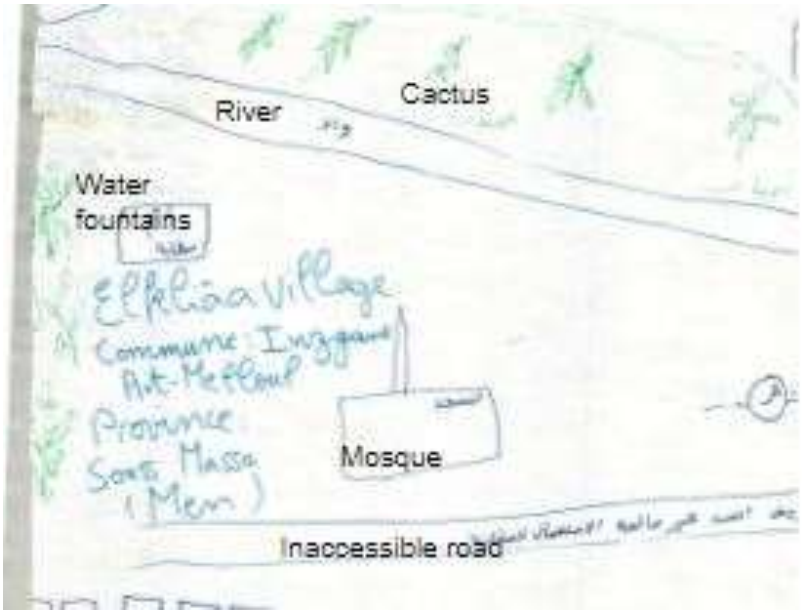

Figure 35 Mosque, Road, and River, Lakliaa Men

Women drew the river and road perpendicular, with the mosque below the river, as seen in Figure 2.

The differences in relative positioning of the same features in the sketch maps made identifying map elements in OSM difficult. The researcher originally thought she would be able to find multiple elements in OSM for the locations Amina was able to

conclusively identify. However, in the process of comparing the sketch maps to OSM satellite imagery, it became clear that the discrepancies in relative positioning of sketch map elements introduced a layer of uncertainty to match elements. Rectifying positional discrepancies would require follow-up interviews with original map participants, repeated community mapping, or ground truthing done by HAF, community members, or a future researcher. This is further discussed in Chapter 5.

4.7 Formal Map Elements

Formal map elements are included in a few instances in the sketch maps. As previously mentioned, four maps of Idganoudane men and women (Figure 61 and Figure 62) and Alhadyane men and women (Figure 65 and Figure 66), included a map legend, as seen below in Figures 36, 37, 38, and 39:

Figure 36 Legend Alhadyane Men

Figure 37 Legend Alhadyane Women

Figure 38 Legend Idganoudane Women

Figure 39 Legend Idganoudane Men

Including formal map elements, such as legends, implies mappers are familiar with formal cartographic map products. It is unclear what previous cartographic products the mappers have been exposed to. These questions go unanswered in this thesis but are addressed in section 5.7 in the discussion of potential future work.

Some maps included examples of distance, areal, or depth measurements. In the men's sketch map from Idganoudane, acreage was noted with the box symbol as seen below in Figure 40:

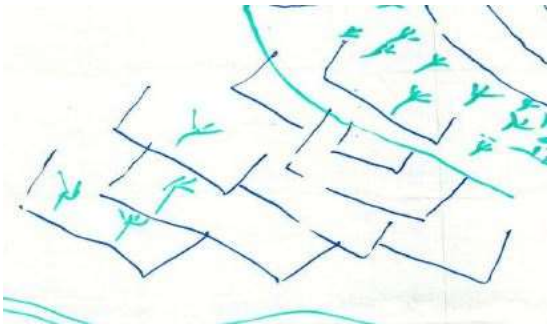
Figure 40 Acreage, Idganoudane Men

The men's map from Taghrit included several distance, areal, and depth measurements, including a well depth of 25 m and length of 1.5 m, road length of 3k m, and distance from a well to the water tower of 200 m, shown in Figure 41:

Figure 41 Distance, Areal, and Depth Measurements, Taghrit Men

Distance, areal, or depth measurements are an indication of scale unseen in the other sketch maps. This could indicate that Taghrit men had done or participated in measuring these distances and depths previously, perhaps with HAF or on their own for unknown purposes. The men's desired development project could be related to these measurements, prompting them to include it on the sketch maps for the subsequent process of resource identification, needs assessment, and priority rankings as outlined in Chapters 1 and 3. Doing follow-up research in Taghrit with the original sketch mappers could provide clarity into this question, and is discussed in Chapter 5.

4.8 Symbols

There are trends in the ways sketch mappers mapped certain elements in terms of the symbols and colors they used. As discussed previously, mosques had a very

consistent symbolic representation, with an evident minaret shown with an oblique view. Houses were drawn with squares and rectangles. To show an oblique view of houses, windows and a door were drawn on top of the square or rectangle. Only in one case, the men's map of Idganoudane (Figure 62), were houses drawn with a three-dimensional oblique view. Interestingly, in the women's map of Lakliaa (Figure 59), the houses have pointed roofs on top of the square bottom. This style of house is very uncommon in Morocco, where houses usually have flat roofs. These mappers could be copying symbols of houses seen previously, or the houses in Lakliaa could truly have triangular roofs. Google street view is not available for Lakliaa and ground truthing is not possible at this time.

Wells were drawn from an overhead view with a blue circle in most cases. In one case from Ighil men, a well was drawn with a rectangle. Rivers were also always drawn with an overhead view with two parallel lines. In all cases except the men's map from Idganoudane (Figure 73), where the river was drawn in green, rivers were drawn in blue. In the women's map of Idganoudane, water features were drawn in blue with parallel lines. However, the river was distinguished from the irrigation system by filling in the space between the parallel lines differently. This is shown in the map legend (Figure 38).

Common symbols are used to represent trees in all legends: an oblique view with a visible trunk and treetop. The villages of Lakliaa and Alhadyane also have cactuses. Cactuses were drawn using green in all cases, but have different symbolic representations, as is shown in Figures 43, 43, 44, and 45:

Figure 42 Cactus, Lakliaa Men

Figure 43 Cactus, Lakliaa Women

Figure 44 Cactus, Alhadyane Women

Figure 45 Cactus, Alhadyane Men

The different symbolic representations could be because the types of cactuses look different between regions of Morocco. Men and women could have decided between

drawing individual cactuses and areas covered by many cactuses. It is likely there are more cactuses in reality than are drawn individually in the maps. There is a possibility that mappers drew a singular cactus or tree to represent multiple cactuses and trees. These mental simplifications are unknown and would require follow up interviews with mapping participants to understand exactly what these natural features represent.

Roads are commonly represented in the map legends as two parallel lines in blue or black ink. In the men's map of Idganoudane (Figure 73), the main road is distinguished from small roads with differences in the space between the parallel line. The main road has nothing in between the parallel lines, which are spaced relatively farther apart from each other. The small roads' parallel lines are relatively closer to each other and have small perpendicular lines. Mountains are symbolized in the maps of Taghrit, Idganoudane, and Ighil. In all cases, they are drawn obliquely with a triangular shape, showing a broader base and a peak at the top. They are symbolized using all colors: blue, green, black, and red. The symbolic representations of map elements changed between maps. The thesis researcher relied on the translated labels, map legends, information from Amina, and her own judgement based on her assumptions about what drawings were likely to represent. This process was subjective and could include errors. Errors in interpreting symbolic representations of map elements could affect the content frequency analysis, covered in the section 4.9. This is discussed further in Chapter 5.

The colors mappers used are generally determined by HAF, who give broad guidelines in their mapping sessions to map natural features in green, infrastructure in blue and black, and dream elements in red in. However, all the maps but one show water

features not mapped in green, as would follow the guideline as a natural feature, but in blue. It is unknown how mappers would choose colors to correspond to various elements if given no instructions. This could be a topic for future research.

There are inconsistencies in mapper's use of red ink. Amina stated that red is meant to represent dream elements. However, there are certain maps that include red in ways that are very unlikely dream elements. For example, the women's map of Idganoudane (Figure 74) shows mountains and rocks in red. The thesis researcher did not code these as dream elements because they were included in the map legend in red ink, and she felt it was very unlikely mappers would dream of the future existence of mountains or rocks. In the men's map of Alhadyane (Figure 78), the peripheral villages and cities are labeled in red. As they exist in reality and the thesis researcher thought it unlikely mappers would be dreaming of nonexistent cities with the same names, she did not code these as dream elements. Evidently, there are inconsistencies in the use of red to mean dream elements. The researcher used her best judgement in interpreting colors to code elements, relying more on the symbol, labels, and broad context to decide how to categorize elements for the content frequency analysis to determine gender trends in sketch mapping, covered in the section 4.9.

4.9 Qualitative Content Frequency Analysis

In this section, the qualitative content frequency analysis of the 12 sketch maps is presented. Content frequency analysis on the 12 sketch maps was done in Dedoose. As covered previously in section 3.7, the coding categories were manmade landmarks, natural landmarks, written labels, Arabic commentary, road segments, dream elements,

map legends, and agricultural parcels. The map elements were coded considering the subjectivity described in the previous section.

4.9.1 Code Count by Gender

Figure 46 and Table 3 shows the count of each code category by gender. At the bottom of Table 3 is the total code count by gender:

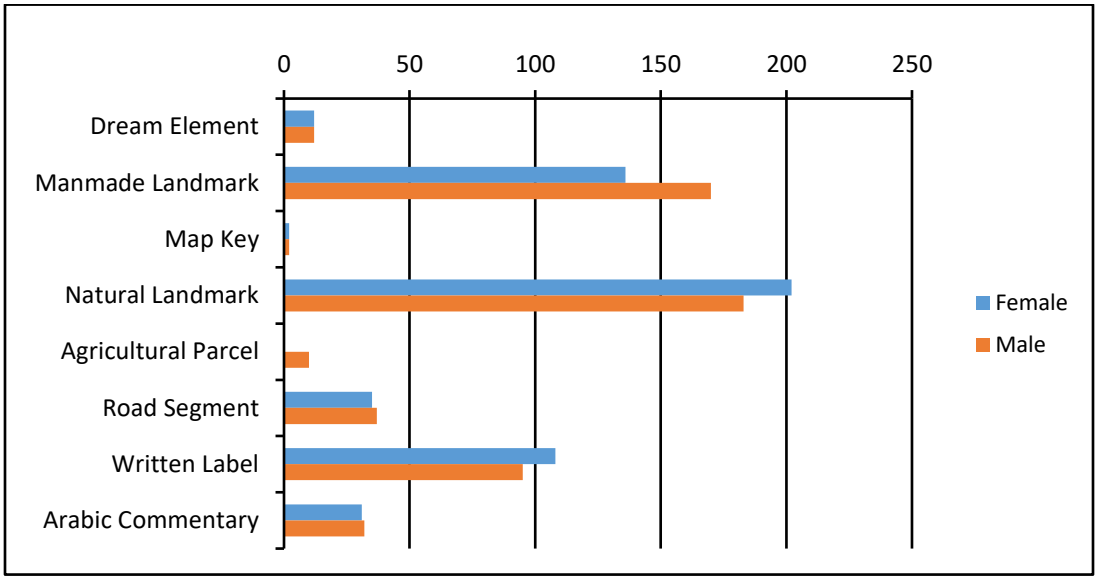

Figure 46 Code Count X Gender

Table 3 Code Count X Gender

	Female	Male
Dream Element	12	12
Manmade Landmark	136	170
Map Key	2	2
Natural Landmark	202	183
Agricultural Parcel	0	10
Road Segment	35	37
Written Label	108	95
Arabic Commentary	31	32
Total Count	**526**	**541**

Overall, men and women added relatively similar amounts of data to the sketch maps, with men adding slightly more elements than women. Natural landmarks saw the most data added, followed by manmade landmarks. The researcher hypothesized that men would add more natural landmarks than women, which was not supported by the data, as women added more. The researcher hypothesized that women would add more manmade landmarks then men, which was also not supported by the data; men added more manmade landmarks to the sketch maps than women.

The researcher hypothesized that men would add more road segments than women because they traditionally spend more time outside of the home and potentially travel to other places more than women. Men did add more road segments to the maps than women, but only slightly at 37 segments to women's 35 segments. Women added more written labels to the sketch maps than men, which does not support the original hypothesis that men would add more writing to the sketch maps as women are more likely to be illiterate or unschooled. Men added more Arabic commentary than women by one count, which does not strongly support the hypothesis that men might feel more comfortable sharing opinions and proposing community changes.

As mentioned previously, Idganoudane men were the only group to add agricultural parcels. This group, as well as women from Idganoudane and men and women from Alhadyane, were the only groups to add map legends. Finally, men and women added the same amount of dream elements. The dream elements and the specific community improvement ideas is discussed in section 5.7.

4.9.2 Code Count by Village

Figure 47 and Table 4 shows the overall code count by village:

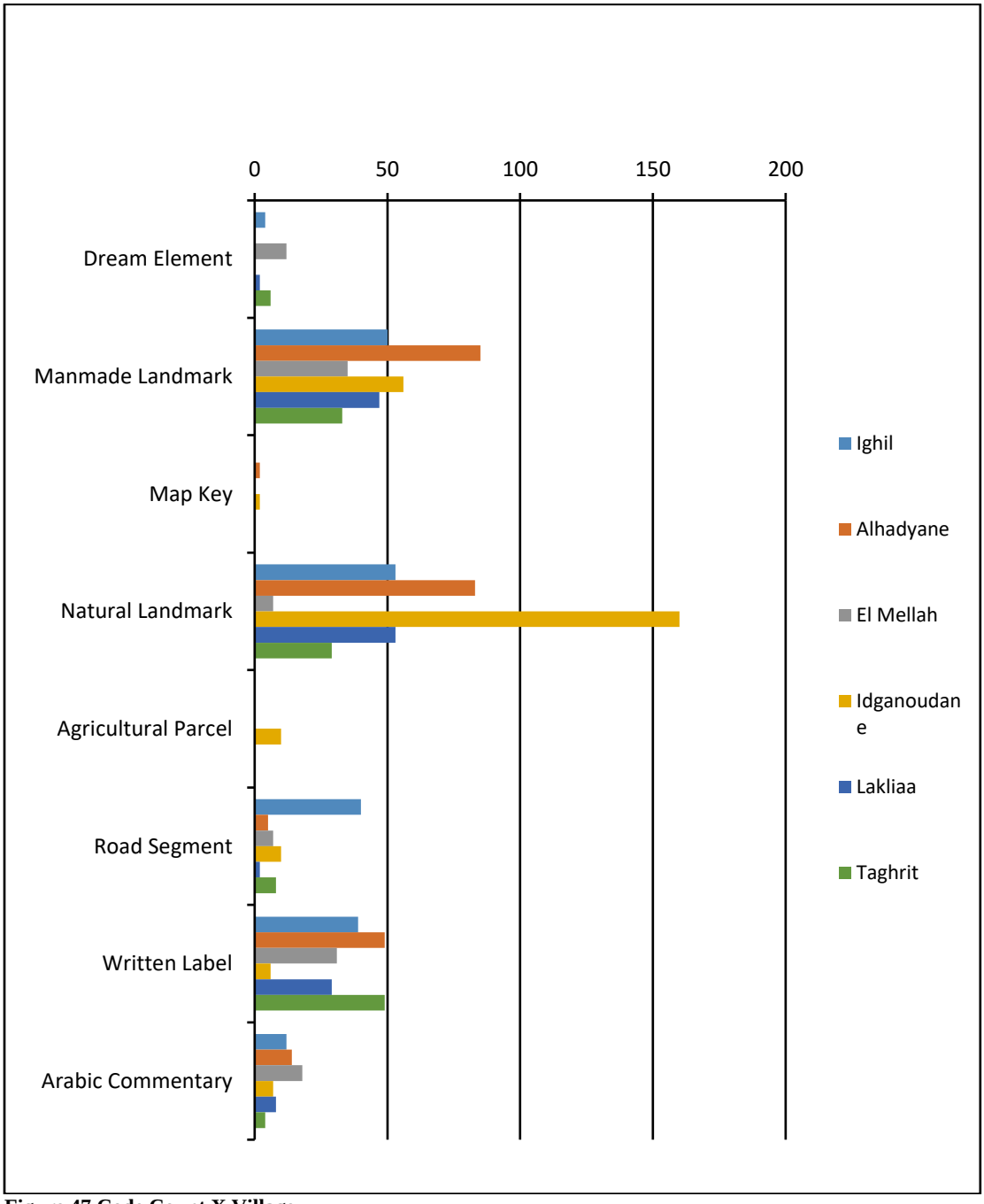

Figure 47 Code Count X Village

Table 4 Code Count X Village

	Ighil	Alhadyane	El Mellah	Idganoudane	Lakliaa	Taghrit
Dream Element	4	0	12	0	2	6
Manmade Landmark	50	85	35	56	47	33
Map Key	0	2	0	2	0	0
Natural Landmark	53	83	7	160	53	29
Agricultural Parcel	0	0	0	10	0	0
Road Segment	40	5	7	10	2	8
Written Label	39	49	31	6	29	49
Arabic Commentary	12	14	18	7	8	4
Total	**198**	**238**	**110**	**251**	**141**	**129**

El Mellah added more dream elements than the other villages. This could be because El Mellah is in the city of Marrakesh, where there is more opportunity for comparison. There could be higher access to the internet and evident income inequality from wealthier city dwellers and visiting tourists. There might be a higher feeling of relative deprivation the rural villages do not experience.

There is a similar number of written labels from all villages, except Idganoudane. This is explained by the fact that the maps from Idganoudane have map legends, which reduces the need for written explanations and labels on the maps. El Mellah provided the most Arabic commentary. This could support the previous theory that people in El Mellah have more exposure to income inequality and a higher feeling of relative deprivation. They have more ideas for improvements in their community and commentary about community issues.

The groups from Idganoudane added significantly more natural landmark data than all other villages. On both the men's and women's maps, many individual trees and

mountain peaks were drawn. Idganoudane is located in the High Atlas Mountain region and has an agriculturally based economy. This could also reflect the priorities of HAF, if they were expecting a community development project related to tree planting or agricultural development. El Mellah provided the least amount of natural landmark data, which is not surprising as they are in a large city.

All villages drew relatively similar amounts of manmade landmarks, with Alhadyane adding the most manmade landmark data with 85 instances. Alhadyane men and women both had map legends, which could have caused the groups to add more manmade landmark data to the map, as each instance took less effort because it did not need to be individually labeled.

4.9.3 Manmade Landmark Count by Village and Gender

Figure 48 and Table 5 show a breakdown of the manmade landmark count by both village and gender:

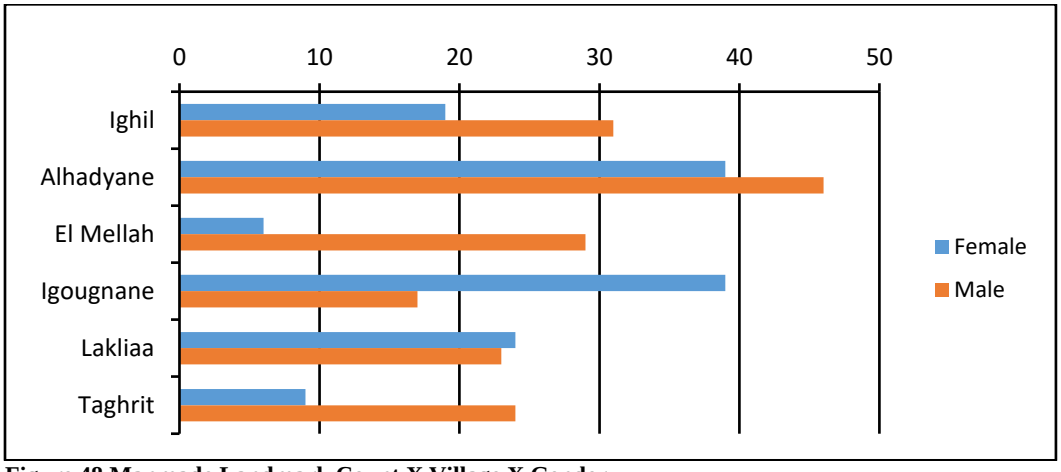

Figure 48 Manmade Landmark Count X Village X Gender

Table 5 Manmade Landmark Count X Village X Gender

	Female	Male
Ighil	19	31
Alhadyane	39	46
El Mellah	6	29
Idganoudane	39	17
Lakliaa	24	23
Taghrit	9	24
Total	**136**	**170**

Overall, men added more manmade landmarks than women. Only the women from Idganoudane and Lakliaa added more than men, with Lakliaa women adding only one more instance than Lakliaa men. It is not universal that men added more manmade landmarks than women, but the difference in four villages was enough to make the overall gender difference 40.7% for women versus 59.4% for men.

4.9.4 Natural Landmark Count by Village and Gender

Section 4.9.4 investigates the natural landmark category. Figure 49 and Table 6 show the code count of natural landmarks by village and gender:

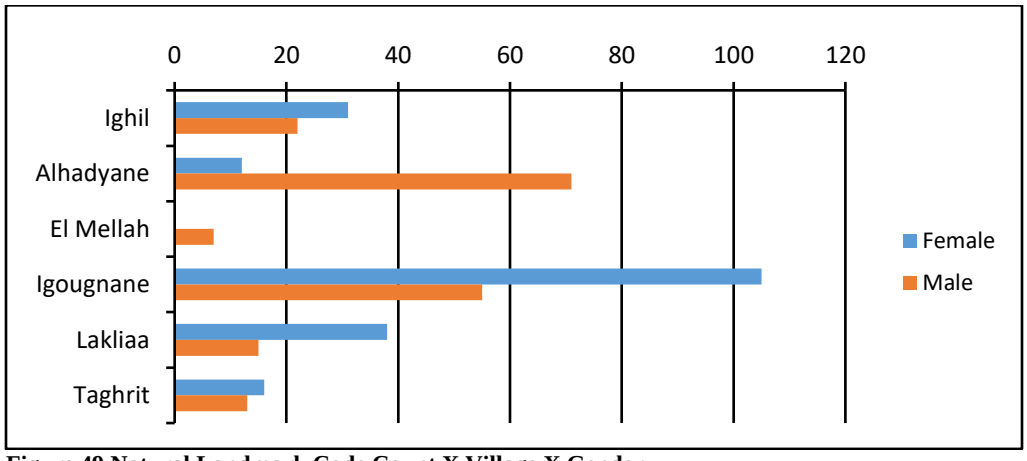

Figure 49 Natural Landmark Code Count X Village X Gender

Table 6 Natural Landmark Code Count X Village X Gender

	Female	Male
Ighil	31	22
Alhadyane	12	71
El Mellah	0	7
Idganoudane	105	55
Lakliaa	38	15
Taghrit	16	13
Total	**202**	**183**

Women added more natural landmark elements than men. This result could support the concept previously covered in section 2.5 that women work in the fields and engage in agriculture by collecting fruits and crops like wheat and barley, cutting alfalfa for livestock, weeding, and collecting wood, leaves, and twigs (Sadiqi, 2011; Haas & Rooij, 2010). Additional research is needed in these villages to discover the patterns of behavior of men and women as it relates to engaging in agriculture. Idganoudane women added noticeably more natural landmark elements than the men, as well as compared to the other villages.

4.9.5 Written Label Count by Village and Gender

Section 4.9.5 investigates the breakdown of written labels by village and gender, as seen in Figure 50 and Table 7:

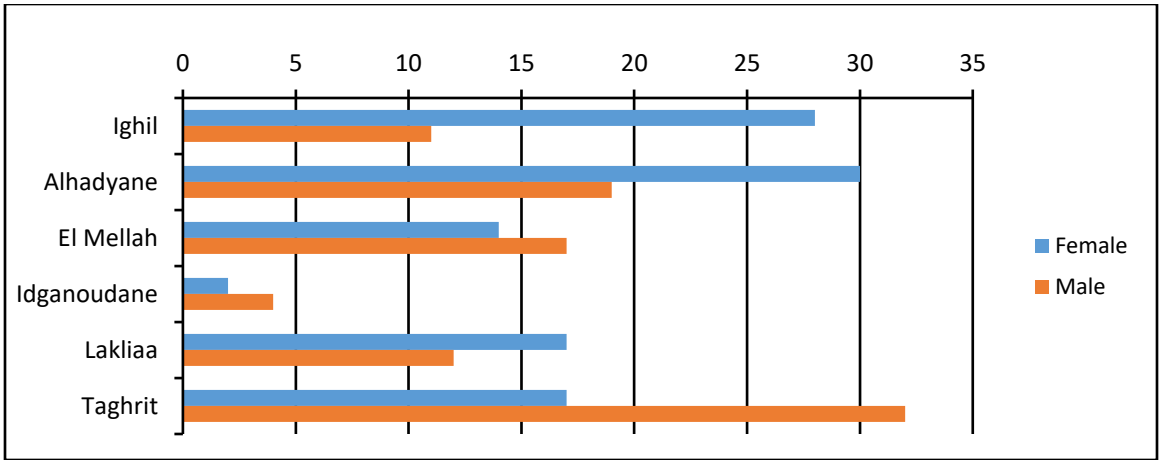

Figure 50 Written Label Code Count X Village X Gender

Table 7 Written Labels Code Count X Village X Gender

	Female	Male
Ighil	28	11
Alhadyane	30	19
El Mellah	14	17
Idganoudane	2	4
Lakliaa	17	12
Taghrit	17	32
Total	**108**	**95**

Women added more written labels than men, but the amounts were similar. Taghrit men added the most written labels of all groups, followed by Ighil and Alhadyane women. Alhadyane women is notable because this group also added a map legend, meaning some of the labeling was redundant. The Alhadyane men also had a map legend and added 19 written labels, also delivering some redundancy.

4.9.6 Arabic Commentary Count by Village and Gender

Section 4.9.6 investigates the breakdown of Arabic commentary by village and gender, as seen in Figure 51 and Table 8:

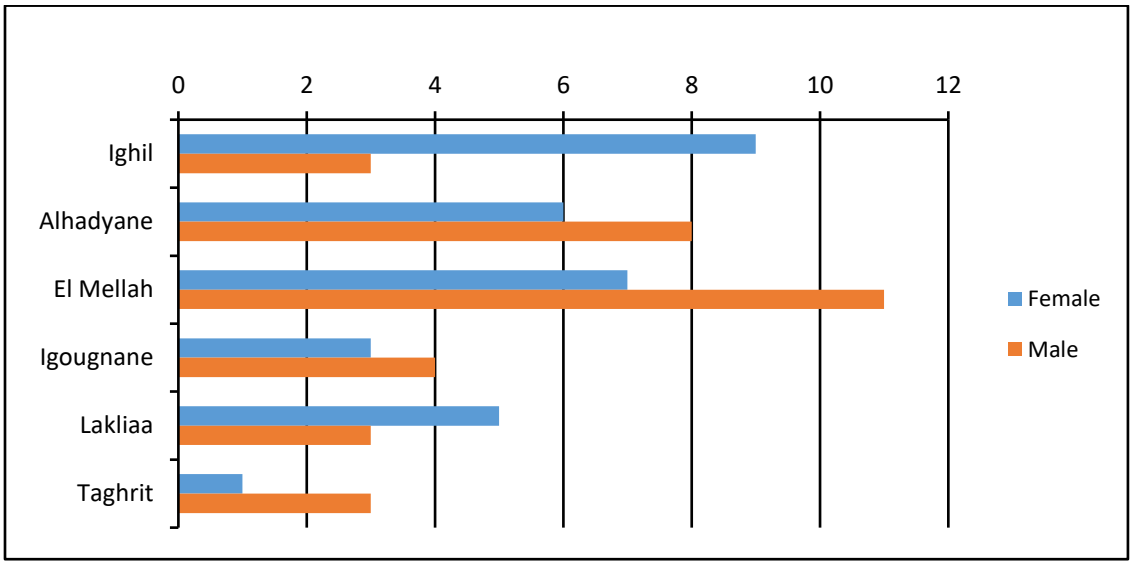

Figure 51 Arabic Commentary Code Count X Village X Gender

Table 8 Arabic Commentary Count X Village X Gender

	Female	Male
Ighil	9	3
Alhadyane	6	8
El Mellah	7	11
Idganoudane	3	4
Lakliaa	5	3
Taghrit	1	3
Total	**31**	**32**

While El Mellah men and women did not write the most labels, they did provide the most Arabic commentary. As mentioned previously, this could be due to feelings of relative deprivation from living in a city. Taghrit men and women provided the least amount of commentary. Variations in commentary could be caused by differences in HAF's facilitation of the mapping. In some cases, if the "dream" stage was emphasized, map contributors could have provided more information. In other cases, if the "dream" stage

was not stressed, less elements might have been added. This are unknowns resulting from the thesis researcher not being there at the time of mapping. There are many unknowns in this research, and the specifics of each map facilitation is a significant unknown that could have affected many aspects of the sketch maps. Future research could involve repeat mapping in each location with different facilitation to see how large an impact the facilitation method has on map results. Facilitation methods could also be studied in the future by splitting the overall group from a community into multiple subgroups of men and women and testing different facilitation methods by comparing the mapping results.

4.9.7 Total Written Arabic Count by Gender

Section 4.9.7 explores the total Arabic written on the map by adding together Arabic commentary and written labels, as shown in Figure 52 and Table 9:

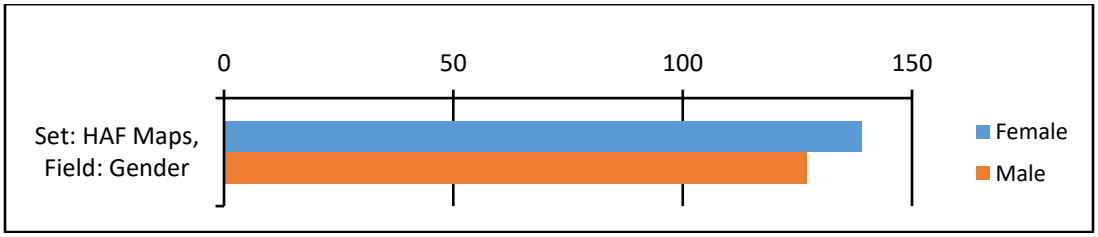

Figure 52 Arabic Commentary + Written Labels X Gender

Table 9 Arabic Commentary + Written Labels X Gender

	Female	Male
Set: HAF Maps, Field: Gender	139	127

Combining the written labels with the Arabic commentary gives the overall amount of writing on the sketch maps. The original hypothesis was that women would provide less

writing than men due to higher rates of illiteracy and lower schooling. However, the data does not support the hypothesis. Women wrote more than men on the sketch maps. Future research into the literacy and education levels of participants is needed to understand this result.

4.9.8 Road Segment Count by Village and Gender

Section 4.9.8 investigates the breakdown of road segments by village and gender, as seen in Figure 53 and Table 10:

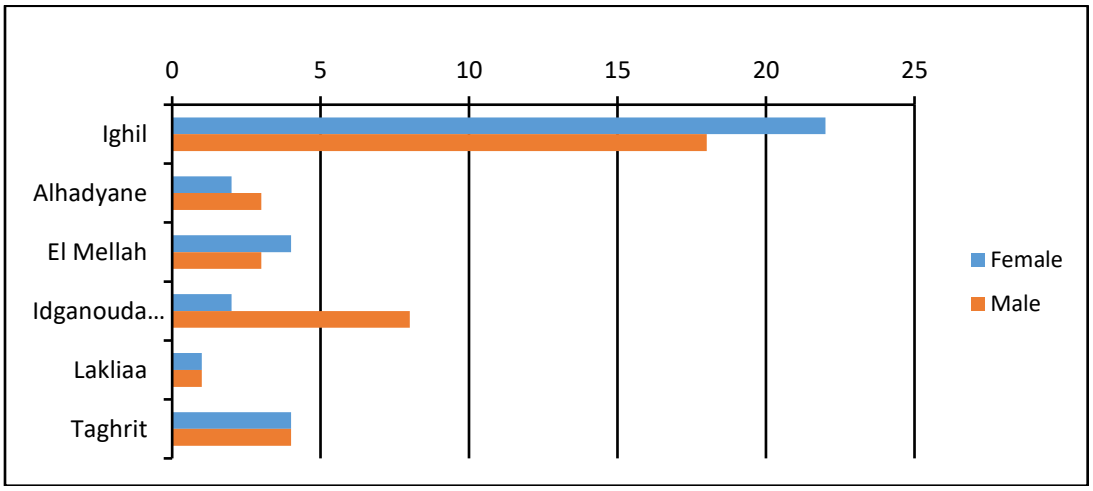

Figure 53 Road Segment Code Count X Village X Gender

Table 10 Road Segment Code Count X Village X Gender

	Female	Male
Ighil	22	18
Alhadyane	2	3
El Mellah	4	3
Idganoudane	2	8
Lakliaa	1	1
Taghrit	4	4
Total	**35**	**37**

Overall, men and women drew a similar amount of road segments. Men drew slightly more road segments than women, which supports the original hypothesis. However, the difference of two is not enough to provide strong support. More data is needed to establish trends in how men and women draw road segments. Compared to the other villages, Ighil saw the most road segments by a significant amount. Both women and men drew more road segments in Ighil than other villages, with women drawing more segments than men. Unfortunately, the satellite imagery of Ighil had high tree cover, which obscured the possibility of seeing the small paths that were drawn on the sketch maps. Ground truthing would need to be done to see if Ighil has an unusually high number of roads as compared to the similar mountain villages of Taghrit and Idganoudane. It was surprising that El Mellah did not have more road segments because being part of a city, there is a dense network of roads with established names.

4.9.9 Dream Segment Count by Village and Gender

Section 4.9.9 investigates the dream elements by village and gender, as seen in Figure 54 and Table 11:

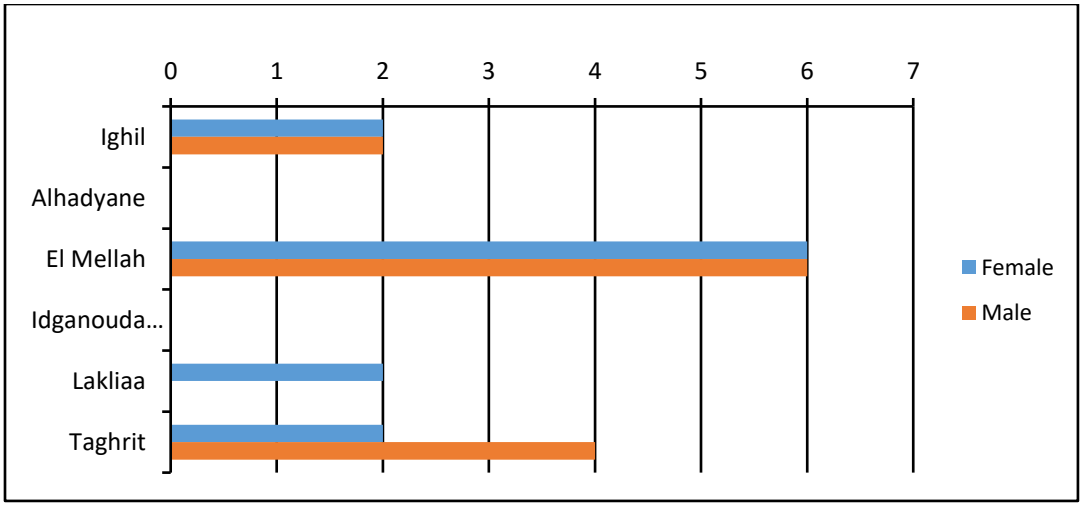

Figure 54 Dream Element X Village X Gender

Table 11 Dream Element X Village X Gender

	Female	Male
Ighil	2	2
Alhadyane	0	0
El Mellah	6	6
Idganoudane	0	0
Lakliaa	2	0
Taghrit	2	4
Total	**12**	**12**

The groups from Idganoudane and Alhadyane did not include any dream elements on their sketch maps. This could be because the HAF facilitator did not include the dream step with these groups, possibly because they ran out of time. As discussed previously, the participants from El Mellah provided the most dream elements, which could be due to their higher feelings of relative deprivation. El Mellah and Ighil men and women provided the same amount of dream elements. Lakliaa women provided dream elements,

whereas the men provided none. Finally, Taghrit men provided four dream elements to the women's two.

The thesis researcher received 12 viable maps for translation and subsequent analysis. Ideally, in a future research project, a larger sample size of maps could be analyzed, downplaying the effects of outliers, and establishing clearer trends in mapping between men and women. There is also the possibility that unknown variables besides gender are more important. Gender is studied in this analysis because it is the only known variable. In a future analysis, the community could be split into groups of other socioeconomic categories like age, income, literacy level, or education level. These results and the implications will be communicated to HAF to spark a conversation about how they split the community and why. Perhaps the community should not be split at all, seeing as in most categories, men and women provided relatively similar amounts and types of data. This is discussed further in Chapter 5.

CHAPTER FIVE

Discussion and Conclusion

This chapter aims to analyze and discuss the results so as to answer the research questions defined in section 1.2. The results are specific to the research population, a group of people living in the seven villages of Ighil, Idganoudane, Taghrit, El Mellah, Alhadyane, Lakliaa, and Boughrar who participated in HAF's sketch mapping activities. However, broader inferences will be drawn to discuss the wider applications of the results. Discussion of the results will be followed by future research needs. The chapter will end with a conclusion to the thesis.

5.1 Research Question 1

Lynch (1960) describes the elements of a place in an urban environment as belonging to one of five categories: paths, edges, districts, nodes, and landmarks. These elements, combined with people and their activities, create meaning of place. This research used descriptive categories of manmade landmarks, natural landmarks, agricultural parcels, road segments, map legends, dream elements, written labels, and Arabic commentary. The research sought to explore participants' meanings of their space by investigating their geographical knowledge as represented on participatory paper maps. The thesis researcher asked this research question: what do participatory paper

maps indicate about the geographical knowledge of local communities in Morocco and how can this knowledge be used to enhance participatory development initiatives?

HAF uses paper PM as a catalyst to have conversations about community needs and development priorities. Internally within HAF, the paper participatory maps contain useful geographical knowledge of communities that is used as a basis for the conversation about community needs, resources, and priorities. The sketch maps are qualitative vessels of information for how participants think about and relate to their community.

The sketch maps contain important features of dream elements, written labels, and Arabic commentary. HAF seeks to collect information about desired community changes and improvements after asking participants to map their communities as they view them in reality. In many of the maps, the dream elements are physical elements that participants want built or improved, such as hospitals, additional classroom space and schools, doctors, police stations, soccer fields, widow's support centers, women's community spaces, bridges, and road improvements (Appendix B & Appendix C). Some of these items, such as hospitals, police stations, bridges, and road improvements, are infrastructure projects or government buildings that are out of the realm of possibility for HAF to adress. However, they do have the opportunity to convey these desires to government officials and facilitate further conversations about these projects.

The maps also contain dream elements that transcend physical building projects, involving indications of societal issues residents experience. In the El Mellah men's map (Figure 69), participants noted societal commentary such as needing more job

opportunities, the problem of unemployment, the lack of medication and doctors, needing doctors and medication, the problem of selling drugs in the neighborhood, needing increased security, the problem of not getting aid for widows, divorced women, and poor families, and the need to repair unstructured houses. This is important information based on geographical knowledge of the community that is unique to a process like paper PM. These opinions, dream items, community problems, and improvement ideas would not have been included if HAF had only done community mapping with OSM.

This knowledge can be used to enhance HAF's participatory development initiatives immediately after mapping and in years to come. Some of these dream elements and commentary may fall within HAF's purview to address soon after mapping. Researching if HAF addressed these specific dream elements and which ones they addressed is not within the scope of this research project but is an area for future research about integration of sketch mapping with monitoring and evaluation methodology over time. The dream elements and suggestions serve as a snapshot in time for how the participants related to their community on the day and time of mapping. Participants could revisit this sketch map over time to evaluate if these problems are fixed, worsened, or improved.

5.2 Research Question 2

Externally, the sketch maps indicate geographical knowledge, but the problems of positional accuracy and location identification as covered in Chapter 4 is a barrier to integrating the data into OSM. There are evident barriers in using sketch map data to enhance the digital mapping aspect of participatory development. This relates to research

question 2: What are the enablers and inhibitions to data integration from paper to digital participatory mapping platforms? What implications does this have for open-source mapping in developing countries?

5.2.1 Spatial Webs

For all communities, there are different village names between the Arabic and English on the sketch maps, sketch map translations by Hassan and Kawthar, Amina's emails, OSM names, and Google Maps data. This research has a spatially distributed name sharing community between the thesis researcher in Virginia, Amina and the HAF President in Marrakesh, HAF's Director of Development in the USA, and sketch mapping contributors in their Moroccan communities. The OSM data could have been contributed by users from all over the world. Google Maps data could have been contributed by the Moroccan government, American government, business community, and unknown individuals in unknown locations. Contributors speak a variety of languages from all over the world, including English, Moroccan Arabic, French, Tamazight, Tashlehit, and more from OSM contributors in unknown countries.

The spatial distribution and language variety leads to many names for each location, as seen in Table 2 in section 4.1. It made it difficult for an outsider to identify village locations based solely on the sketch map data. The thesis researcher required the expertise of Amina, who has been to a number of the communities and is familiar with HAF's geographic scope, to find locations for the communities. Even with Amina's help, she and the researcher were unable to find the specific locations as represented in the sketch maps for Lakliaa, Taghrit, and Alhadyane. If HAF facilitators running the

community meetings had recorded a single set of GPS coordinates for the village location or had taken a picture on their smartphone with location services enabled, the location identification process would have been simple and authoritative. This will be expressed to HAF as an important step to include for the future.

5.2.2 Gazetteers

Location identification difficulties also point to the need for an official gazetteer for Morocco, done in multiple languages in coordination with locals, to capture internal naming variants in multiple languages. If place names are standardized, organizations like HAF could more easily connect sketch maps done years before to locations and better track their work. It would make it possible for village residents to see sketch maps from earlier times. An official gazetteer would also likely be integrated into OSM and used to edit Google Map place names, creating better interoperability between the platforms.

However, there is potential danger in imposing an official gazetteer and place naming process in Morocco. French colonialism previously erased and changed place names in indigenous languages and Moroccan Arabic to French. Imposing a systematic, governmental process to choose one name and spelling for each place could erase local meaning by elevating one spelling or language over others. An official gazetteer could benefit academic researchers, government officials, development organizations, and the business community, but hurt local Moroccans and local Moroccan society by erasing their language and meanings of place. To strip communities of their local context would be a form of colonialism and result in a loss of meaning and dignity. Gazetteers and data

structures in developing countries that have unwritten languages should include flexibility to integrate local meaning. This is further discussed in section 5.2.5.

5.2.3 Map Feature Identification

A strong digital base map is important for NGO's, tourism, business, natural hazard response, and governing. Integrating paper and digital mapping platforms is a way to include locals in anything that relies on digital geospatial infrastructure technology, including development work like that done by HAF. To explore the interoperability of data between paper participatory and digital mapping, the researcher sought to add data from the sketch maps to OSM by analyzing the contents of the maps and the relative positioning of map elements to match them with OSM satellite imagery and Google Maps data.

Few elements were able to be identified from the sketch maps in OSM satellite imagery and Google Maps, as covered in section 4.3. In section 2.6, the thesis researcher established the framework to do a positional accuracy analysis. However, the reality of working with the sketch maps revealed there was not an adequate amount of sketch map elements that could be identified in satellite imagery to undertake that level of analysis. The thesis researcher instead analyzed the relative positioning of map features and the process to identify them, sometimes unsuccessfully, in OSM. Although the positional accuracy analysis was not undertaken in the way outlined in the literature review, important conclusions can be drawn from the exercise.

The thesis researcher explored concurrence between map features and ground features. There was uncertainty from differences of map feature positioning between the

men's and women's sketch maps. Also, issues of high levels of tree cover in satellite imagery and problems identifying community location made identifying individual buildings and landmarks difficult. In many cases, there were multiple possibilities of concurrence, but none convincing enough to add sketch map elements to OSM. Because of these difficulties of concurrence, she had to make general comments about the topology of the map features in section 4.3. She identified a mosque in Ighil based not on the sketch map relative positioning of the mosque, but rather on the shadow of a minaret apparent in the satellite imagery. She also identified a school in El Mellah not from the relative positioning on the sketch maps, but by finding a school in the general area in Google Maps with a similar name.

5.2.4 Scale and Dimension

The thesis researcher was able to identify peripheral villages outside of Ighil based on the women's sketch map (Figure 75). These peripheral villages are at a smaller scale than the scale at the center of the sketch map. In the sketch maps, these villages are not true to metric scale, but provide meaning by placing the village location relative to nearby village locations that residents know of because they travel to them. One scale may be used for the village itself, but another scale might be used at the map boundaries to provide a regional view of village position relative to nearby villages. The smaller scale of the peripheries of the sketch maps made it possible for the researcher to identify peripheral village locations in OSM.

Map scale and dimension are important aspects of humanitarian work, and especially natural disaster response. Morocco is at a high-risk level for earthquakes,

tsunamis, droughts, and floods. In December 2014, 47 people died in the Guelmim Region and in 1995, 100 people died in Ourika from flooding. In 2004, an earthquake in the north killed 600 people and damaged 12,000 homes in Al Hoceima (OECD Review on Risk Management Policies Morocco, 2016). It is clear that an individual unfamiliar with the area of Ighil could not use the sketch map to provide accurate directions from Ighil to Izrane if there was a natural disaster in Izrane due to the differences in scale throughout the map. This is an aspect that is improved upon in OSM. To address many potential needs of a region, multiple maps with different purposes are needed. A metrically accurate map in OSM is important if there is a natural hazard in the Ighil region, but a sketch map better addresses the development needs of HAF for them to get to know a community. If the communities in which HAF works are at risk for natural hazards, they might take the importance of scale and positional accuracy into account and include OSM mapping in their process in the future.

Based on the results, it is evident the process HAF used to facilitate the sketch maps was not adequate to do a positional accuracy analysis in the way outlined in section 2.6 of the literature review. If HAF is interested in integrating positional accuracy in their process, they need to do a process of ground truthing to collect GPS coordinates for various map features at the time of mapping alongside sketch map contributors. This could be done by a researcher, a HAF employee, or a local community resident, with a process as simple as taking a photo with a smartphone capable of using location services and embedded EXIF tags for location. However, for the sketch maps already completed between 2010-2020, there is no guarantee the same sketch map participants could be

found and gathered for the exercise. They also might not remember exactly what elements they mapped. Finally, the community might have changed, with new roads built, buildings demolished, or other development projects done.

5.2.5 Georeferenced Audio Descriptions

Another way to add meaning about relative positioning to the maps could be to collect audio memos about the positioning of important places on the sketch maps from mapping participants at the time of mapping. Audio memos could capture additional information from individual mappers, adding nuance to the aggregated group map, and provide necessary context to identify map elements in satellite imagery.

HAF could collect georeferenced audio descriptions of a community in addition to the sketch maps. This could allow for residents to share oral histories connected to important places. Residents could describe their space in their local language in a way that has meaning for them. HAF could ask questions about relative positioning, time it takes to walk between important places, and how places have changed over time. These questions could be used to add additional layers of meaning to the sketch maps. If the ultimate goal for HAF is to understand a community as much as possible, they should expand their process to include an audio aspect.

These positive potential outcomes can be extended to explore limitations of OSM in general. As it stands at the time of this thesis, OSM is a wholly visual platform. It allows for comments related to place, but the contributor needs to have a certain level of digital competency, literacy, and access to technology to use this feature. OSM as it stands is also inaccessible to many disabled individuals. If OSM could expand to include

georeferenced oral commentary, the platform could better accommodate illiterate people, those with low digital literacy, and some disabled people who cannot currently use the platform. These millions of people could participate in the collection and explanation of geospatial data in their spaces. However, it still would be constrained by the digital divide and access to technology.

5.2.6 Original Mapping Intent

Finding concurrence between sketch map elements and satellite imagery in OSM might have been difficult because the original intent of the maps was not to capture positional accuracy. To HAF, the purpose of the sketch maps is to understand elements in a community and how participants relate to their space. Because positional accuracy was not stressed as important by HAF, the mappers might not have spent a lot of effort making sure the positioning was correct. This leads to the conclusion that people might not inherently care about positional accuracy as much as map content.

HAF seeks to understand the overall picture of a community. For this purpose, sketch maps, even ones that are incomplete and relatively positionally inaccurate, are more useful to HAF than a map that shows GPS coordinates of landmarks in the same community. However, HAF and local residents would benefit from integrating some aspects of digital mapping into their process. HAF could have improved records of locations in which they met with communities and did projects. They could monitor projects over time and decrease the potential loss of data if an employee left. It would also benefit locals who want to use digital maps to advocate their needs to local

government and improve business and tourism to their communities if desired, which could bring jobs and income.

In conclusion, PM should not go so far in the digital mapping direction that important local context and meaning is lost. It is clear that the sketch maps collected by HAF include meaning from labels, commentary, and symbols that would have been excluded if only OSM was used. This is especially important in communities that use unwritten languages and have illiterate residents.

5.3 Research Question 3

This research sought to analyze the mapping behavior of men and women by asking the research question: is there a difference in the sketch mapping behavior of men and women in terms of content and positional accuracy and if so, what factors may account for this? Based on the thesis researcher's time living in Morocco, her literature review about gender dynamics in Moroccan society as seen in section 2.5, and her conversations with HAF, she hypothesized that women would map more manmade landmarks due to their lower mobility compared to men. She hypothesized that men would map more natural features and road segments because men tend to work more outside the home, which includes agricultural work. Results showed that in contrast to the hypothesis, men mapped more manmade landmarks and women more natural landmarks.

The researcher hypothesized that men would include more Arabic labels and commentary than women because men have higher educational levels and literacy than women, especially in rural areas of Morocco. However, women wrote more on the maps in total (combining written labels and Arabic commentary). These results show the

importance of challenging assumptions of a place. The researcher did not only study Morocco from an academic view, but also lived in rural Morocco with the Peace Corps for eighteen months.

Results could have been affected because the sketch maps were done in a group setting. While most women might have been illiterate or had low education, as long as one participant was comfortable writing on the sketch maps, all participants could channel their geographic knowledge onto the maps through that individual. Women might be more likely to cooperative with each other in a group setting than men, hence including more recorded information and labels on the sketch maps. Future research could include comparing the group sketch maps results to individual sketch maps. Perhaps, if each participant did their own sketch map, differences in literacy and education would be more apparent.

Research question 3 queries the difference in mapping behavior of men and women. This question was built from the available dataset: sketch maps facilitated by HAF by groups of men and women. However, this research is limited in that gender is the only known socioeconomic variable. In a future analysis, the community could be split into a variety of other socioeconomic categories such as age, income, literacy, education, and mobility. Potentially, the community does not need to be split at all. They could do one overall map, or each individual could do their own sketch map. Individuals could compare their maps to others within the same gender identity as theirs, and then compare them as a group to the community at large.

HAF could also begin to collect additional information about mapping contributors related to the beforementioned socioeconomic indicators. This could add additional dimensions to a future analysis as to the effects of gender, age, income, education, or other factors on sketch mapping behavior. The results will be communicated to HAF with a recommendation to challenge their assumption that the community should be split by gender and gender be the only socioeconomic indicator for which HAF collects data.

5.4 Research Limitations

A research limitation to the results is that the thesis researcher was limited to analyzing the sketch maps sent to her by HAF. There are as many as 180 maps from 90 villages in the HAF offices. 18 total maps were sent to the thesis researcher, and 12 of those maps were appropriate for a content frequency analysis. HAF is an operational development organization and was in the midst of a busy and important season of their work. Amina was able to send 12 maps in adequate resolution for a content frequency analysis. Potentially, future work could expand these results by analyzing additional sketch map documents, but it would require an additional time commitment by HAF employees who could answer questions about community locations.

5.4.1 Post Mapping Interviews

The sketch maps contain information from symbols, colors, labels, and Arabic commentary that go past the geographic location of a place. Four of the sketch maps from Alhadyane and Idganoudane contained map legends. Including map legends indicate that these sketch map participants have seen maps before that use formal cartographic

elements. As the thesis researcher accessed the sketch maps after they were mapped, she was unable to follow up with participants to ask questions about their mapping choices and their experiences seeing or working with other maps.

There are many other sketch map aspects, including most notably, choices of symbol, where the thesis researcher is unable to ask mapping participants why they might have chosen a particular way of representing features in their communities. Future research would benefit from interviewing participants about their mapping choices directly after the mapping exercise to reveal additional information about mapping decisions.

5.4.2 Translations

To gather meaning from map symbols, the thesis researcher relied on translated labels from Hassan and Kawthar. In some cases, the two translators translated the same map element differently. For example, Kawthar translated a word as “valley” where Hassan translated it as “river.” The thesis researcher was able to use her knowledge of Moroccan Arabic to decide that the better translation was “river.” This decision was also based on the fact that the item was drawn in blue, rather than green, when many other natural items on the same sketch maps were drawn in green. In some cases, a map element was translated only by Kawthar and not by Hassan. There was no opportunity for comparison of translation in these cases, and the researcher took the available translation. Evidently, this process was subjective and could include errors. Errors in interpreting symbolic representations of map elements could have affected the results of the content frequency analysis.

Interpreting symbols inevitably includes a level of subjectivity and decision making on the part of the researcher. She has a certain worldview that might affect her view of symbols as compared to how a Moroccan might interpret the same symbol. A limitation of this thesis research is that the researcher is an outsider working with documents from another country and culture. She was able to draw upon the expertise of native Moroccans who work for HAF and provided translation, but she is unable to determine if her outsider worldview and related assumptions affected the results of the thesis in any way. An area for future research is to seek out a peer review of the thesis research by a Moroccan researcher.

5.5 Dream Elements

The dream elements and their attached labels and Arabic commentary were interesting aspects of the sketch maps. Between villages, there was a great variation in the amount of dream elements and related labels and commentary. For example, Idganoudane had no dream elements on their sketch maps, where El Mellah and Lakliaa had many dream elements on both male and female maps. This difference could be due to difference in HAF's facilitation of the sketch mapping. If the "dream" stage was emphasized, the map contributors might have provided more information. In other cases, if the "dream" stage was not included or not emphasized, little or no elements might have been added.

The community of El Mellah added the most dream elements. El Mellah is a neighborhood in Marrakesh, one of the largest cities in Morocco. Residents of El Mellah might have added more dream elements because they experience a higher feeling of

relative deprivation as compared to rural, mountain villages like Idganoudane and Ighil. Relative deprivation is a feeling that one is generally "worse off" than the people one associates with and compares oneself to. This feeling is relative, rather than absolute (Chen, 2015). Because El Mellah is in a city, the residents interact with a wider range of people, including relatively wealthy tourists, expats, and Moroccans. The residents of El Mellah indicated a number of needs for their community, including the need to improve housing infrastructure, needing medicine and doctors, job opportunities, more security to combat drugs in the neighborhood, and needing aid for widows, divorced, women, and poor families.

These needs were distinct from the dreams and needs of other communities, who indicated infrastructure needs, such as well digging, road improvement, hospitals, teacher's dormitories, more classrooms, a middle and high school, and a women's center, rather than the overarching societal problem. For example, instead of writing "lack of education" on the sketch map, Ighil men drew a middle and high school. In contrast, the El Mellah men could have drawn a police station, without indicating the underlying need for more security, or that drugs were being sold in the community. This level of information represents a high level of understanding of the community's needs in society. It could be related to living in a large city and relative deprivation or could be the result of the facilitator's specific mapping directions for that day. In the future, HAF would benefit from eliciting a similar level of commentary on all sketch maps.

5.6 Naming Conventions

The thesis researcher was struck that Google Maps, a relatively simple interface, has a high level of sophistication at accepting search terms not only in Modern Standard Arabic, but that are specific to Moroccan Arabic. For example, as covered in section 4.2, Google Maps includes the letter "gaf" in their available alphabet and spellings of places and businesses. This letter is distinct to Moroccan Arabic.

In OSM, the platform includes the Tifinagh alphabet. This script is used to write the Amazigh languages and was introduced in the 20th century. Until recently, no books, articles, or websites were published in Tifinagh. The Tamazight, Tashlehit, and Tarafit were only spoken languages, with occasional writing using the Latin or Arabic script. It is therefore notable that OSM allows for Tifinagh. The alphabet is used by researchers and the government, for example, official government signs in Morocco include Tifinagh by law. However, it is rarely used by indigenous Moroccans, although the alphabet is beginning to be taught in schools.

Evidently, western-made tools, like OSM and Google Maps, are adapting to include many language and possible spellings of the same place. This increases the sophistication of place name support that both people outside the region and inside the region might use. With multiple languages and spellings, various languages and methods might resolve to the same place. For example, Casablanca is a westernized name for a city in Morocco. Casablanca is a Spanish name, literally meaning "the white house." In Arabic, the city is spelled الدار البيضاء, and pronounced *ad-Dār al-Bayda*. All three spellings of the city resolve to the same location in Google Maps. In OSM, Casablanca

and الدار البيضاء resolve to the correct location, but the transliterated spelling *ad-Dār al-Bayda* resolves to an incorrect location in Saudi Arabia. In this case, Google Maps seems to be farther along in name sophistication than OSM.

5.7 Future Work

In addition to the ideas for future work mentioned earlier in this chapter, there are a number of ways future research can build and improve upon this thesis research.

5.7.1 Group vs. Individual Sketch Mapping

As previously mentioned, the HAF sketch maps were done in groups by gender, rather than individual maps. In the literature review, all research surveyed covered individual sketch mapping. It is unclear how gender affects groups of men and women compared to individual men and women. A future research area is to explore what aspects of sketch mapping behavior are exacerbated or diminished in a group setting of the same gender as compared to individual mapping.

5.7.2 Overlapping the Paradigms: Sketch Mapping and Paper PM

Group mapping was surveyed in the literature related to participatory mapping. There is apparent space between paper participatory mapping, as it is referred to in development literature, and sketch mapping, as it referred to in the literature about mental cognition and sketch map creation. A future research area is to further explore the overlap of these two paradigms. A limitation of the literature about sketch map creation and mental cognition is that much of the research was done in academic settings in developed countries. The discipline would benefit from researching a wider variety of peoples with different cultures, religions, languages, and worldviews. It would make the research more

applicable to the lived experience of the developing world and could provide a roadmap for development practitioners using sketch mapping as a form of data collection.

Overlapping these paradigms in this research resulted in the evolution of the descriptive coding categories from Lynch (1960) and subsequent codebooks relating to mental cognition and sketch map content creation to the codebook seen in Table 1. Future research into the space between participatory mapping and sketch map content creation will advance the evolution of the codebook to address aspects of sketch mapping specific to developing countries and poor, rural people. Sustainable development is trending away from large, international aid organizations to smaller, community-based organizations led by locals. As development changes, community needs will adjust, which may change the codebook to reflect new priorities.

5.7.3 Descriptive Coding Categories

In future research, the descriptive coding categories could be altered. A researcher could code within the dream elements to analyze what things men and women want in the community. The community could be split into other socioeconomic groups to explore the development priorities of the group in terms of age, educational level, or income. The results could be compared to the history of projects and current plans for future projects undertaken by HAF. This could reveal trends into whose concerns HAF addresses within the community. For example, if the “dreams” of men are addressed more than women, HAF should examine their decision-making process and potentially search for funding for projects that address women’s needs.

The manmade landmarks category could be split into additional categories. As this was the most populated category on the sketch maps, digging further could reveal additional information about the sketch map behavior of men and women. Over a larger sample size, this type of analysis could investigate the extent to which men and women found different manmade elements important, such as schools, hospitals, shops, wells, government buildings, etc. Men might find manmade landmarks related to government buildings and shops more important and map them more frequently because they engage more with commerce and interface with the government as heads of households. Women might find items such as schools and wells important because they deal more with childrearing and household responsibilities. Investigating manmade landmarks could reveal information into whether residents map this category differently due to traditional gender roles of Moroccan society.

A future analysis could also remove the descriptive categories of agricultural parcels and map legends from the codebook structure. Agricultural parcels were only included in one sketch map in this dataset. They could have been commented upon separately without being include in the codebook. Similarly, map legends were included one time on four maps. It is unlikely this element would be included multiple times per sketch map. The map legend category could have been unincluded in the codebook, but discussed as an interesting inclusion of a formal cartographic map document. However, if a future dataset of additional sketch maps revealed more instances of map legends and agricultural parcels, these categories could be maintained in the codebook at the discretion of the researcher.

5.7.4 Road Distance Analysis

A future area of analysis could be to explore the road distance analysis. Road segments were more easily identified from the sketch maps on satellite imagery than individual buildings. This could be a fruitful way to determine relative scale if other landmarks on the road could be determined. It could be a way to quantitively compare scale from the center of town to the peripheries of town, especially if the road drawn in the center of town connects to villages drawn on the peripheries.

5.7.5 Recommendations to the High Atlas Foundation

There are a few specific items the thesis researcher would recommend to HAF to change in their work based on this research. These recommendations would allow for scientific benefits and better understanding into the symbolic representations of map elements and the nonlinear scaling and distortions represented in the map documents. As previously mentioned, the researcher would recommend HAF question their practice of dividing the community into gendered groups because there were not significant distinctions between the mapping behavior of men and women. She would recommend HAF facilitate individual maps and collect data about age, mobility, educational level, and socioeconomic status. This would allow for flexibility in data analysis and a better understanding of the breakdown of the people with whom HAF works.

The researcher would recommend HAF record the process of mapping in each group. This would provide additional context into what discussions people have as they decided to map each element. She would also recommend HAF take a digital picture of the map documents directly after mapping with location services enabled, which would

provide the resource of a digital copy immediately and make location identification simple. She also recommends HAF walk around the community with the group after the time of mapping and take pictures of important map elements with location services enabled. These walks could be recorded to capture a post-mapping interview and oral history of important places in the community. Recording the amount of time to walk between map elements would give an approximate distance measurement, which could help a map reader understand scale in the sketch maps.

5.8 Conclusion

This research was motivated by the desire to explore a unique data set: sketch maps facilitated by the High Atlas Foundation in Morocco between 2010-2020 as part of their process of participatory development. The process of participatory mapping is important to participatory and sustainable development because it gives locals the opportunity to represent their community to outsiders and provide the necessary meaning to understand not just where people live, but how people live (Vajjhala, 2005, p. 2). The sketch maps used in this research were unique because they were done by an under-addressed population that lives in relatively unmapped places.

The history and methods of participatory mapping were discussed in the context of gender dynamics and sustainable development in Morocco. There is a real opportunity to include the voices of marginalized Moroccans into the world of digital mapping that is used by business, governments, and humanitarian organizations. These voices should be heard and brought into the overall discussion of sustainable development. Improving data interoperability between paper and digital PM environments will provide local

communities the benefits of both and improve the open-source map of the world. This research addressed this need and explored if and how data from sketch maps could be added to digital platforms. It was found that the contents contributed to the sketch maps are unique and indispensable to a development organization learning about a local community, but there are many barriers related to positional accuracy and language that prohibit ease in adding data to OpenStreetMap.

The research also explored the differences in the sketch mapping behavior of men and women. It was found that men and women did not differ significantly in their expressions of geographical data. However, men contributed more overall map elements, manmade landmarks, road segments, and Arabic commentary. Women contributed more natural landmarks and overall written elements. Inferences about spatial webs, naming conventions, and the scale, distortion, and symbolization of map elements were drawn. These results will be useful to the High Atlas Foundation to enhance their participatory development initiatives.

This research was significant because it bridged a gap in the bodies of research between sketch map accuracy and content done in developed countries, and participatory mapping done in developing countries. It included nontraditional data sources that address the needs of a local community, with data from that community itself, rather than outsiders using satellite imagery. The end result of this research is an improved understanding of geographical knowledge of local communities in Morocco and the benefits and limitations of integrating paper and digital participatory mapping environments.

APPENDIX A

Paper Participatory Maps

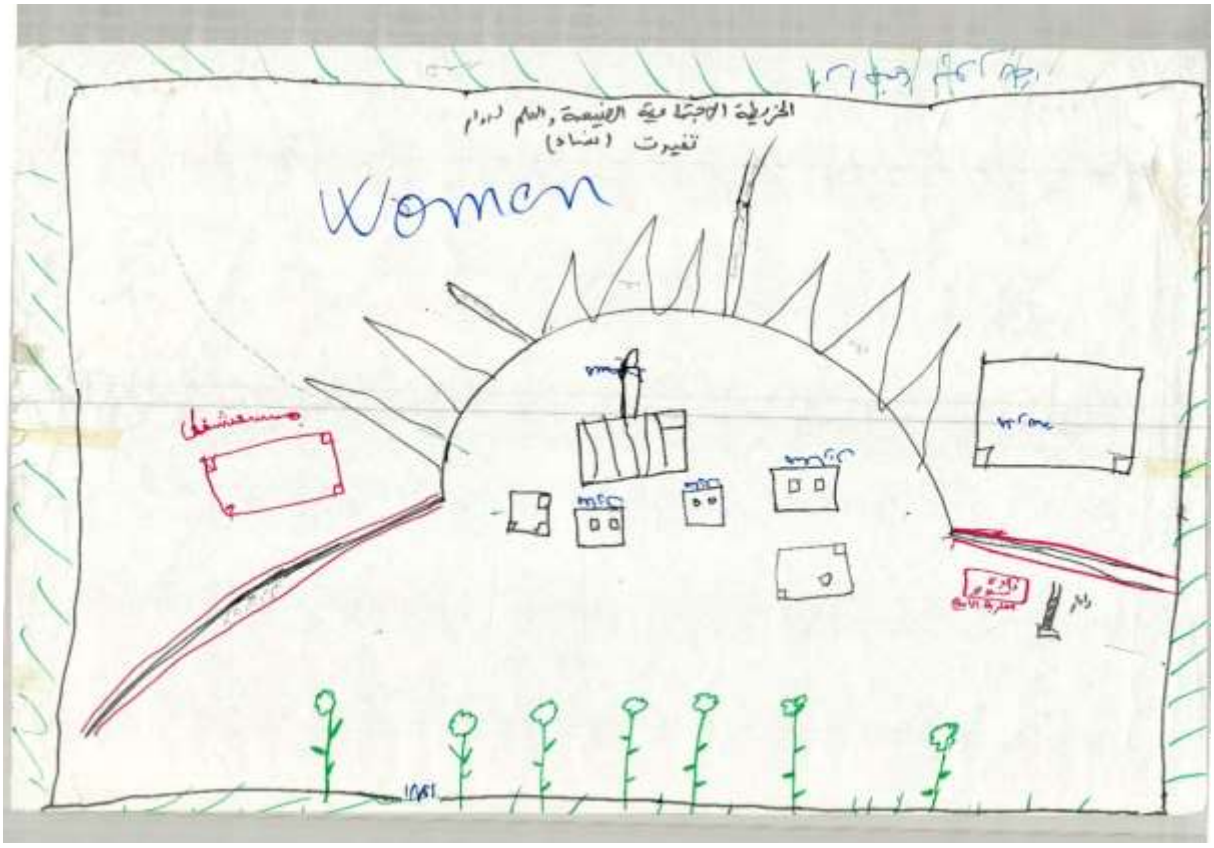

Figure 55 Taghrit Women

Figure 56 Taghrit Men

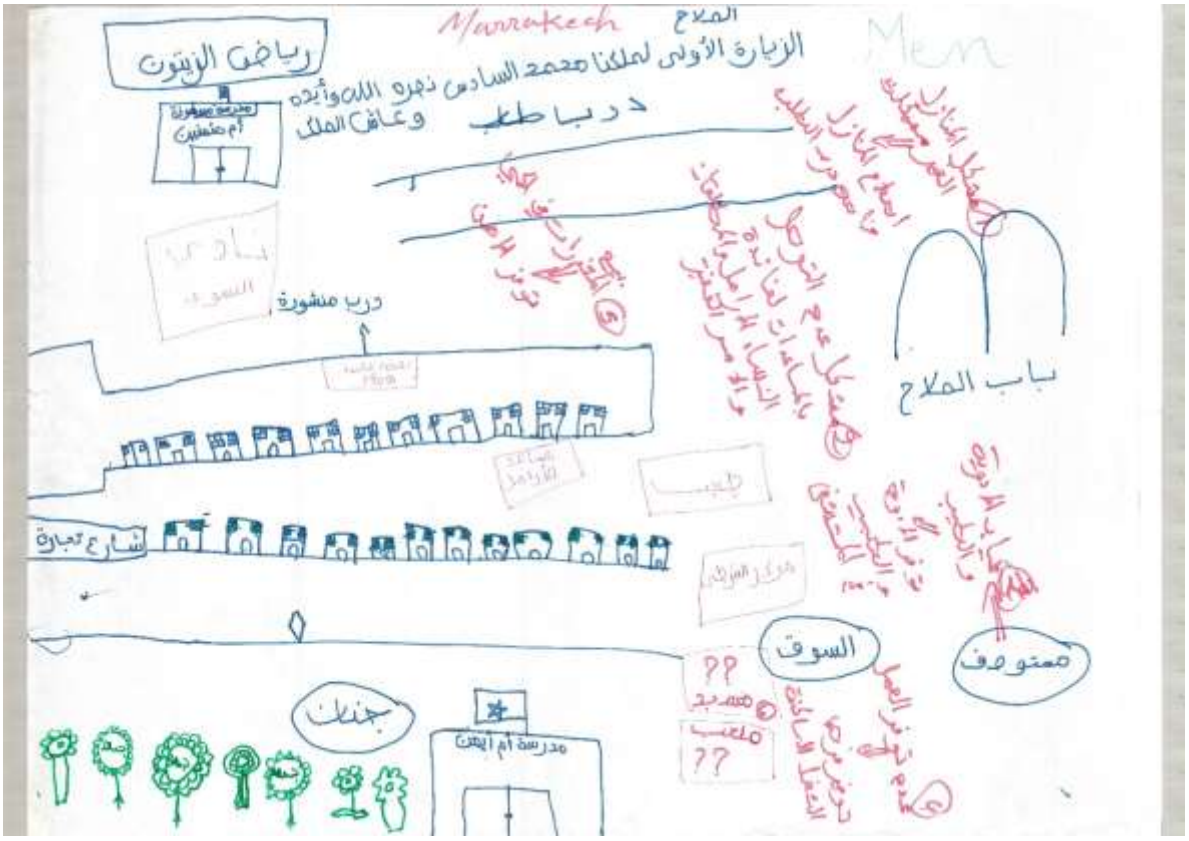

Figure 57 El Mellah Men

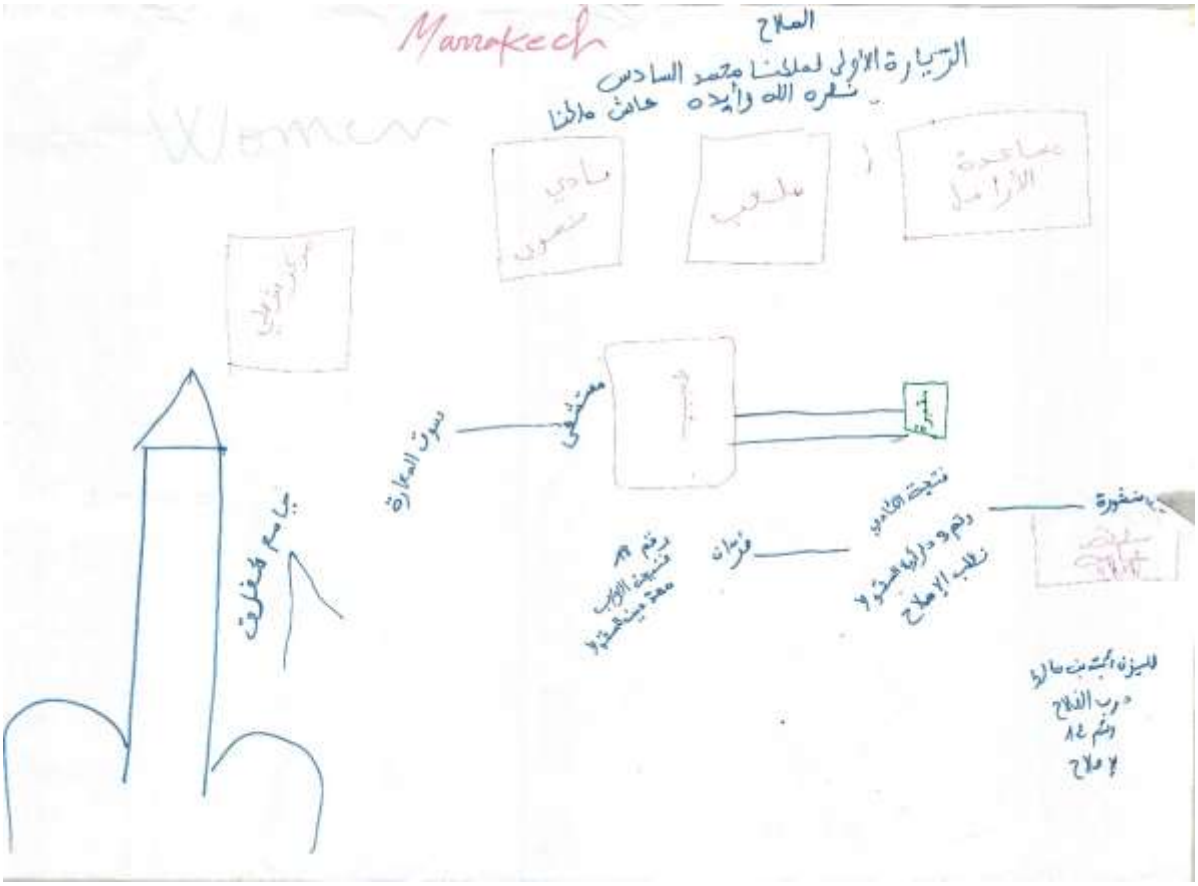

Figure 58 El Mellah Women

Figure 59 Lakliaa Women

Figure 60 Lakliaa Men

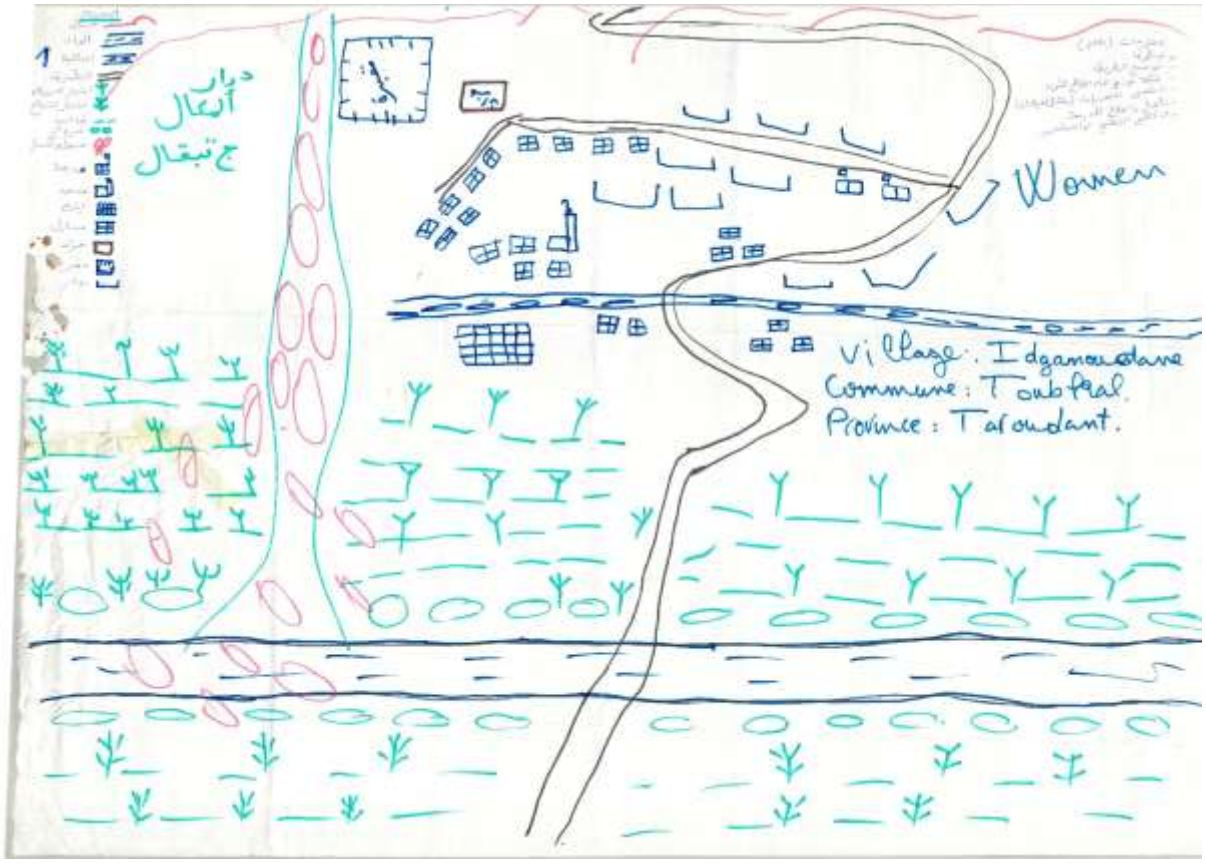

Figure 61 Idganoudane Women

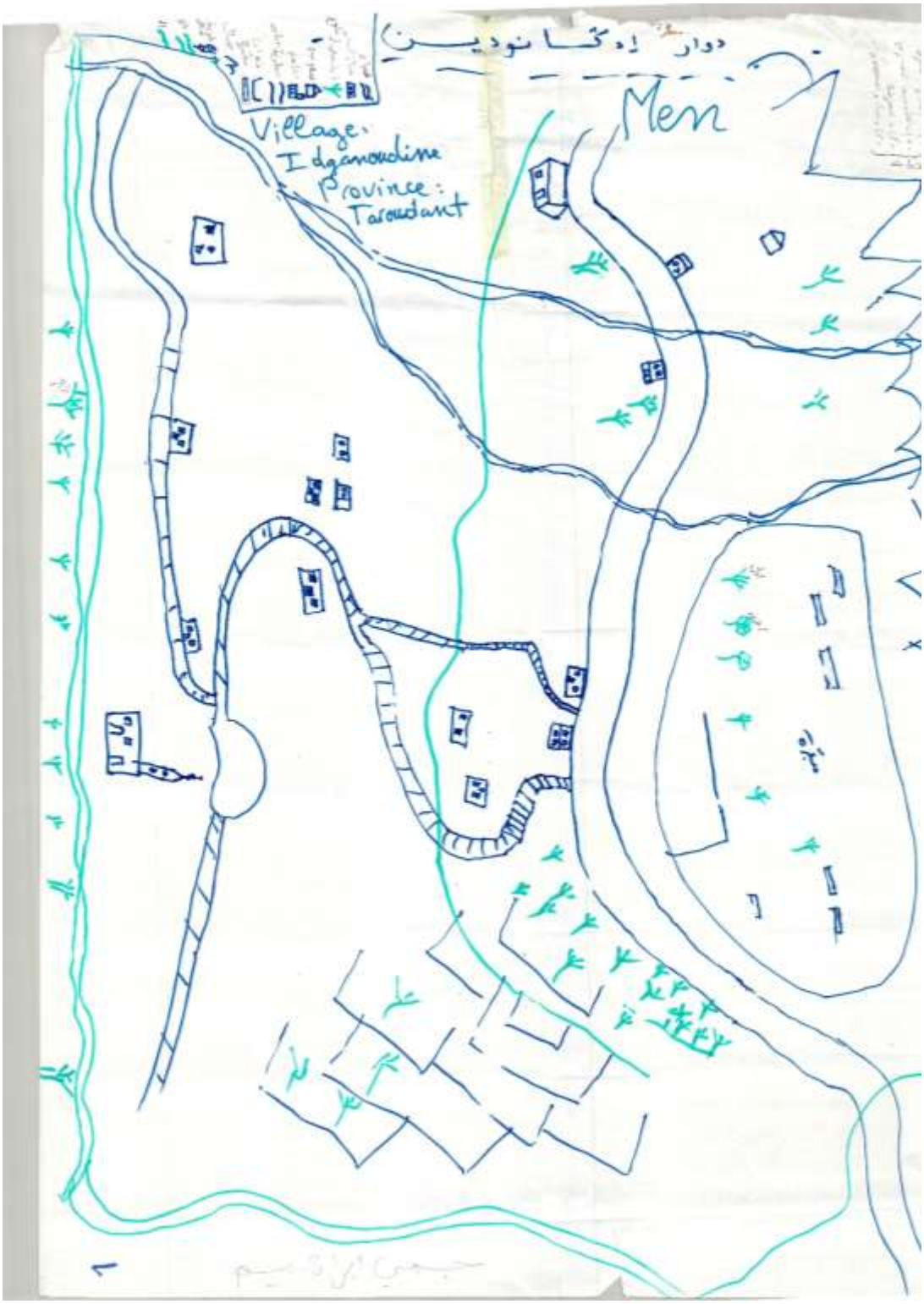

Figure 62 Idganoudane Men

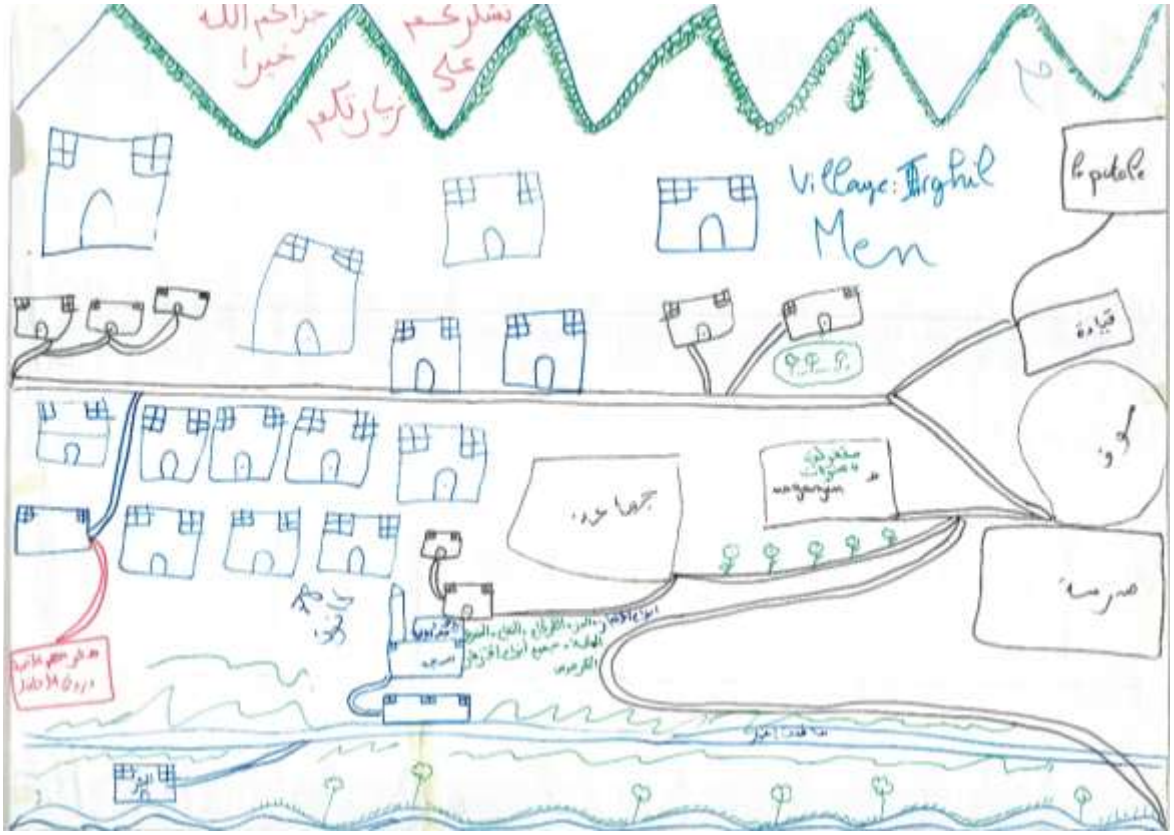

Figure 63 Ighil Men

Figure 64 Ighil Women

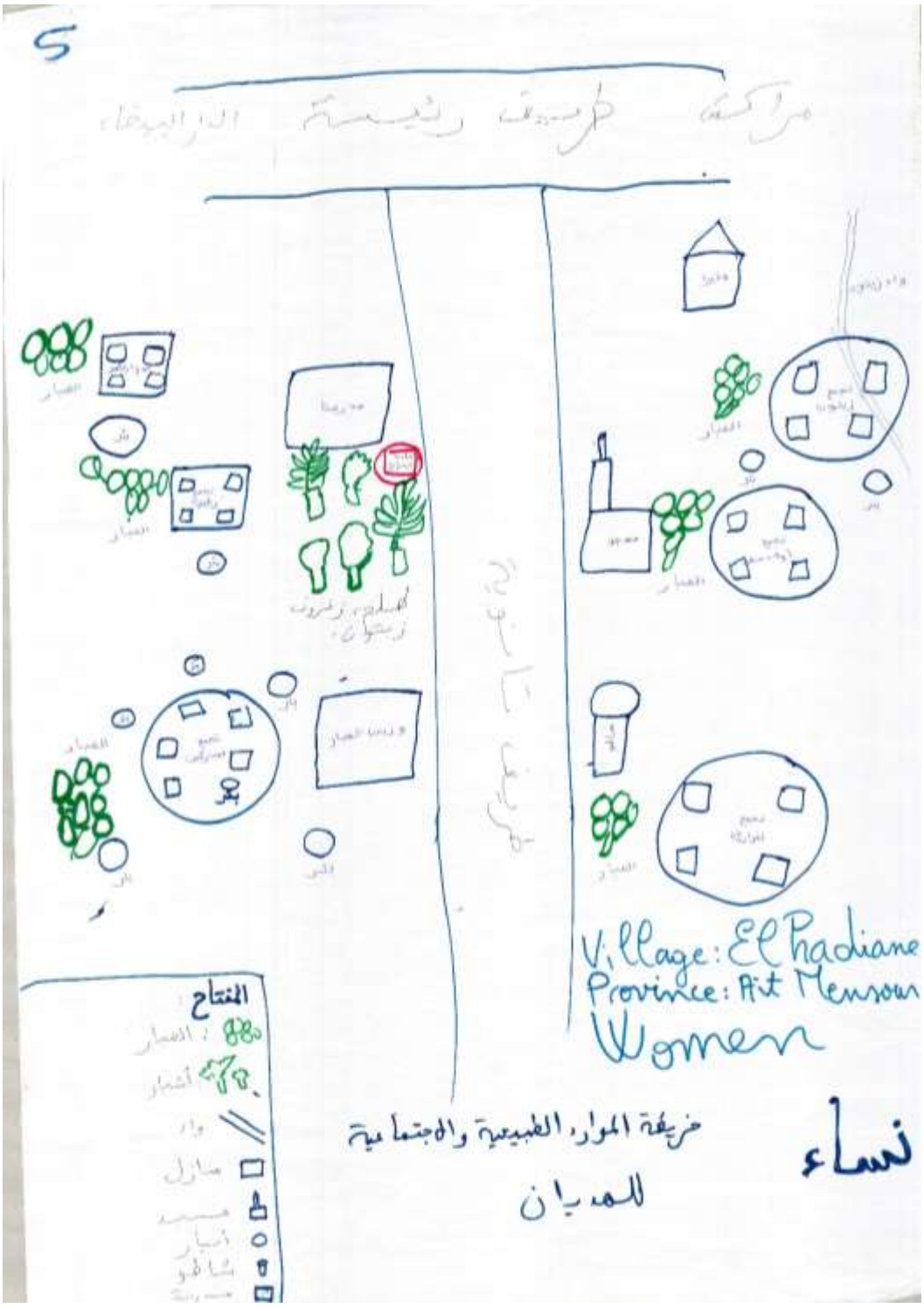

Figure 65 Alhadyane Women

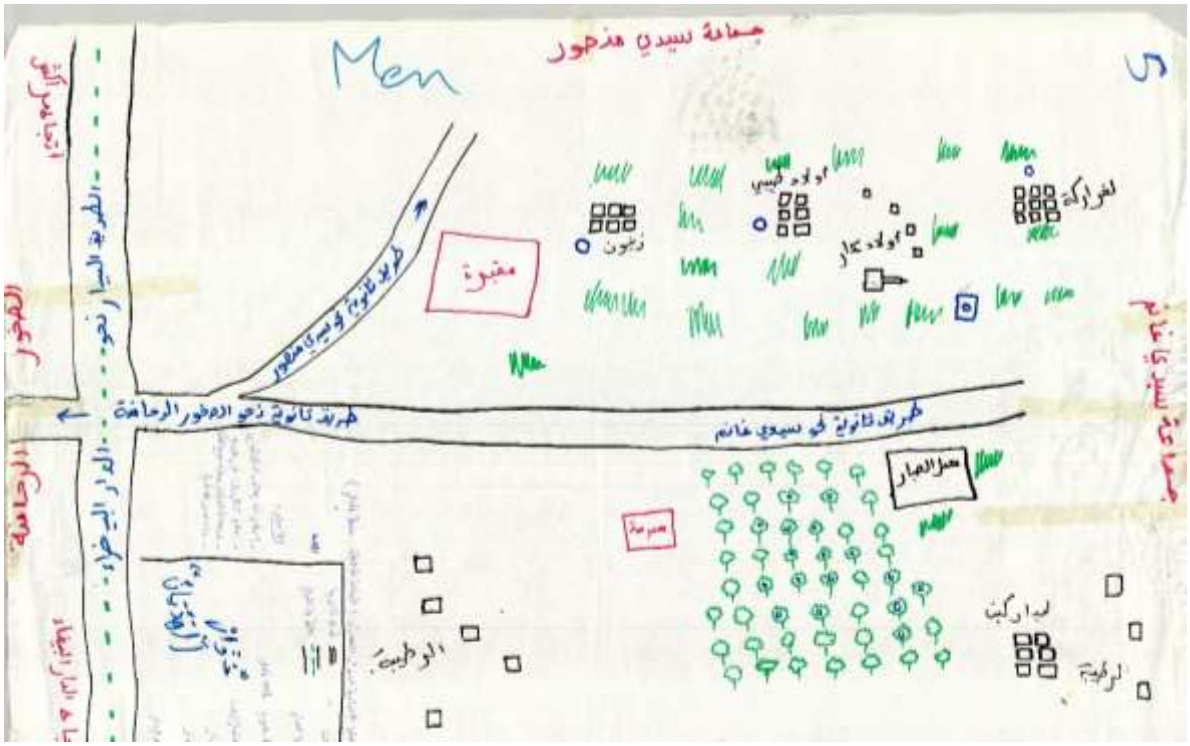

Figure 66 Alhadyane Men

APPENDIX B

Map Translations- Kawthar

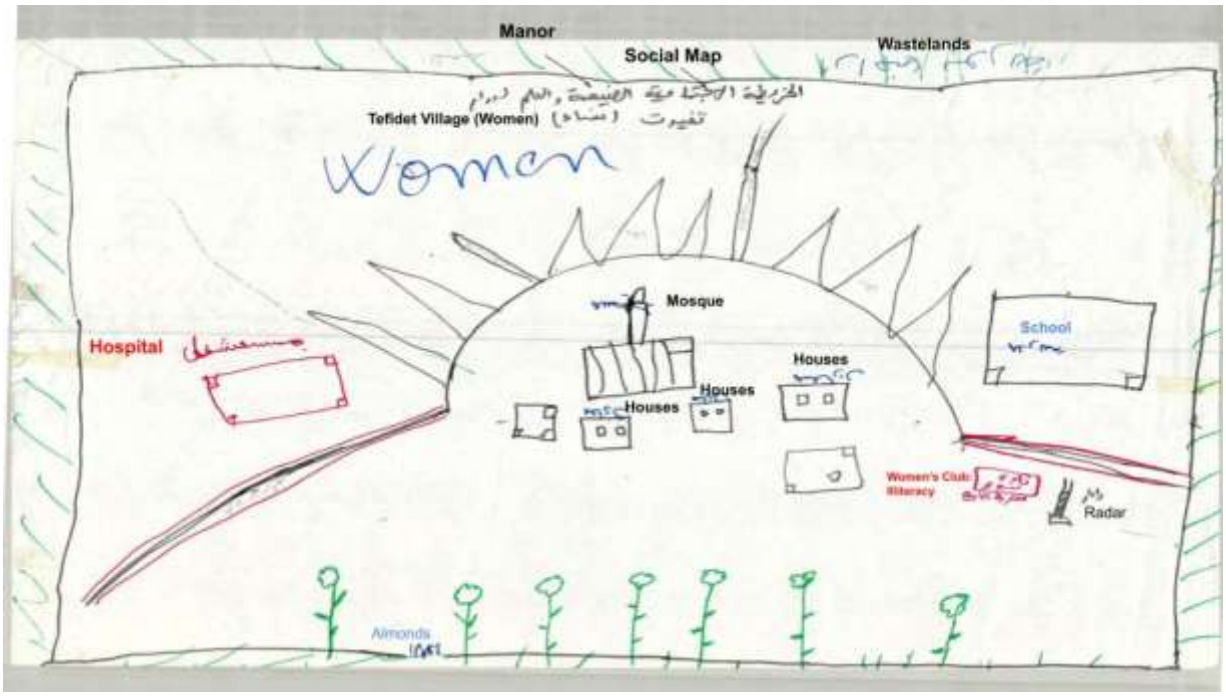

Figure 67 Taghrit Women Translation Kawthar

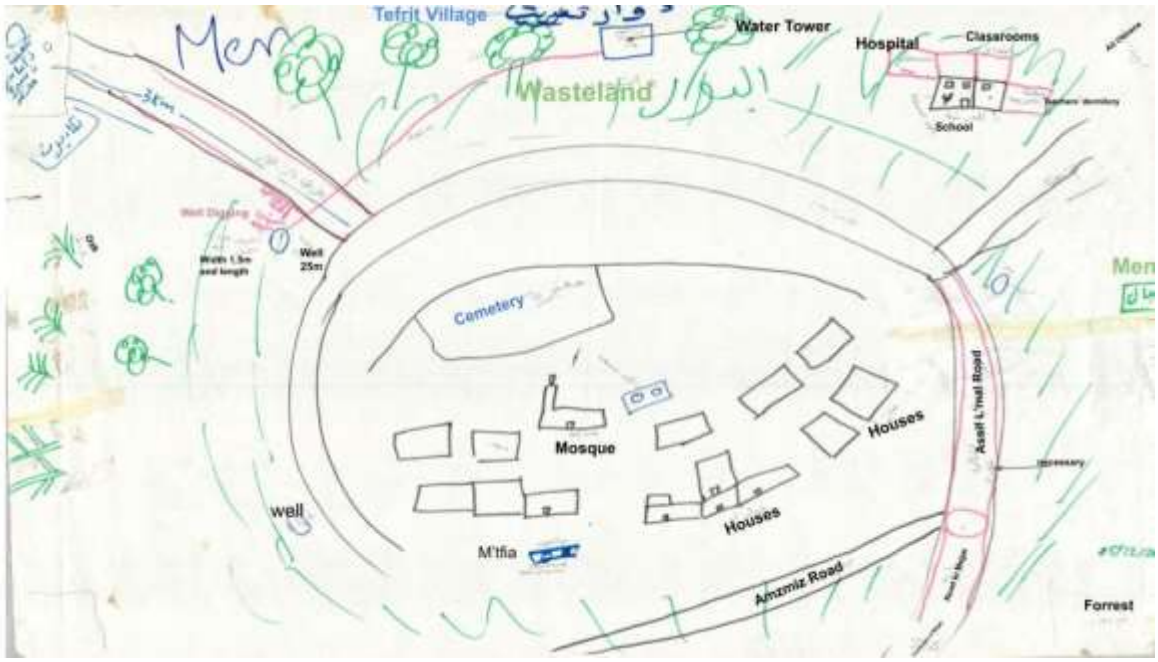

Figure 68 Taghrit Men Translation Kawthar

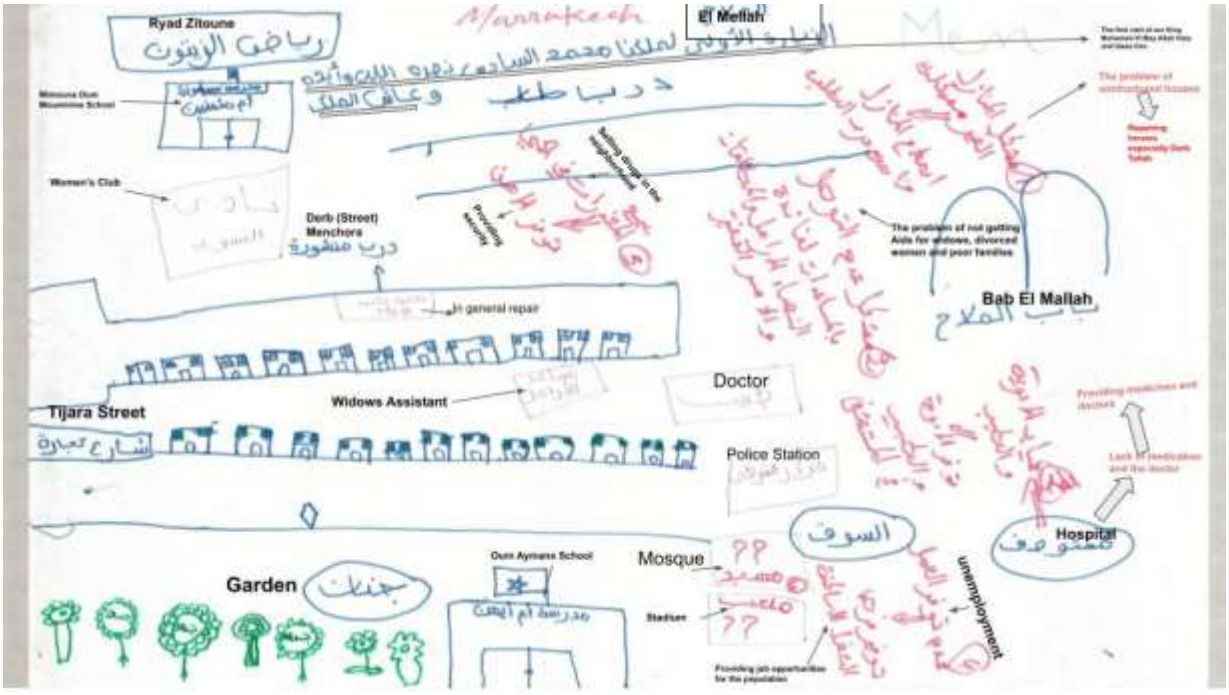

Figure 69 El Mellah Men Translation Kawthar

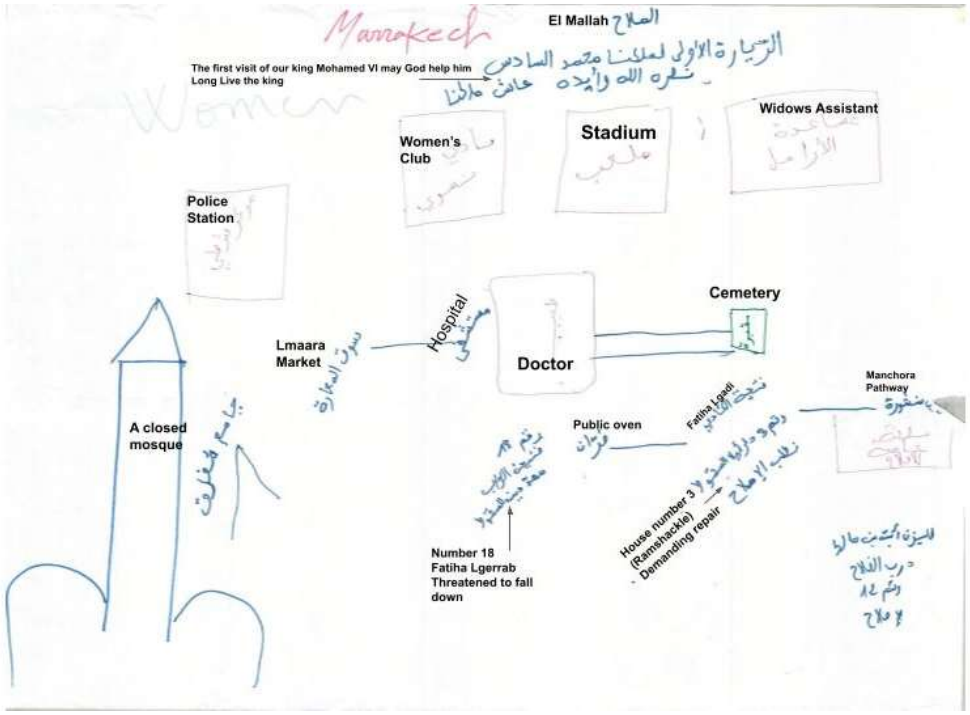

Figure 70 El Mellah Women Translation Kawthar

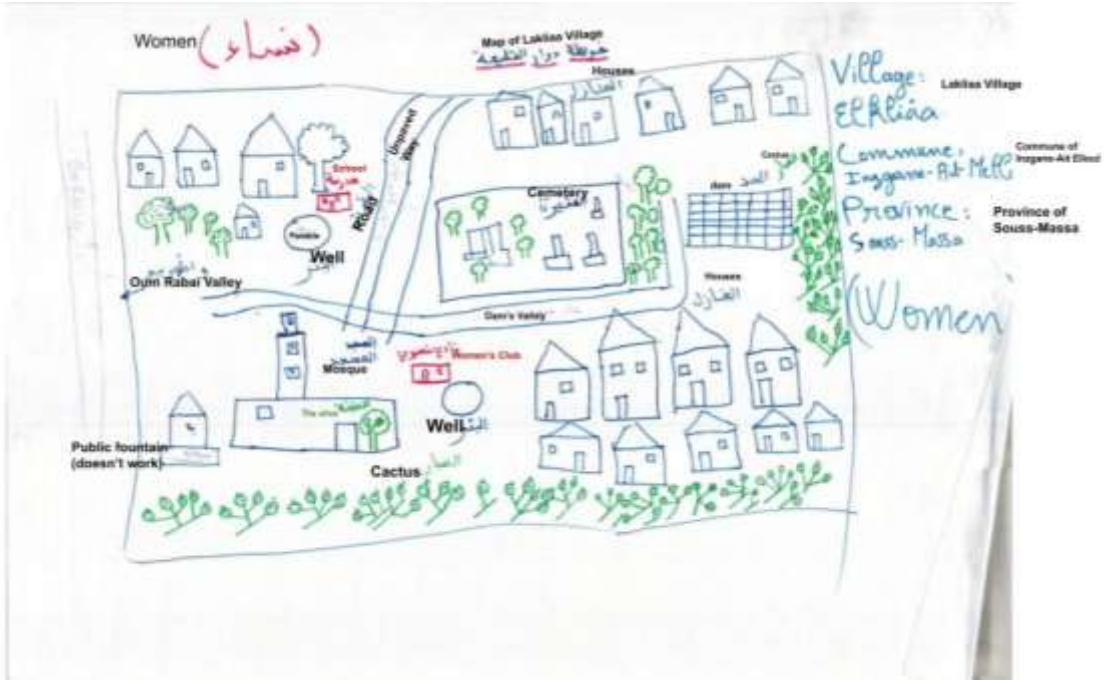

Figure 71 Lakliaa Women Translation Kawthar

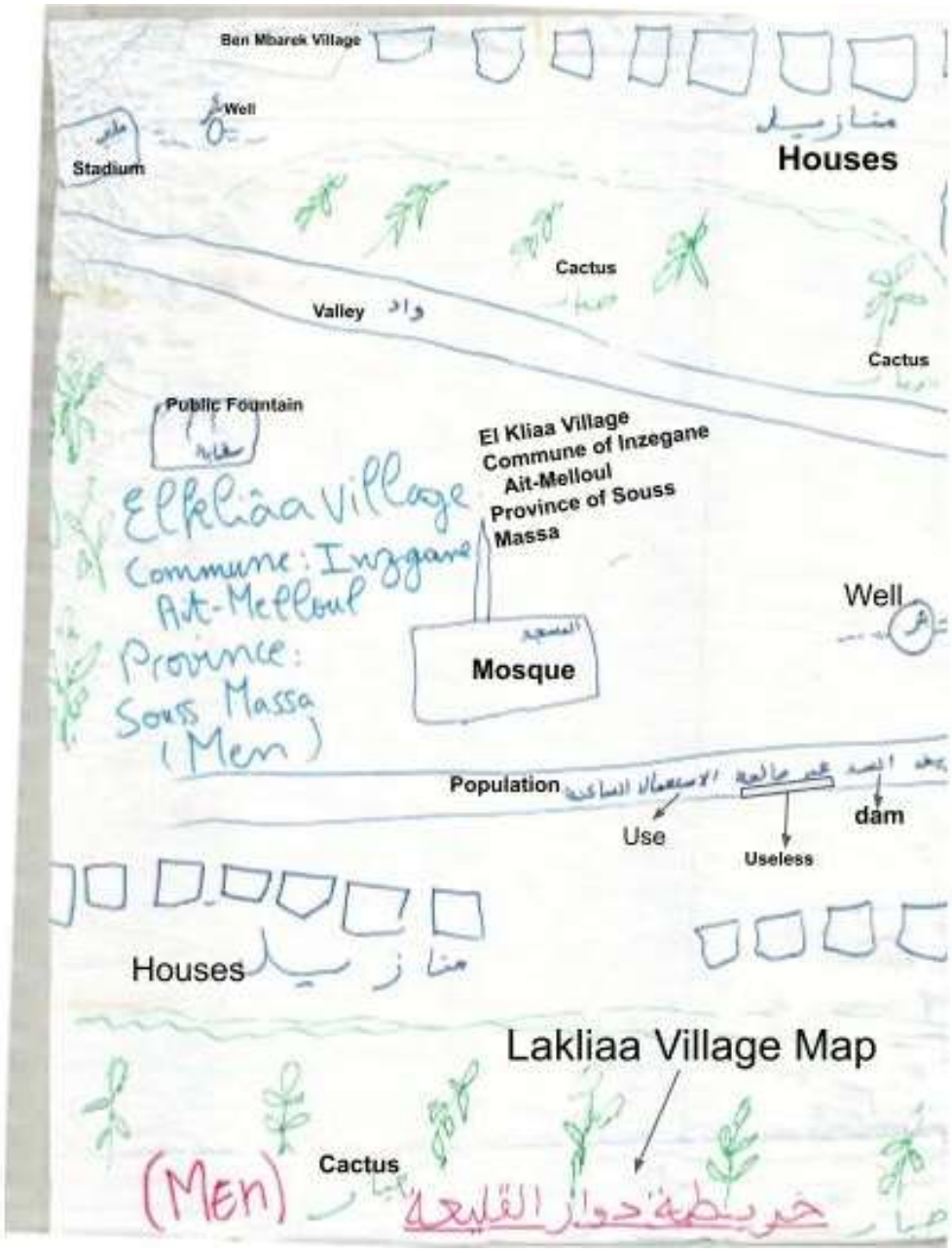

Figure 72 Lakliaa Men Translation Kawthar

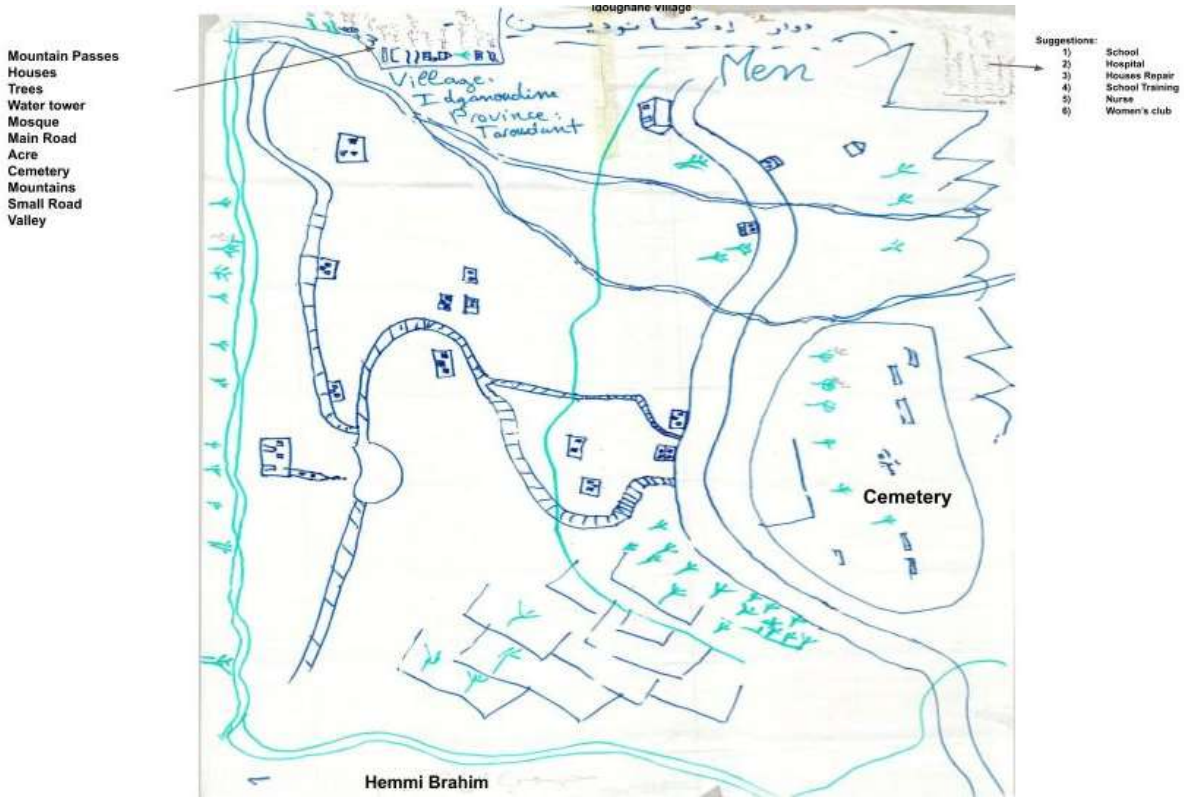

Figure 73 Idganoudane Men Translation Kawthar

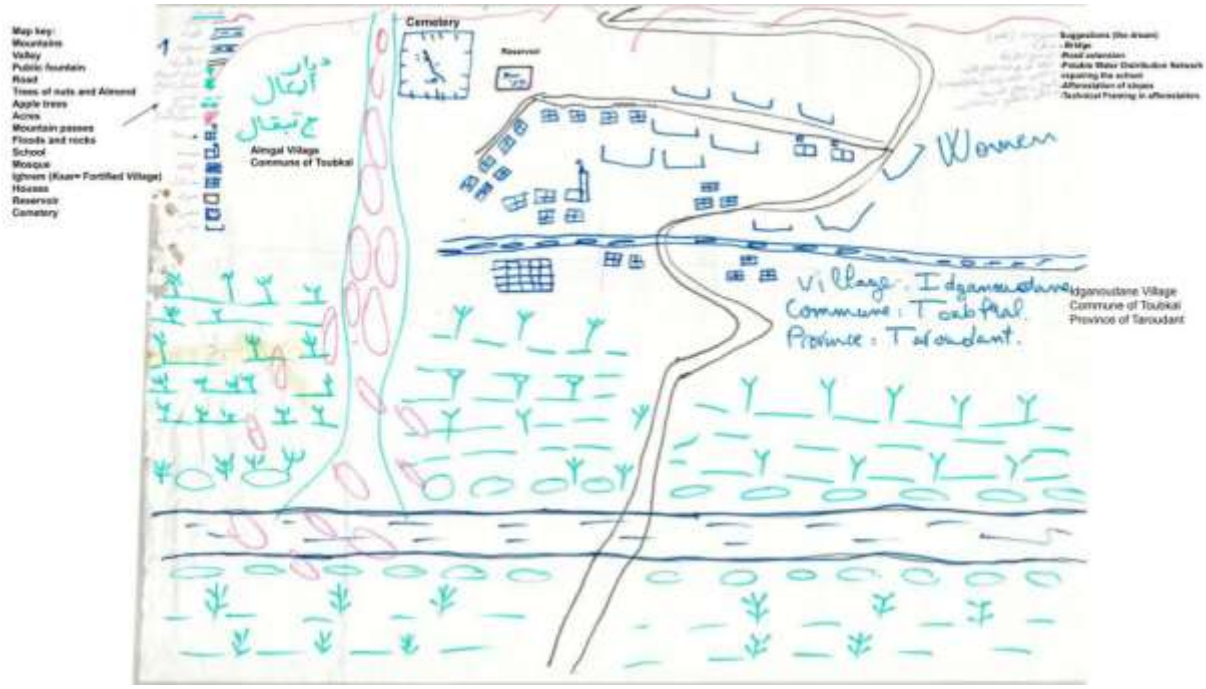

Figure 74 Idganoudane Women Translation Kawthar

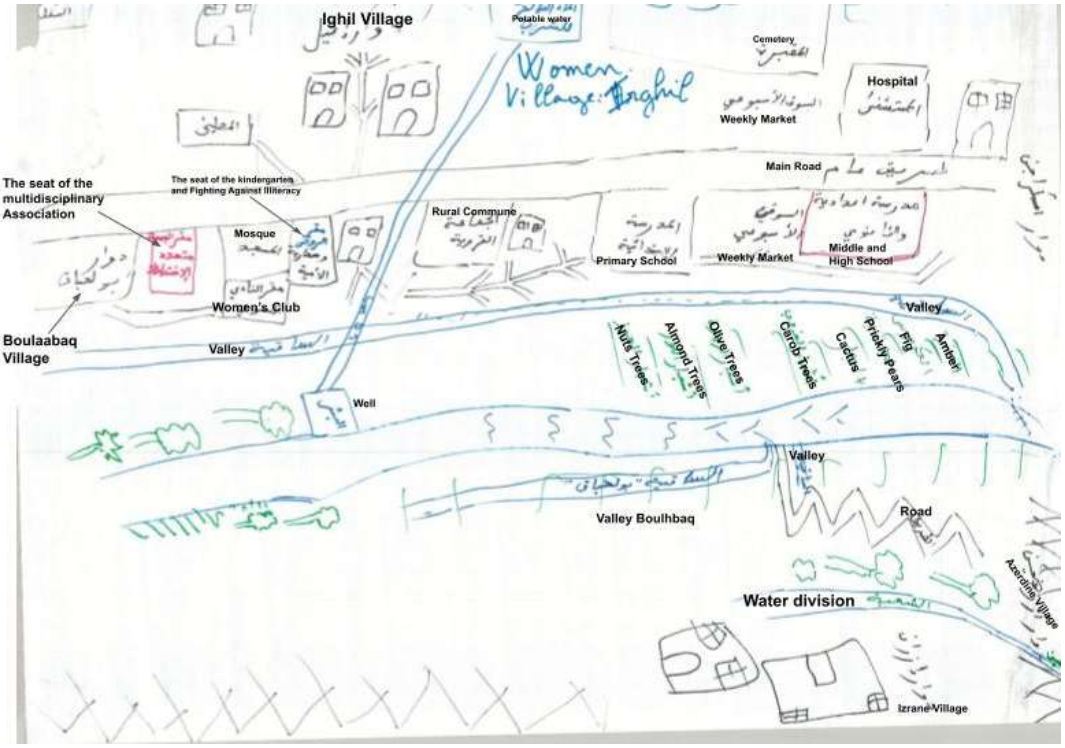

Figure 75 Ighil Women Translation Kawthar

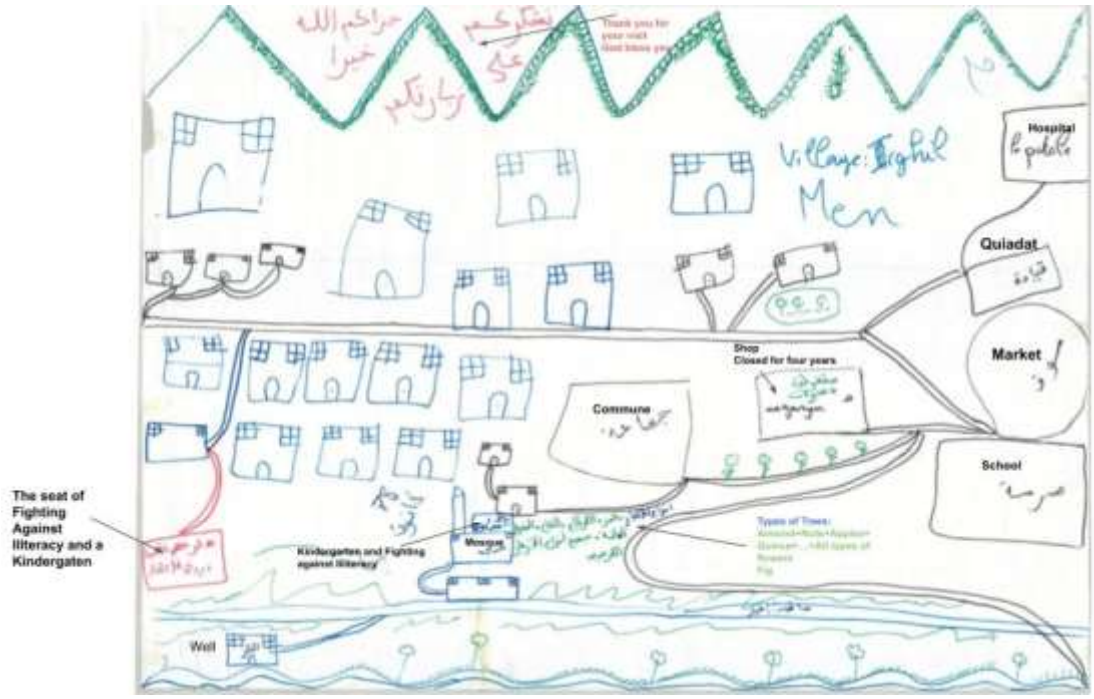

Figure 76 Ighil Men Translation Kawthar

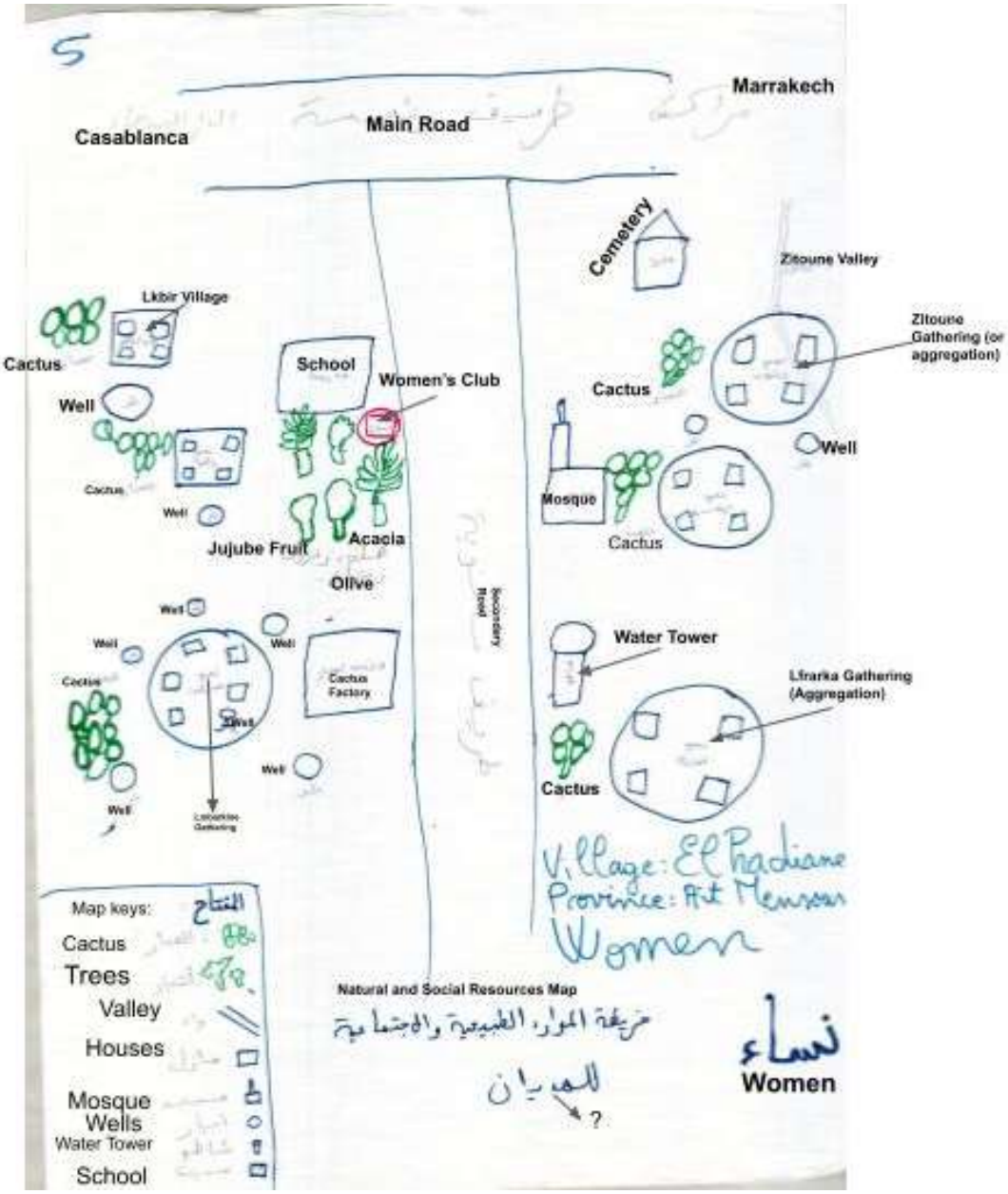

Figure 77 Alhadyane Women Translation Kawthar

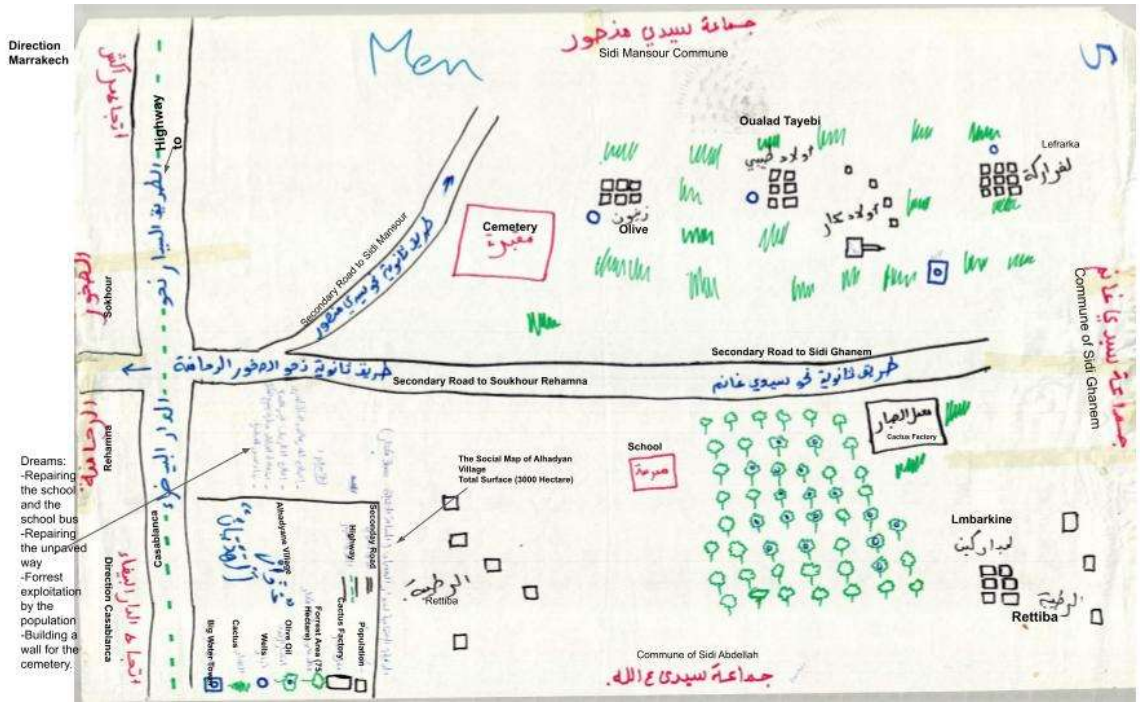

Figure 78 Alhadyane Men Translation Kawthar

APPENDIX C

Maps Translations- Hassan

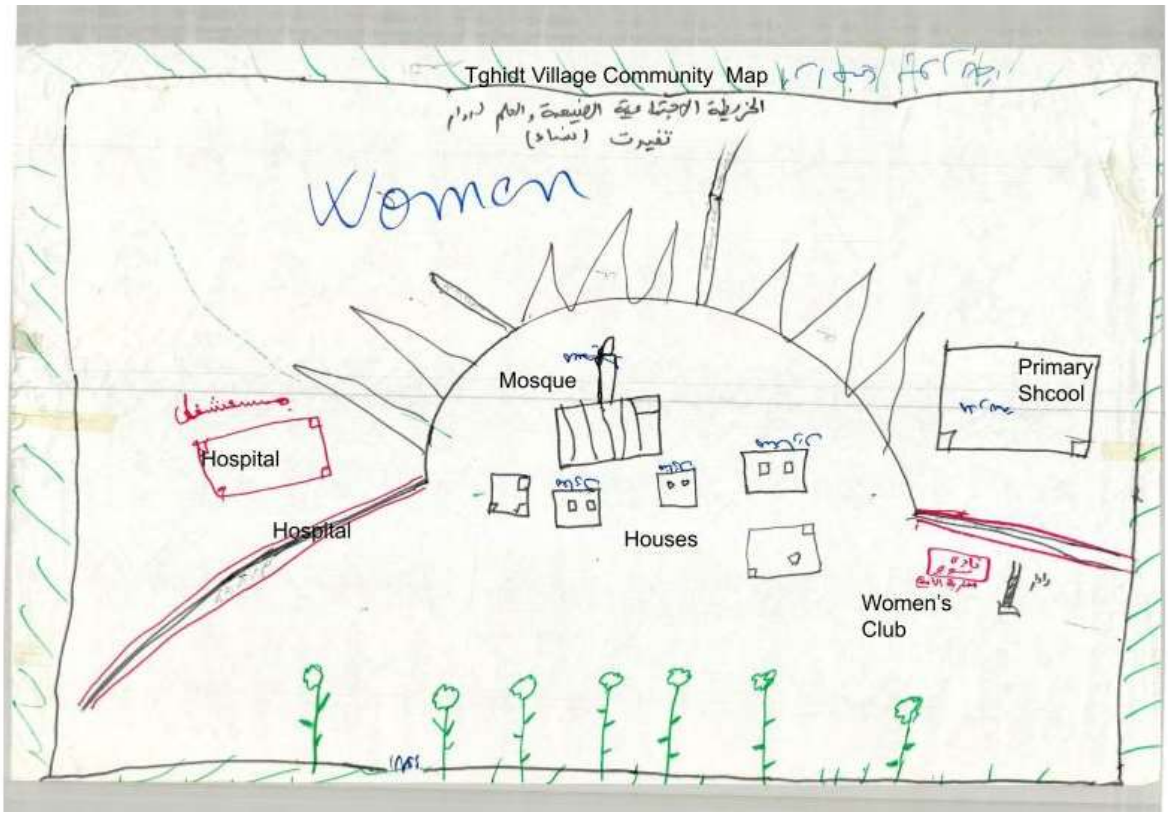

Figure 79 Taghrit Women Translation Hassan

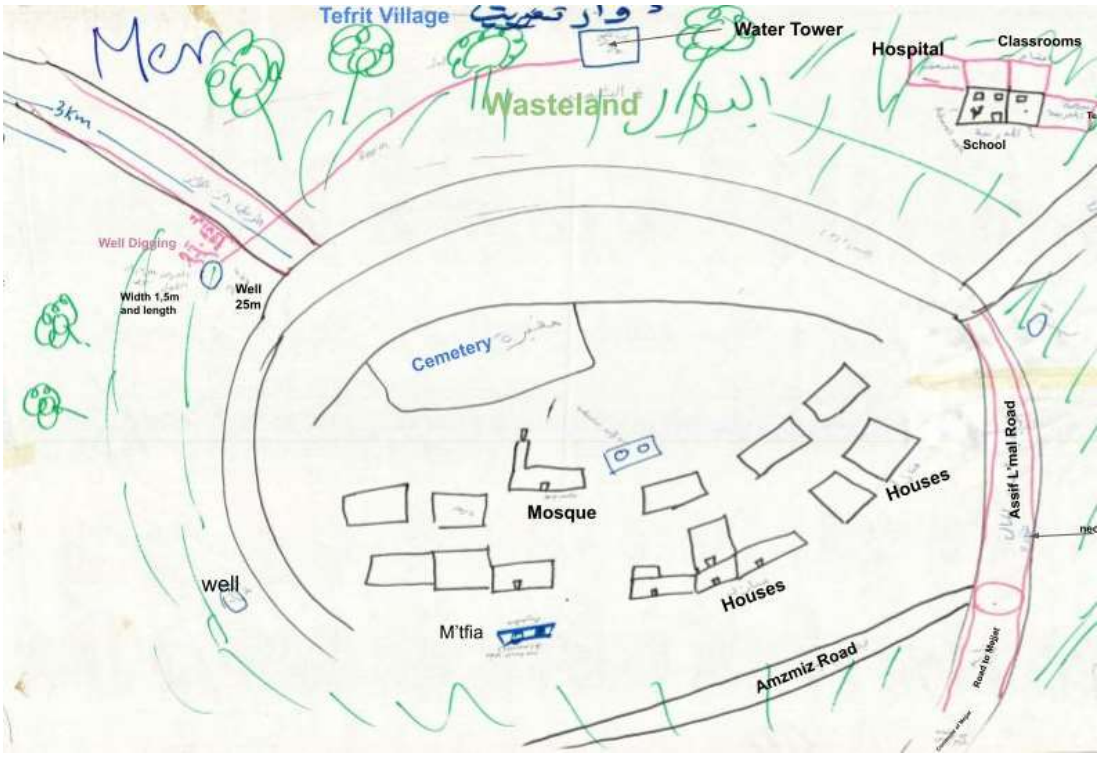

Figure 80 Taghrit Men Translation Hassan

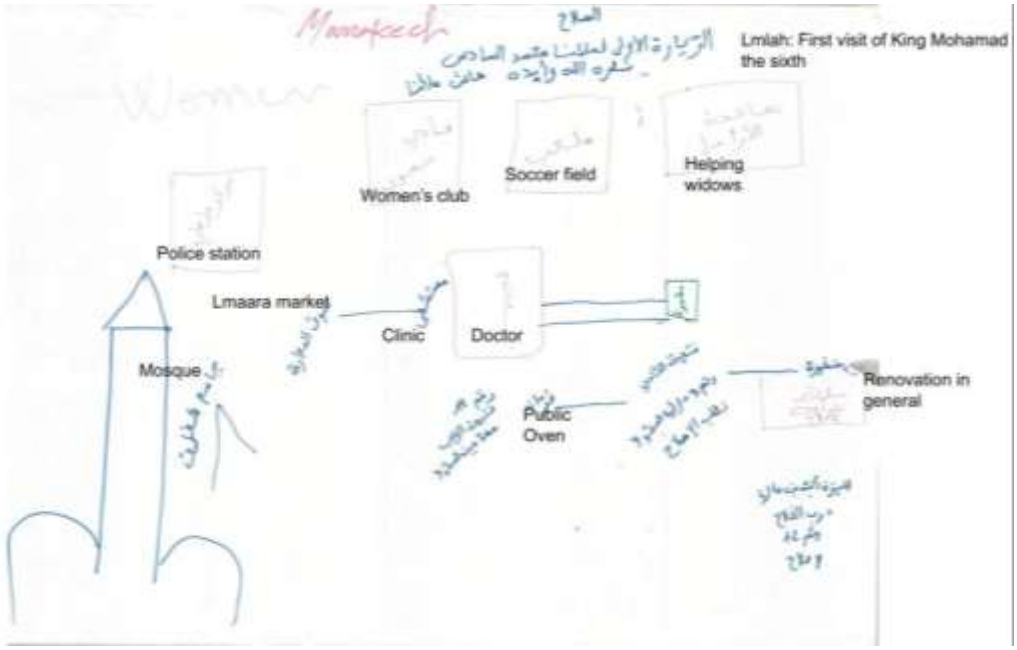

Figure 81 El Mellah Women Translation Hassan

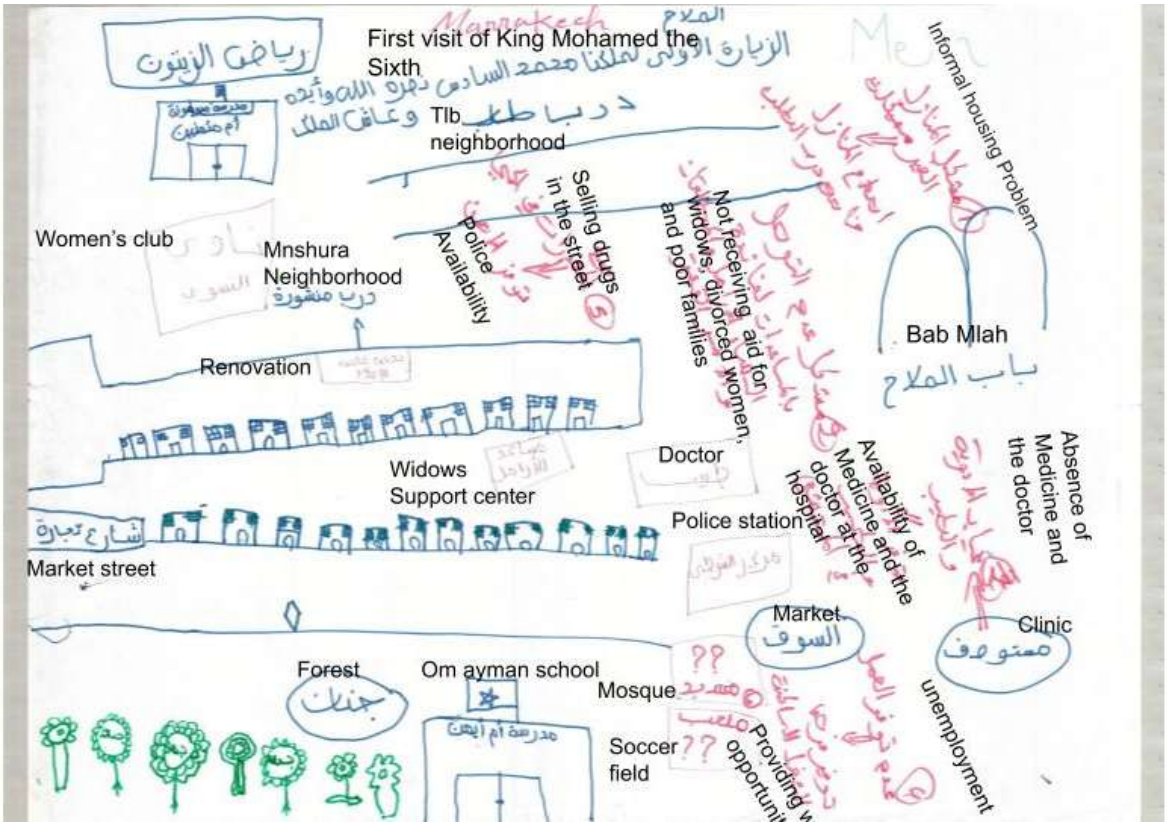

Figure 82 El Mellah Men Translation Hassan

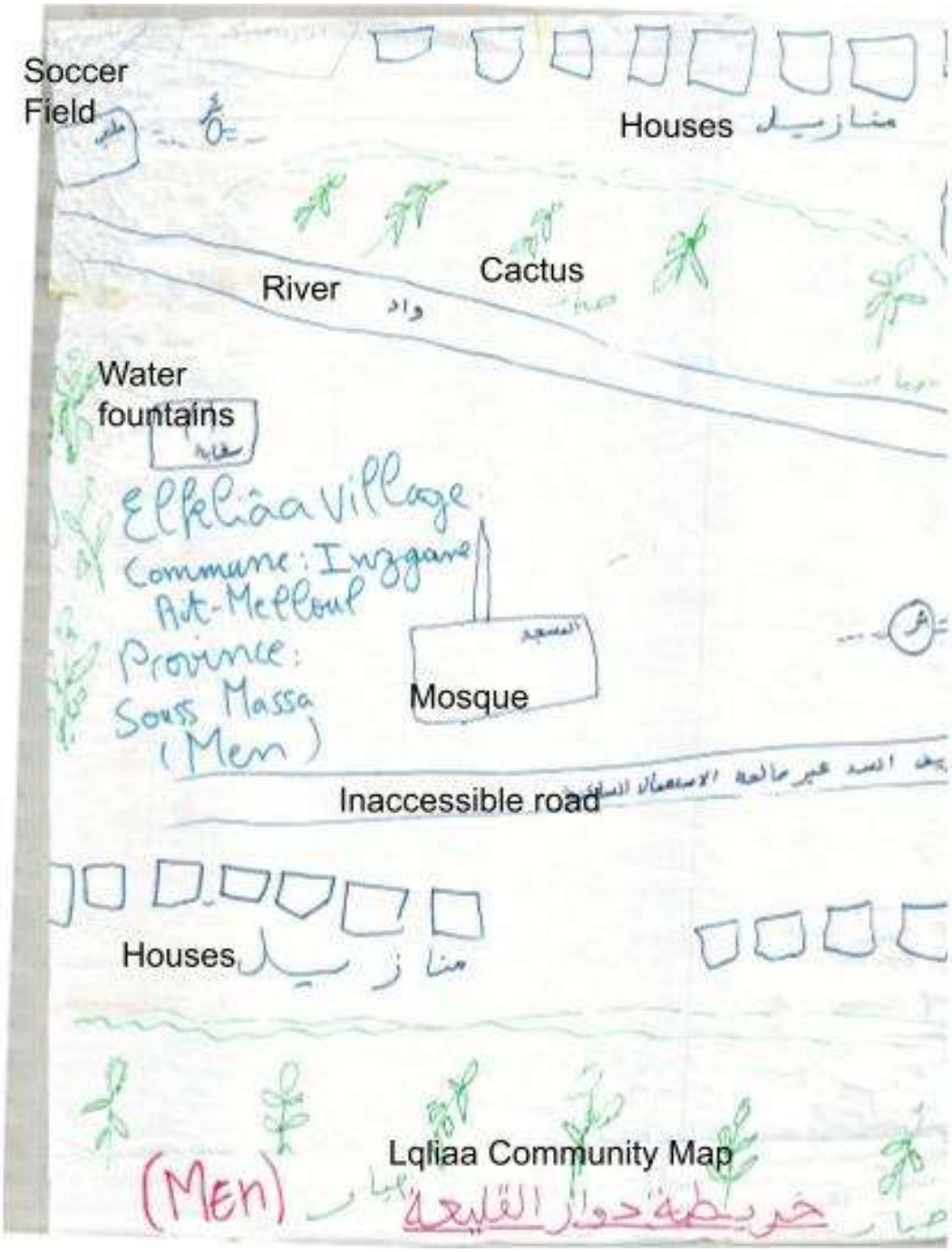

Figure 83 Lakliaa Men Translation Hassan

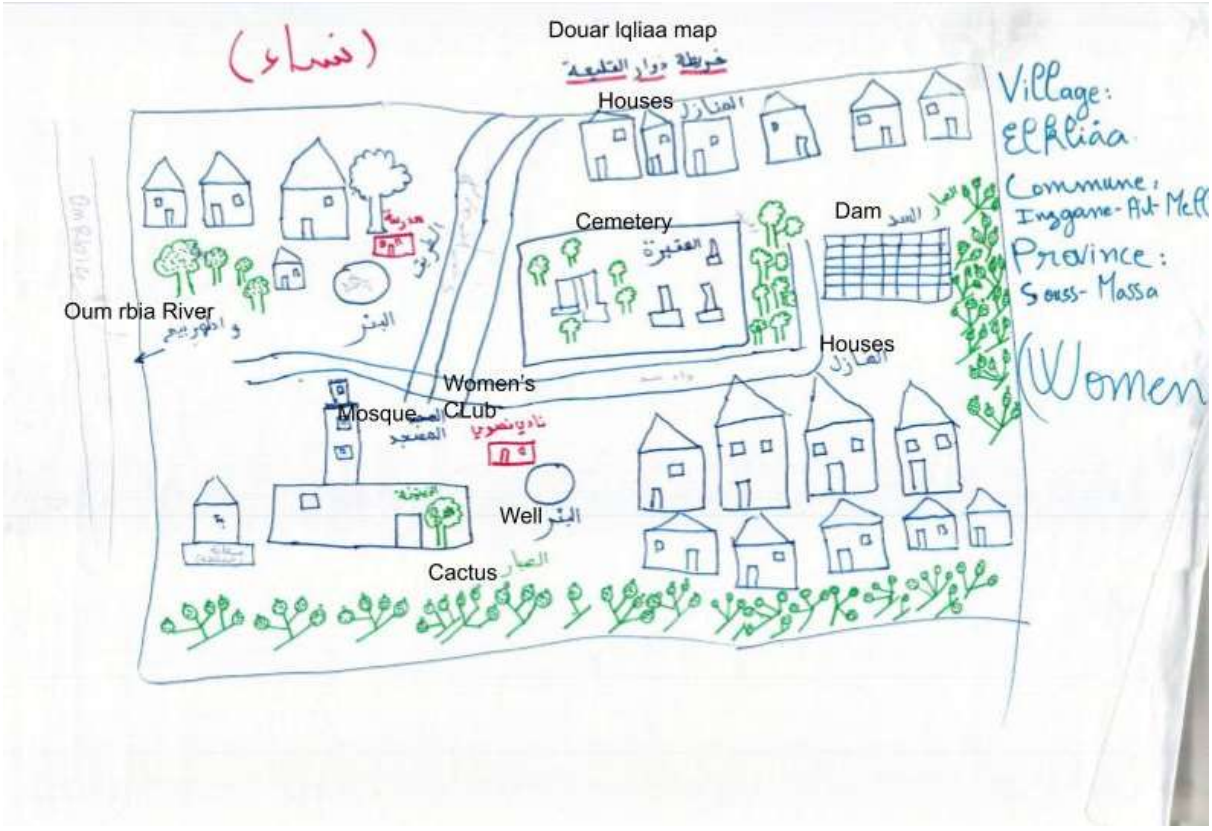

Figure 84 Lakliaa Women Translation Hassan

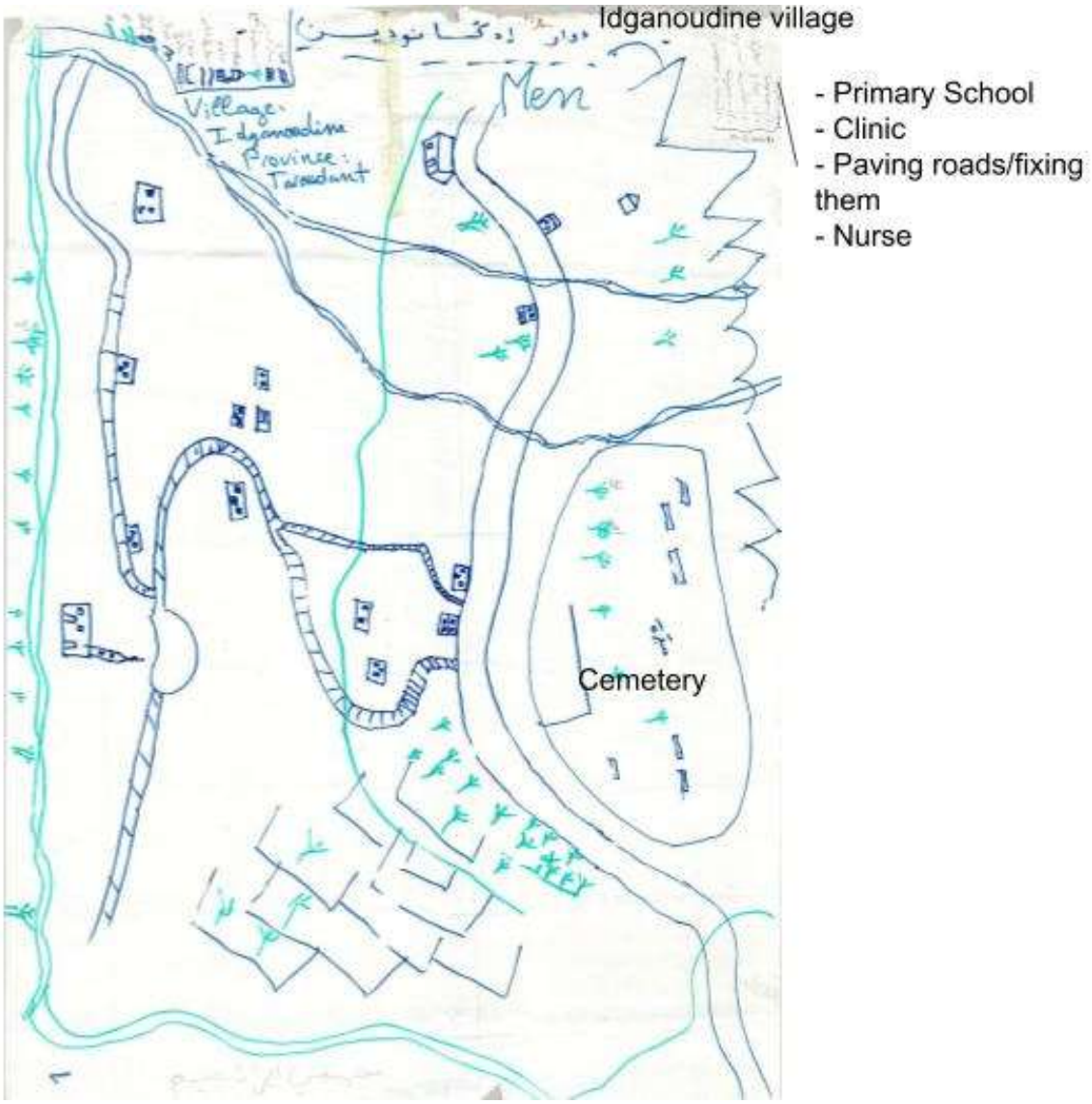

Figure 85 Idganoudane Men Translation Hassan

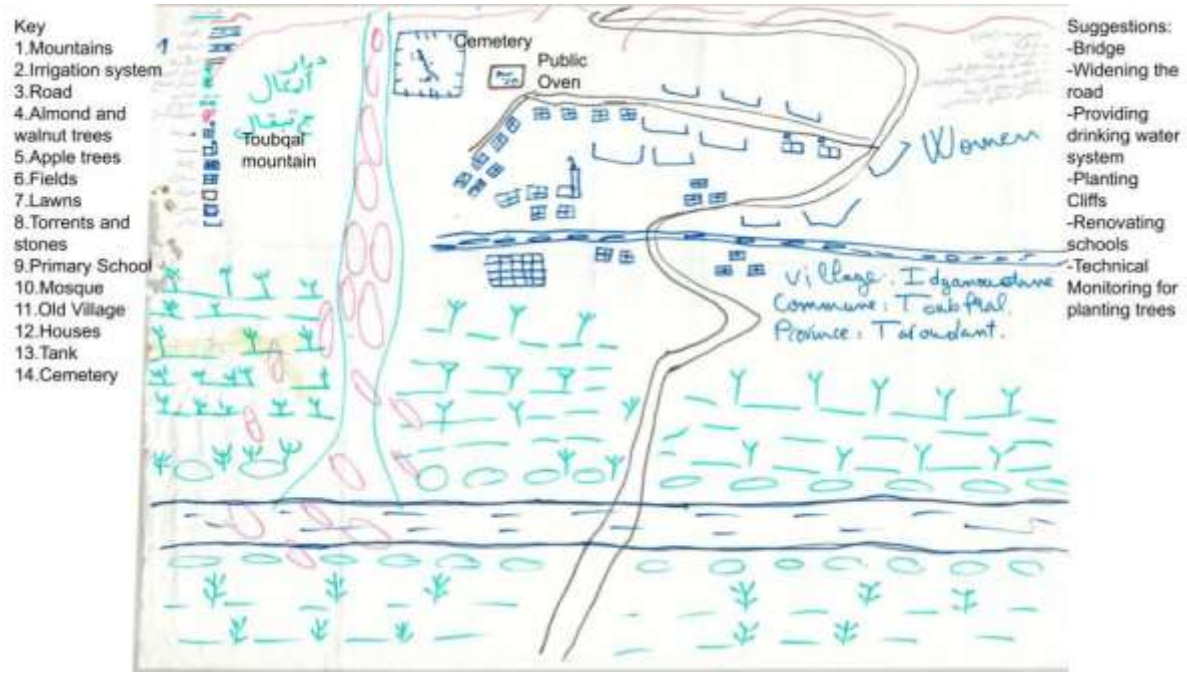

Figure 86 Idganoudane Women Translation Hassan

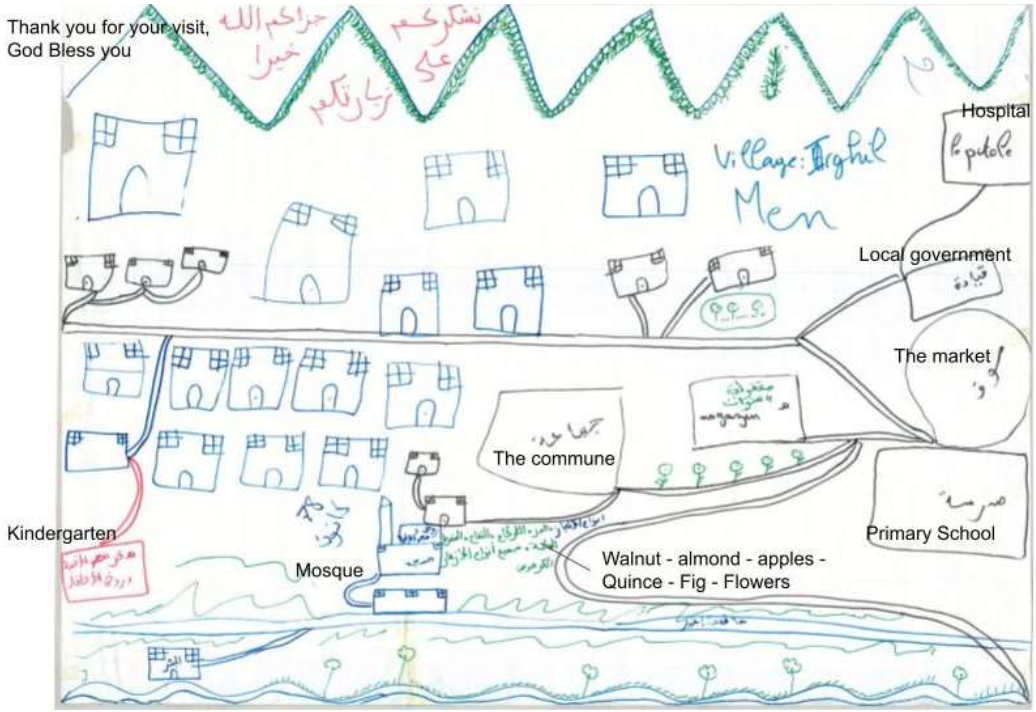

Figure 87 Ighil Men Translation Hassan

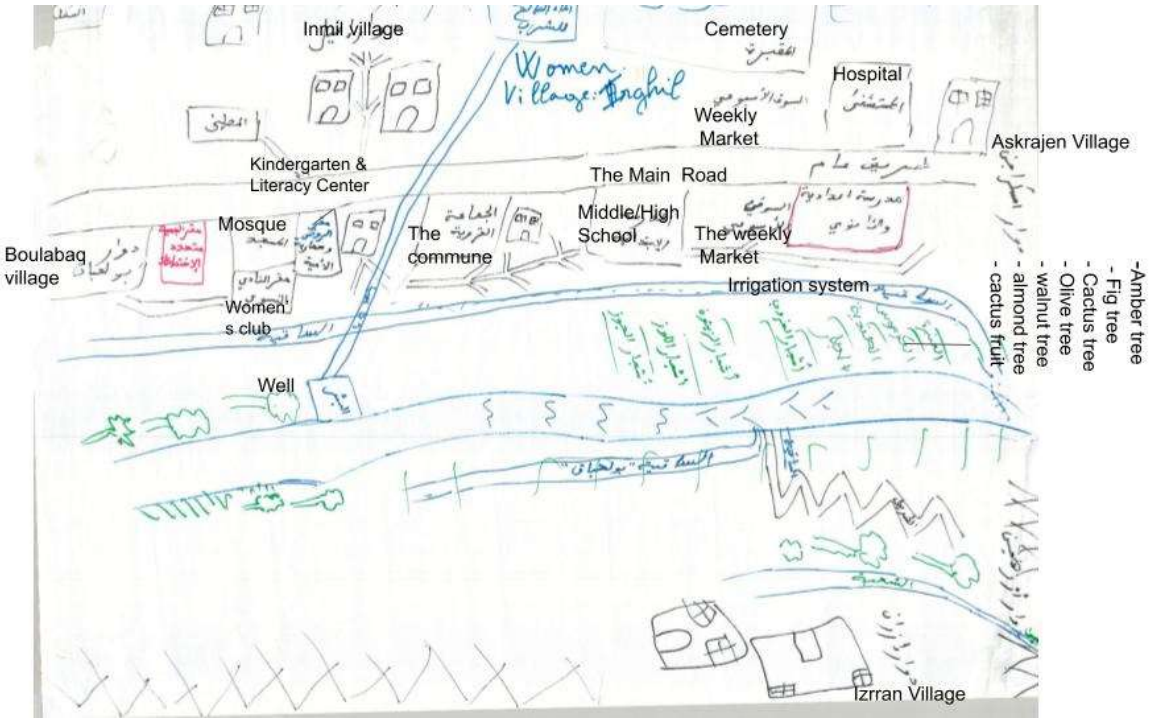

Figure 88 Ighil Women Translation Hassan

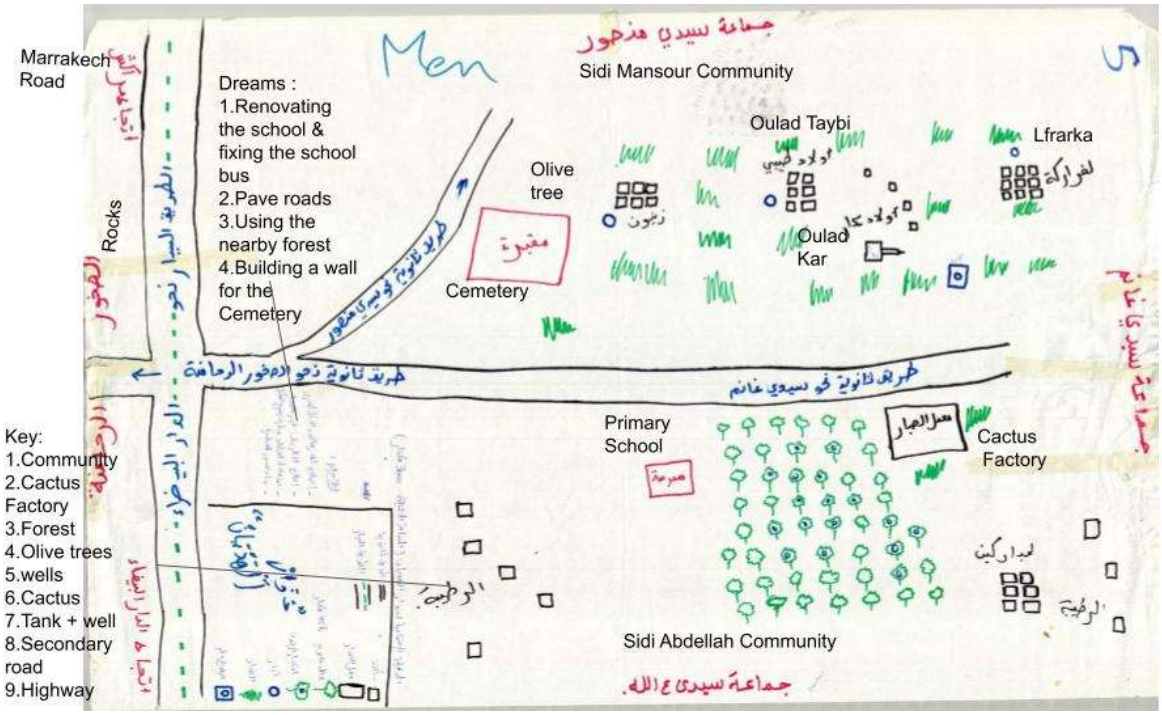

Figure 89 Alhadyane Men Translation Hassan

Figure 90 Alhadyane Women Translation Hassan

APPENDIX D

Consent Form

Consent Form

I, Yossef Ben-Meir, President of the High Atlas Foundation, give Cora Stern, Master's student at George Mason University in the Department of Geographic and Cartographic Sciences, permission to use the digital copies of the community maps (sketch maps) sent to her by High Atlas Foundation for her thesis research. These community maps can be analyzed and included in her published thesis. The original paper copies of the community maps will remain in Morocco at the High Atlas Foundation offices.

Figure 91 Consent Form

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