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Roads to Participatory Planning

Integrating Cognitive Mapping and GIS for Transport Prioritization in Rural Lesotho

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Abstract

It is increasingly understood that transport infrastructure and services are critical elements to achieving poverty reduction, gender equality, and sustainable development, but relevant methods to systematically characterize and address differences in mobility and access are lagging. This paper presents a series of maps based on an integrated pilot application of geographical information systems (GIS) and participatory sketch mapping to elicit and evaluate differential mobility and access patterns of villagers in the highlands of rural Lesotho. Fieldwork was carried out in the Senqu and Senqunyane Valleys in southern Lesotho—among the most isolated areas in the country—to link local-level information and perspectives on transport and other services to the enhanced GIS at the Ministry of Public Works and Transport. The resulting cognitive maps and focus group interviews reveal significant gender differences in mobility and access with implications for healthcare, education, and transport planning; they also provide a basis for cross-sectoral participatory decisionmaking through the integrated GIS.

Key Words: cognitive mapping, GIS, health, transport, gender

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Introduction

Spatial exclusion is an important component of social marginalization and vulnerability. Within the transport sector, it is increasingly understood that transport infrastructure and services play a critical role in addressing exclusion and achieving the goals of poverty reduction, gender equality, and sustainable development. However, to date, methods to systematically characterize and address differences in mobility and access are lagging. Failure to consider the linkage between spatial exclusion and vulnerability often leads to transport investment planning from afar and often does not address the infrastructure needs of communities on the ground. This paper presents a participatory mapping study of differential mobility and access patterns of villagers in the highlands of rural Lesotho, carried out in collaboration with the Ministry of Public Works and Transport (MoPWT).

Constraints imposed by topography and poverty are particularly important underlying dynamics in the distribution of inequality in Lesotho. Three-quarters of the terrain is mountainous, 85 percent of inhabitants live in rural settlements, two-thirds of the population is poor, and HIV/AIDS rates are among the highest in the world. Investment in transport infrastructure since the mid-1960s has concentrated on urban centers and export/import corridors, leaving the majority of highland rural areas underserved. To address this gap, over the past five years the MoPWT has been developing an interactive geographical information system (GIS) database of the national road network. This undertaking resulted in comprehensive base

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Special thanks to our field collaborators, Thasi Phomane, Government of Lesotho Ministry of Public Works and Transport, Department of Rural Roads; Nonkuleleko Zaly, Government of Lesotho Ministry of Public Works and Transport, Main Roads Branch; Senate Moonyane, Government of Lesotho Ministry of Public Works and Transport, Department of Rural Roads; and M. Mokhoro, Government of Lesotho Ministry of Public Works and Transport, Main Roads Branch. This work was supported by the World Bank Africa Transport Division.

maps of the national road infrastructure combined with other layers of related information, including the environment, water, topography, airports, bridges, health centers, schools, villages, and many major footpaths.

As part of the Lesotho Integrated Transport Program, the government identified options for how to integrate information systems to better address the needs of Ministry users and identify sources of spatial data that would enhance the GIS by linking poverty and social information and issues to transport sector planning and management (Oddsson et. al. 2004; Walker and Lema 2005). The objective of these efforts was to use GIS as a tool and decision support system that allows the MoPWT to better target investments, achieve poverty reductions, coordinate data across sectors, monitor indicators and impacts, and facilitate effective stakeholder communication and participation. Despite these national integrated development planning efforts, one of the most important uses of the information in the GIS has yet to be fully exploited: namely, its use as a communication tool to facilitate the participation of stakeholders at the local level in the analysis and prioritization of road works.

To date, most local-level transport sector studies of mobility and access have been based on data from individual time and/or activity diaries or household survey questionnaires covering cost, distance, time, and mode. Although these methodologies are useful, they are time-consuming to implement and often costly. In addition, they reveal little about local perceptions regarding barriers to mobility and access (physical, financial, or social) or about how decisions regarding mobility are made for different members within a household. Failure to disaggregate data can mask gender and other relevant social dimensions that subsequently lead to the design of inadequate transport infrastructure and limited services for vulnerable groups within a population. Recent advances in GIS technology have allowed for more extensive data analysis on mobility and access, but the relevant methodologies have not made extensive inroads into how transport ministries operate or make decisions (Lovett et al. 2002; Boothby and Dummer 2003).

Methods

This pilot study aims to bridge the gap between collecting spatial information and fostering stakeholder communication in transport planning by integrating two methodologies: participatory sketch mapping and GIS. This combination of mapping methods allows groups and communities to work with familiar hand-drawn participatory maps, while still taking advantage of the storage and analytical capabilities of GIS (see Brodnig and Mayer-Schönberger 2000; Kienberger et al. 2005; Mapedza et al. 2003; Mbile et al. 2003; Robiglio et al. 2003; Tripathi and Bhattarya 2004; Vajjhala 2005a, 2005b; and Weiner et al. 2002 for related methodological

discussion and applications). The new maps have the appearance of traditional participatory maps, but each icon accesses the database of spatial information typically stored in a GIS and establishes a direct digital interface with other related project information. Our approach balances the social and spatial dimensions of participatory mapping and GIS to illuminate local perspectives and to bring communities and local government into the road network decisionmaking process.

The participatory methodology was designed to elicit hand-drawn cognitive maps of mobility patterns and access to services in five steps. First, focus group interviews were conducted centered on mapping key destinations, services, and routes (e.g., footpaths and roads) and identifying opportunities and barriers to transport or service access (e.g., cost, time, mode, and seasonal disruption). Sketch maps were developed by a "scribe" from within the group or a member of the fieldwork team based on group responses to interview questions. Second, global positioning system (GPS) points were taken for key destinations and paths, following village mapping interviews. Third, the information from interviews and paper sketch maps was compared and consolidated to allow for team dialogue, and "case study" maps were created; these activities focused on the analysis of key issues, such as emergency transport and school access, raised in the interviews. Fourth, the consolidated participatory sketch maps were incorporated as layers in GIS, extrapolating from GPS points and place names taken in the field. Finally, the layers were set up to be viewed alongside base maps and other layers in the existing MoPWT GIS, thereby integrating the perspectives and issues into the Ministry decision support system.

The fieldwork team was composed of two World Bank consultants (a social development specialist who works on the Lesotho transport team and a participatory GIS specialist), the MoPWT GIS specialist, a Department of Rural Roads planning engineer, a member of the Roads Branch responsible for environmental and social safeguards, and a member of the MoPWT economic planning unit. Semistructured interviews were first carried out with the village elders and chiefs to gather general information on access to services (cost, time, distance, and mode); gendered dimensions of mobility and access; transport constraints (seasons, infrastructure, and security); ownership and use of intermediary modes of transport; and indicators for monitoring and impact assessment. In addition, interviews were carried out with relevant service providers, including grinding mill operators, taxi and ferry drivers, health clinic providers, police officers, pension administrators, and shop owners in the area.

The early, open-ended village interviews were followed by participatory map-making exercises with focus groups of men, women, elders, and youth. Across all villages, groups

averaged between 8 and 20 participants and were divided by gender and age where possible. Maps were hand-drawn on 18-inch by 24-inch blank sheets of paper with a black pen or marker. Importantly, the team found that participatory sketch maps could be produced in a variety of ways. Individuals in some focus groups elected to create sketch maps themselves, gathering input from the group. In other cases, the group decided to narrate and point out places, routes, and barriers to a member of the fieldwork team, who then served as a scribe, marking and verifying responses based on key features in the landscape, locations of services, and important destinations. In all cases, sessions were very interactive and an enormous amount of information was collected.

Together, the maps and interviews provided the basis and context for understanding gender differences in access and mobility at the community level, key barriers (physical, financial, and social) for mobility and access to basic services, and relevant local-level indicators for the success of a large bridge project planned in the pilot study area.

Pilot Study Area

Fieldwork for the pilot was carried out in the Senqu and Senqunyane Valleys in southern Lesotho—among the most isolated areas in the country. These valleys lie south of the district town of Semongkong and northwest of Qacha's Nek. This area is marked in the box on the map in Figure 1. The region includes numerous villages with very limited road access. Roads from the north stop before reaching the edge of the escarpment before the Senqu River, and tracks from the south end at the opposite side of the Senqunyane River, essentially cutting off the valley completely. Focus group interviews centered on seven villages on either side of the rivers, as shown in Figure 2: three in the Semongkong–Ha Topa Corridor (Ha Matlosa, Ha Lepekola, and Ha Tumo) and four in the Hloahloeng–Senqu/Senqunyane Valley Corridor (Ha Reli, Ha Phafoli, Mokopung, and Ha Nkau).

The area has no regular transport services. All travel occurs on foot, by horse and donkey, or occasionally by private vehicles. Traveling south from Semongkong, a rural earth road gradually turns into a track after about 20 km. Taxi service from Semongkong is erratic, and many villagers reported traveling by horseback or taking shortcuts on footpaths.

River crossings are made by small, government-supplied metal row boats at established ferry points. Government ferries are free; however, service is both intermittent and unreliable. A private ferry crossing has been established at Hloahloeng (where the existing road now comes to a stop at the river's edge). It costs 2 maloti (or rand) per person per crossing and runs from

around 7 a.m. till dusk. The distance across the river at this point is only about 40 meters, but when the river is high after the rains, it is too dangerous to row across. Many people interviewed reported not knowing how to swim, and accidents are a frequent danger. In the dry season, it is possible to cross the Senqu River at Hloahloeng and the Senqunyane River near Mokopung by foot or on horseback.

During this study, the World Bank was discussing the construction of two bridges across the Senqu and Senqunyane Rivers, thereby providing a necessary component to ensuring year-round motorized access into the valleys. Both rivers flood seasonally and isolate populations from important basic service centers. Although the valleys are quite fertile and are viewed as a potential breadbasket area for the country, the lack of access to services, limited opportunities, and poor farm prices have led to high out-migration and made this one of the highest female-headed household regions in the country (Hall and Adams (n.d.). Since this time, construction on the two bridges has progressed, ferry service has ceased, and the impact of improved access and reduced costs at the crossings for the local communities has been immediate. The bridge construction is the first section of a planned connection directly through the center of the country, linking Semongkong to the southern towns and cutting vehicle travel time from the capital in Maseru by about eight hours.

Maps

Figures 3 through 8 are examples of the types of participatory maps collected in village focus group interviews. The first map (Figure 3) represents the village of Mokopung, and was created by all participating villagers, working with a member of the fieldwork team as a scribe. It shows the locations of important services provided by the village for the region (the district court and the grinding mill), key features in the local area (schools, clinics, fields, and grazing areas), and transport options (the local ferry) with comments on distances, travel times, and the availability or quality of services.

Figure 4 is a sketch map of Ha Tumo village and surrounding areas drawn by a women's focus group with a scribe nominated from the village. Along the main road or track, the women marked steep terrain as a mobility barrier. By denoting both horizontal and vertical landscape features and movements on their participatory map, these women illustrated how changes in elevation limit access along the frequently traveled paths to major destinations and shift movement from roads to footpaths at specific points. Similar to Figure 3, Figures 5 and 6 were developed with the aid of a MoPWT scribe to represent the villages of Ha Nkau and Ha Phafoli. In these two cases, the small populations resulted in a single village focus group interview

representing all villagers, and notes mark key differences expressed by smaller subgroups of men and women or youth and elders.

Figures 7 and 8 are paired men's and women's participatory sketch maps from Ha Lepekola village, both drawn by members of the field team as scribes. Note that the women's map is less dense than the men's from the same village, showing fewer paths and destinations and longer travel times. In all cases, these maps can be viewed as narrative maps of community mobility and access that also include information about transport service costs, distance, and time for different modes of transport and seasonal variations in access.

Building on these and other sketch maps, Figures 9 and 10 represent GPS and GIS integrated versions of participatory information from Ha Tumo village men's and women's focus groups. Figure 9 shows key destinations and routes marked by men, where the map follows a largely north–south orientation indicative of horse travel along the main road or track. In contrast, Figure 10 depicts women's patterns of travel, which are largely perpendicular to the men's and centered on footpath travel to avoid unsafe areas frequented by shepherds along the main road. Additionally, women noted their lack of access to horses and mules; thus, although men had horse-access to the clinic at Ha Nkau (across the river), women were limited to the farther clinic in Semongkong. However, even the men reported difficulties in seasonal access, especially when traveling with heavy loads.

The final two figures are examples of the types of integrated participatory digital case study maps created by the fieldwork team to address specific cross-sectoral transport issues. Figure 11 shows the relationship between regulated and emergency taxi service rates indicated by villagers in each focus group along the Semongkong–Ha Topa corridor, where emergency service can reach up to 40 times the cost of regular service. Calling the emergency taxi also means that someone from the village must first travel for several hours by horse up to Semongkong, locate the taxi driver, and then return for the patient. Similarly, Figure 12 shows the catchment area for Ha Samuele school with the total number of students attending the school marked under each village. Children attending the school walk up to about three hours each way, each day, and teachers interviewed noted that distance is a major factor in absenteeism. The catchment area (dotted circle) shows that all villages are roughly equidistant, but this is not reflective of footpath access, actual travel times, or mobility constraints.

Conclusions

It is clear from the interviews, maps, and analysis in this study that, despite many barriers and difficulties (physical, economic, and social), residents of rural Lesotho are highly mobile, which is contrary to many transport planners' assumptions about rural and isolated communities. As a result of variations in individual mobility patterns, transport investments have important differential impacts on access to services within rural communities that need to be identified and addressed to achieve the maximum impact for residents and to use scarce resources to the best advantage.

The participatory methodology piloted here in combination with GIS facilitates a transformation of local-level perspectives into information that can be more effectively incorporated into and used during national and regional planning and implementation processes. Together, the maps generated through this study reveal significant differences in mobility and access with implications for access to and use of diverse services, such as healthcare, education, banking, the postal system, and pension distribution. They show how cognitive and participatory mapping approaches can provide an important counterpart to traditional GIS-based planning efforts. By systematically eliciting local perceptions of barriers to mobility and access in a spatial format, it is possible to make hidden vulnerabilities visible in planning processes.

The method and resulting information have since played an important role in guiding MoPWT planning decisions; they also provide a basis for cross-sectoral participatory decisionmaking through integration with the national transport GIS. Today, participatory mapping exercises are a regular methodology employed for social assessments of planned infrastructure with communities; they are used as a tool for the prioritization of maintenance and investment with local councils and governments. The combination of participatory mapping integrated into the transport sector GIS allows for new forms of communication and the creation of a regular process of collaboration and decisionmaking within the sector. The methodology has also been a powerful tool of communication for MoPWT and local governments with other sectors, such as health and education. Rationalization studies in these sectors tend to emphasize spatial location, catchment areas, staffing, and kinds of services, but do not have efficient ways to investigate the role of access as an important barrier to the use of services. Having a methodology to analyze these issues across sectors and to highlight barriers is an important instrument for governments seeking to direct resources and maximize benefits for their populations.

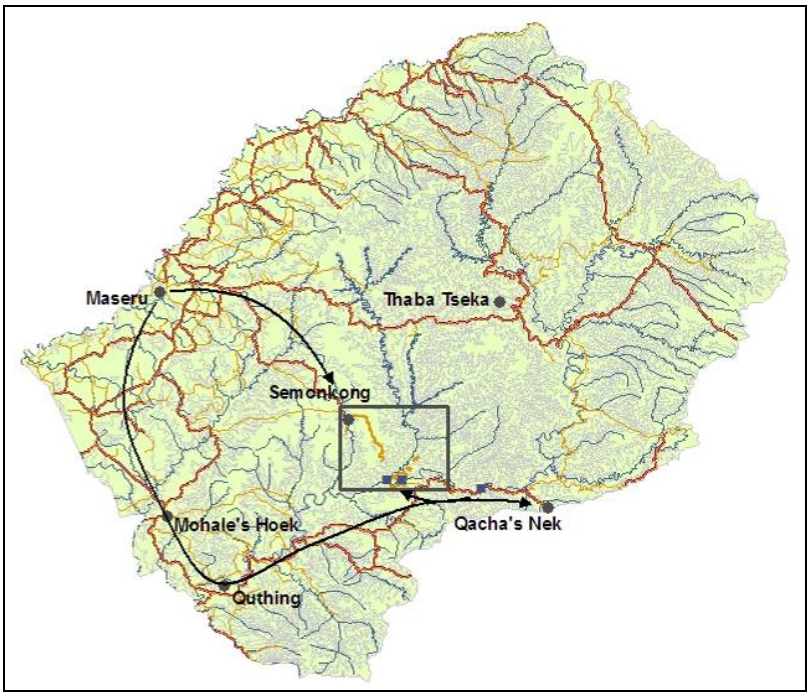
Taken as a whole, this work takes a step toward defining critical local-level transport indicators for future projects and assessments, and identifies the central role that transport infrastructures and services play in implementing and achieving development objectives, such as the Millennium Development Goals.

Figures

Software

All maps in this study were created using a combination of hand-drawn sketch mapping, a hand-held GPS unit, and ArcGIS 8.1 software.

Figure 1. GIS Map of Lesotho Showing Roads, Rivers and Waterways, and Terrain



Notes: The participatory mapping study area is marked by the rectangle near the bottom center of the map, and the arrows show travel paths. To reach either side of the valley, the field team traveled from the capital Maseru to villages on the northern side of the Senqu Valley; then, because the river was impassable, the team returned to the capital and traveled the periphery of the country to reach villages on the south side of the valley.

Figure 2. Detail Map of the Senqu Valley Study Area Marking Villages where Focus Group Mapping Interviews Were Conducted and Showing Terrain, Major Waterways, Main Roads, Paths, and Tracks in the Region

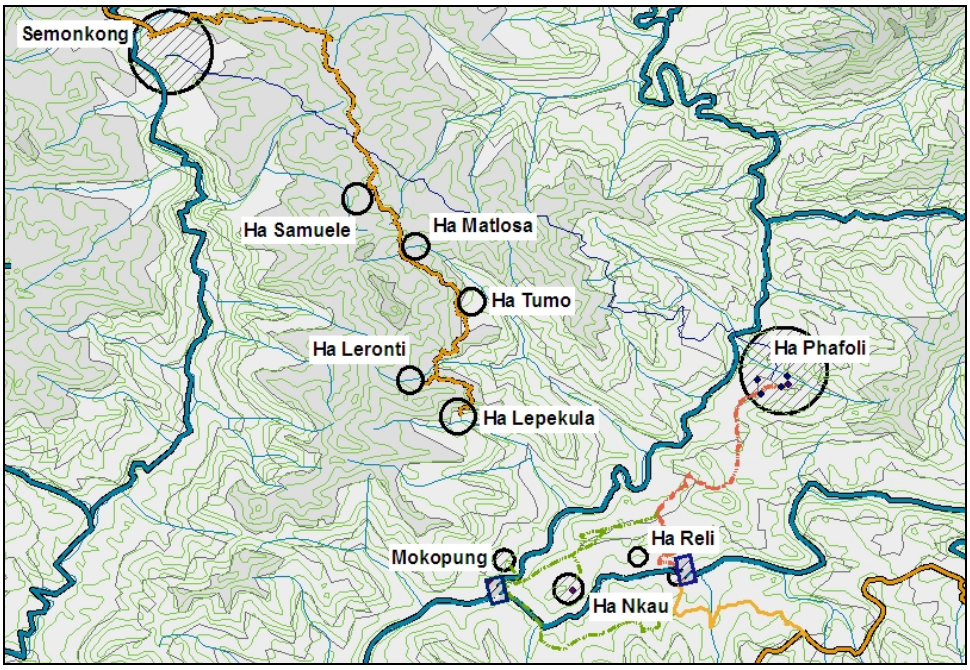
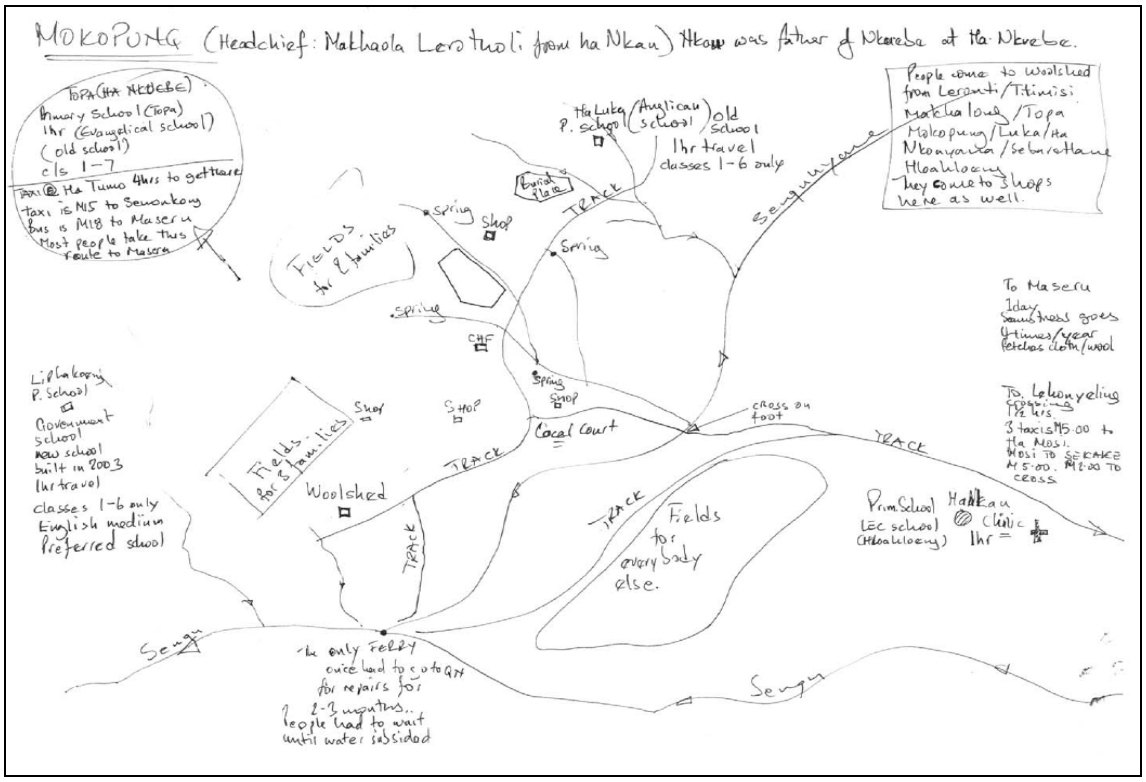
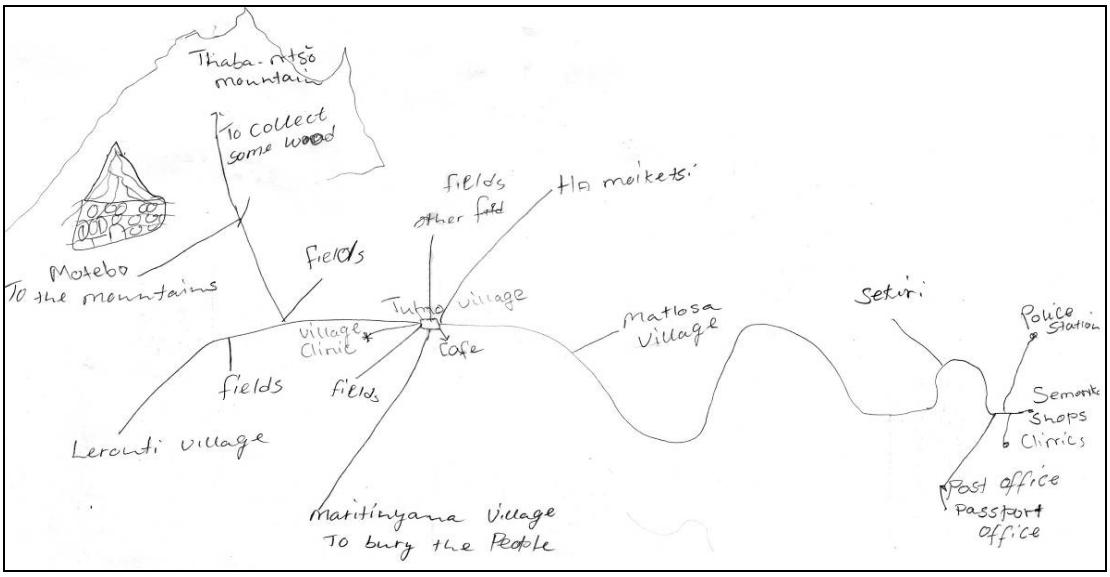


Figure 3. Participatory Sketch Map of Major Destinations, Routes, and Services around Mokopung Village Near the Confluence of the Senqu and Senqunyane Rivers



Notes: The map was hand-drawn on an 18-inch by 24-inch blank sheet of paper with a black pen. A MoPWT scribe was selected to add information to the map based on village focus group responses to key interview questions. A handheld GPS was used to mark key paths and destinations on the participatory maps following each focus group interview.

Figure 4. Participatory map of Ha Tumo drawn by a women's focus group with a scribe nominated from the village.



Notes: Along the main road or track, the women marked steep terrain as a mobility barrier.

Figure 5. Participatory Sketch Map of the Central Valley Villages, Hlaohloeng and Ha Nkau, Created by a MoPWT Scribe as Part of a Focus Group Representing All Participating Villagers

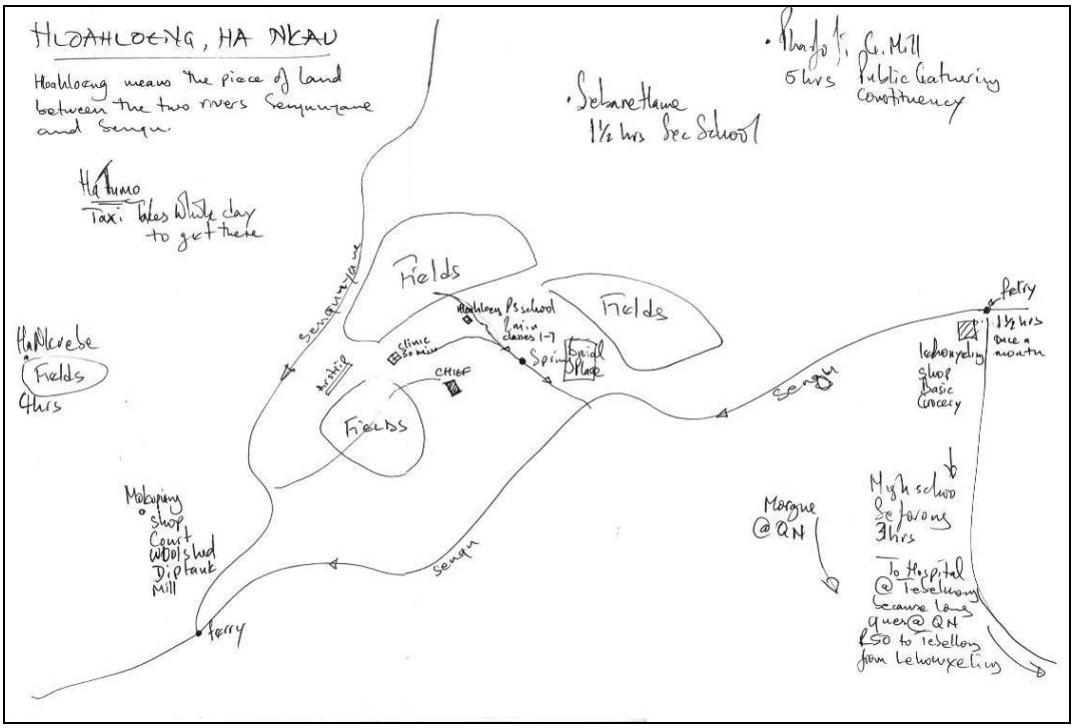


Figure 6. Participatory Sketch Map of Ha Phafoli Village Showing Key Destinations and Travel Times

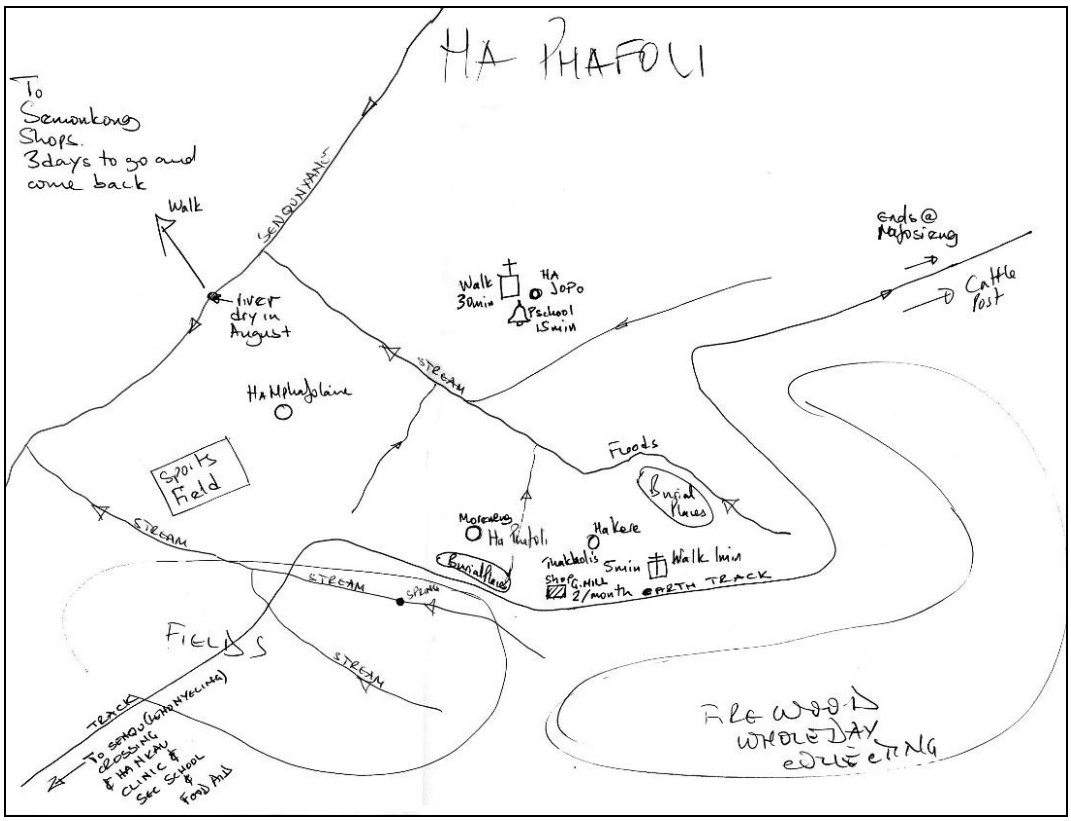


Figure 7. Participatory Sketch Map from a Men's Focus Group in Ha Lepekola Village, Drawn by a Member of the Field Team from the World Bank as a Scribe, with Notes Describing Barriers to Access

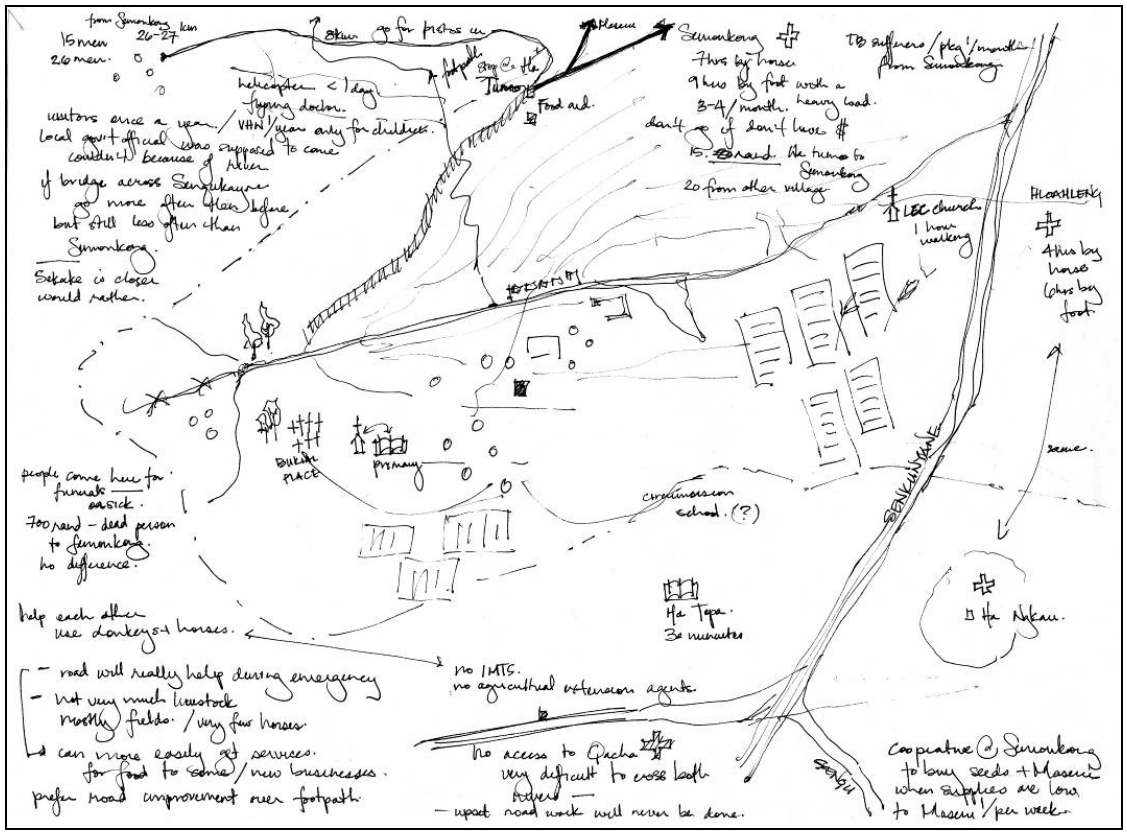
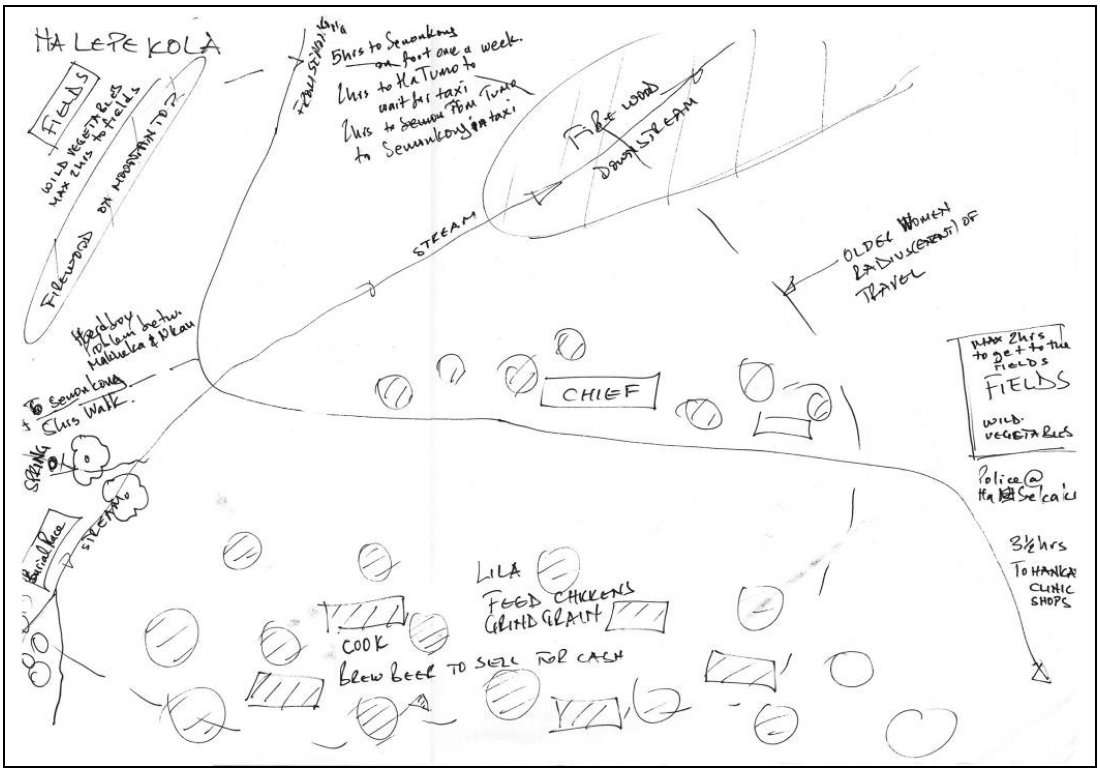
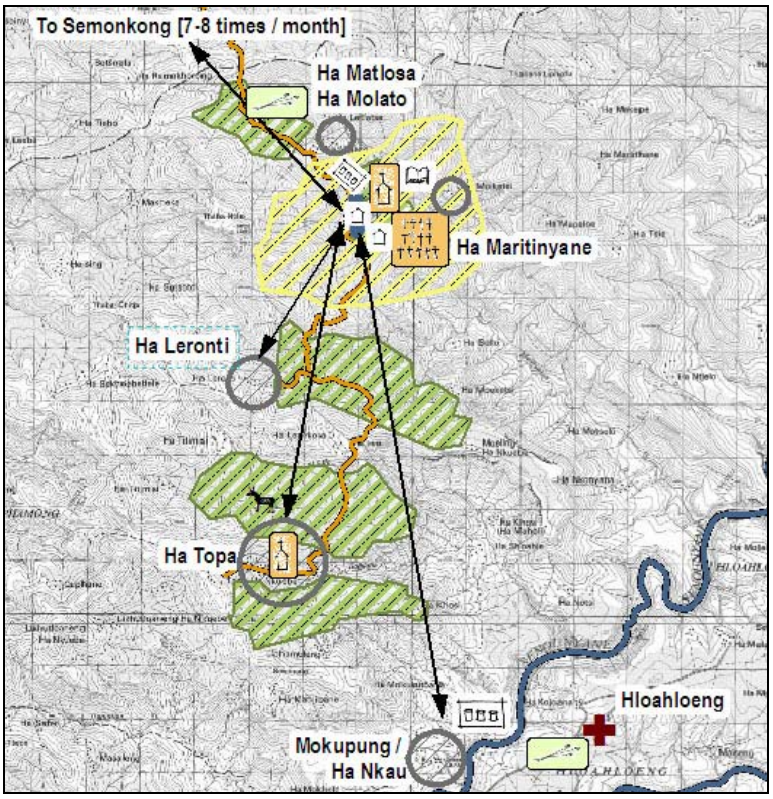


Figure 8. Participatory Sketch Map from a Women's Focus Group in Ha Lepekola Village, Drawn by a Member of the Field Team from the MoPWT as a Scribe



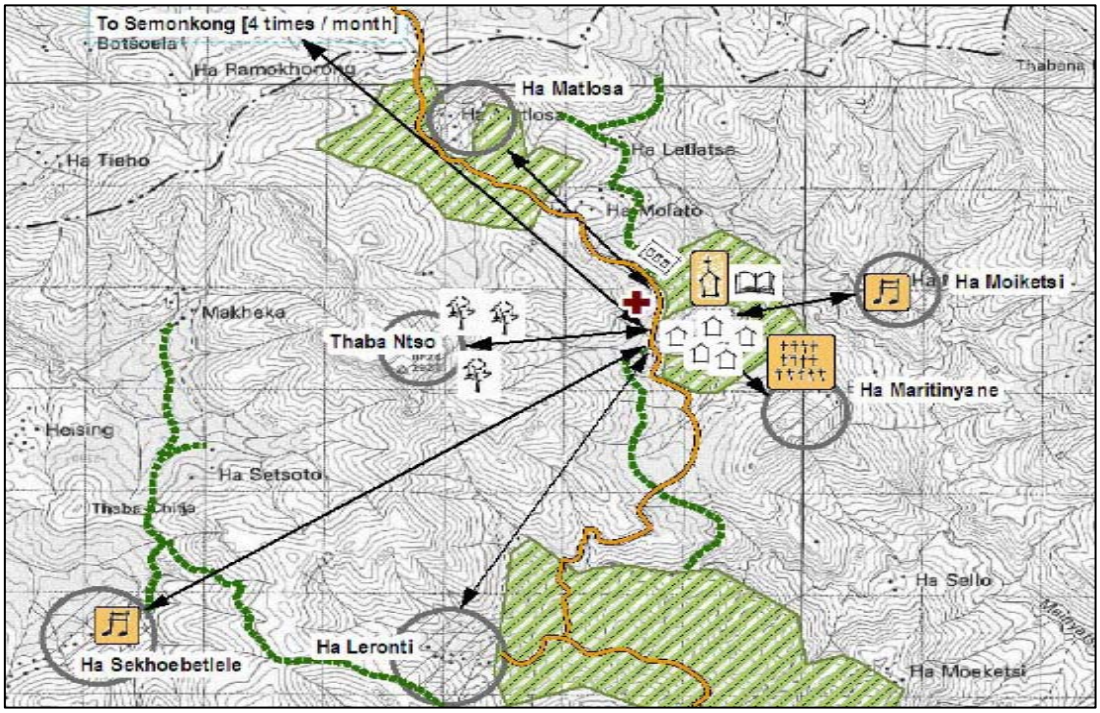
Note: Note that the women's map is less dense than the men's from the same village, showing fewer paths and destinations and longer travel times.

Figure 9. Men's Focus Group Map of Ha Tumo Village, Centered on the Main Road and Track, Showing Mobility and Access Patterns Dominated by Horse Travel to Neighboring Fields, Villages, and Services



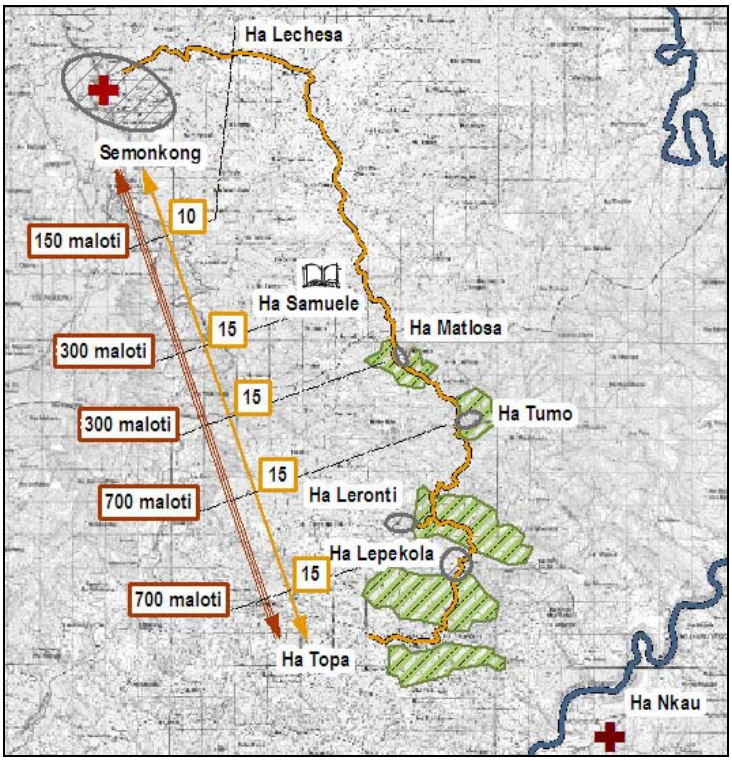
Notes: The integrated map with GIS terrain base layer was created using ArcGIS 8.1, with hand-drawn symbols from participatory maps uploaded into the GIS symbol library. Roads (orange lines) were extrapolated from GPS points taken by the field team.

Figure 10. Women's Focus Group Map of Ha Tumo Village, Centered on Footpaths, Showing Mobility and Access Patterns Largely Perpendicular to Those Shown in the Men's Maps, Centered on the Main Road



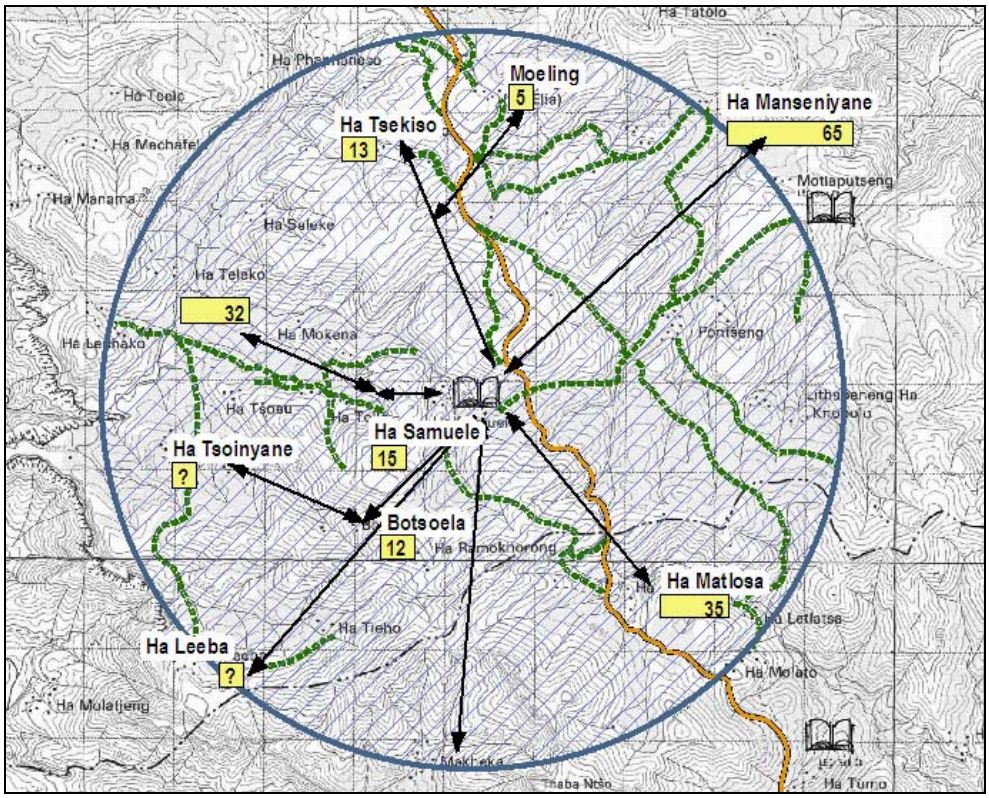
Note: Footpaths (green lines) were extrapolated from GPS points taken by the field team.

Figure 11. Taxi Costs for Regular Versus Emergency Travel from the North Side of the Senqu Valley to the Hospital in Semongkong



Note: Emergency rates are more than 40 times higher for the same distance.

Figure 12. GIS Map Showing the Catchment Area for the Ha Samuele School (center)



Note: Although most children travel from within the radius marked on the map, travel times vary greatly, ranging from 30 minutes to up to 3 hours walking each way. The book symbols mark locations of other schools in the area, indicating that many parents send their children further to Ha Samuele, where all instruction is in English and from where children have a better chance of continuing to high school in Semongkong.

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