Report on the Meja Watershed Participatory 3-D Mapping

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ACRONYMS

P3DM	Participatory Three-Dimensional Mapping
SWAT	Soil and Water Assessment Tool
GIS	Geographic Information Systems
F	Farmers
S	Students
WLE	Water, Land, and Ecosystems (CGIAR CRP)
IWMI	International Water Management Institute

GLOSSARY OF LOCAL TERMS

Kebele: Smallest administrative unit in Ethiopia, similar to a ward or neighborhood.
Woreda: Second smallest administrative unit in Ethiopia, similar to a district.

Meja Watershed Participatory 3-D Mapping

PARTICIPATORY THREE-DIMENSIONAL MODELLING

Participatory Three-Dimensional Modelling (P3DM) merges indigenous knowledge and spatial information to produce stand-alone, to-scale relief models. The models are illiterate friendly and easy to understand by all members of a community. The maps produced by a P3DM workshop are also accurate representations of local knowledge and ecosystem representation[1]. Although the official name for the methodology uses the word "modelling," this is often substituted with "mapping," as the creation of a map is the ultimate goal of the tool.

As stated on the website, "Participatory 3D modelling works best when used jointly with Global Positioning Systems (GPS) and Geographic Information Systems (GIS) in a Participatory GIS (PGIS) context. Participatory 3D models are manufactured at village level based on the merger of traditional spatial information (elevation contours) and peoples' spatial knowledge (cognitive maps). Elevation contours are used as templates for cutting out sheets of carton board of a given thickness (i.e. expressing the vertical scale). Cut-out sheets are progressively superimposed to build the relief.[2]"

There P3DM system allows participants to create the model from their own inherent and community knowledge. "Based on their spatial cognition, informants depict land use and cover and other features on the model by the use of pushpins (points), yarns (lines) and paint (polygons). Once the model is completed a scaled grid is applied to transpose spatial and geo-referenced data into GIS. The grid offers on one hand the opportunity for adding geo-coded data generated by GPS readings or obtained from secondary sources to the model, and on the other hand to take approximate coordinates on the model and verify these on the ground by means of GPS readings. This is extremely useful when models are used to support boundary negotiations.[3]"

There are many advantages to the P3DM methodology. These advantages include,

- "Both process and output fuel self-esteem, raise local awareness of interlocked ecosystems and delineate intellectual ownership of the territory.
- Relief models provide stakeholders and local authorities with a powerful medium for easing communication and language barriers and create common grounds for discussion.
- The method is especially effective in portraying relatively extensive and remote areas, overcoming logistical and practical constraints to public participation in land/resource use planning and management.

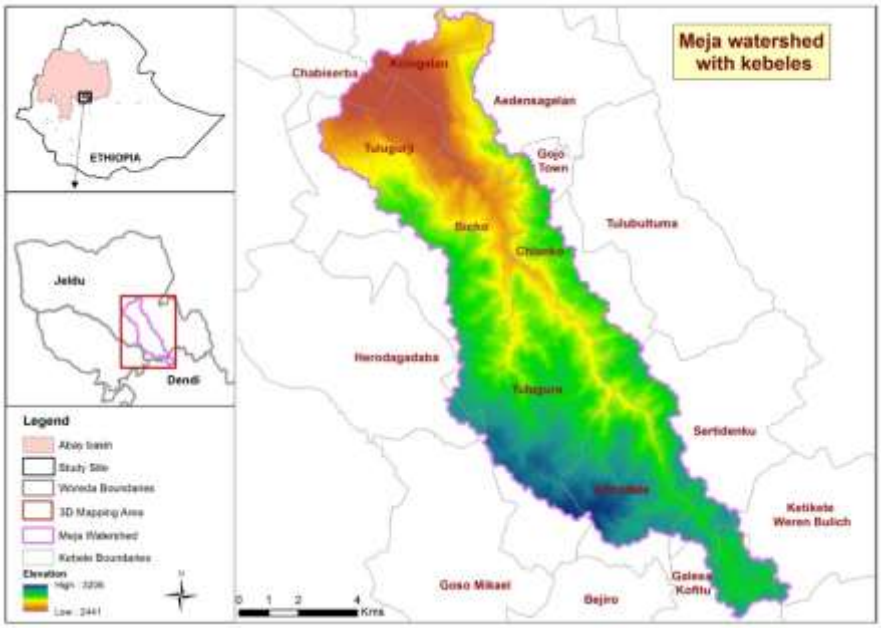
[1] "About Participatory 3-Dimensional Modelling (P3DM)," Participatory Avenues, the Gateway to Community Mapping, PGIS & PPGIS, accessed 22, March 2015, http://www.iapad.org/participatory_p3dm.htm.
[2] Ibid.
[3] Ibid.

- 3-D modeling is an efficient community-organizing tool because it gathers people to share information and concerns. Old people share history with young people, passing on legends and religious beliefs, sacred rites and places so essential to conserving tradition.
- In Participatory Monitoring and Evaluation (PM&E) sketch maps, transect diagrams or other conventional spatial tools, produced at different times are compared. There is an inherent weakness in the fact that the outputs are not properly geo-referenced and consistently coded. P3-DM overcomes this weakness, because the relief model is a constant with its legend and coding embedded.
- The use of a coding system based on a rich assortment of different materials and colors allows a 3-D model to function like a rudimentary community-based GIS accommodating overlapping layers of information. This is extremely useful to establishing visual relations between resources, tenure, their use and jurisdiction.[4]"

Case Study: Jeldu Workshop

LOCATION

The Meja watershed is located in Jeldu *woreda*, which is found in the south of the Abay basin. Its attitude ranges from 2441 to 3206 meters above sea level and is predominantly a high land area. The upstream area of the watershed starts just outside of Jeldu *woreda* in the Dendi *woreda*.



[4] Ibid.

The P3DM methodology was selected for this workshop in order to gain better understanding of local community dynamics in the context of land water and ecosystem management. This specific methodology was selected because it can be used to generate a substantial amount of indigenous knowledge from the maximum number of participants in a rather short amount of time, as compared to participatory planning workshops, focus group discussions and classical ethnographic fieldwork. This is because all the conversations that take place during mapping are recorded and can subsequently be transcribed and analyzed, depending on the needs of the research and the project. The purpose of doing P3DM in Meja watershed was to mobilize the knowledge of the local community for better natural resource management and to ensure the passage of local, intergenerational knowledge. In general, P3DM is used for watershed management planning, sacred sites protection, transfer of intergenerational knowledge, and mobilization of local communities to critically examine natural resources and land degradation.

The workshop was funded under the Water Dynamics component of CGIAR Research programme on Water, land and ecosystems. IWMI has been working in this watershed also under the Nile Basin Development Challenge in order to develop a plan for efficient and sustainable water usage in the watershed. Researchers worked to understand the hydrology of the area and to create a water management plan that benefits the local communities through participatory methods.

The objectives of this specific workshop were to

1. To investigate the value of P3DM for social scientists working in research for development projects
2. To explore P3DM as an innovative methodology for understanding community dynamics, especially in regard to gender, in the context of the WLE program

47 people worked in shifts on the model which covers, at a 1:10700-scale, a total area of 328 sq km^2 over 11 *kebeles*. Assisted by the facilitator, 28 students and six supporters manufactured the blank model. Twenty elders representing the 11 *kebeles* contributed to the creation of the map legend and 38 community members participated in the actual depiction of the land area on the model. At its completion, the model contained 43 different symbols: 25 points, 4 lines, and 14 area types.

Project implementation

The project was conducted over the following phases: (i) Preparatory, (ii) Modeling, and (iii) Handover.

Phase 1 - PREPARATORY PHASE

This phase lasted five months. Activities undertaken included (i) identification of the area (ii) sourcing spatial data and preparing the base map, (iii) choosing the appropriate mapping scales (vertical and horizontal) (iv) procuring workshop materials, (v) facilitator training, (vi) consulting and mobilizing students and stakeholders, selecting trainees and (vii) organizing the logistics. The facilitator training was one of the key proponents to the success of the workshop, as it prepared all IWMI staff, consultants, and interns for the process of P3DM.

Identification of project area
An area within the Meja watershed was selected for modeling by IWMI researchers due to the familiarity of researchers with this landscape and local government officials.

Sourcing of data and preparation of the base map
Preparation of the base map featuring color-coded contours was carried out by IWMI prior to the mapping exercise. Two models measuring 148 cm x 191 cm each were constructed on two separate base tables, each also measuring 148 cm x 191 cm. Table height was 60 cm. Cardboard for the layered map construction were measured and cut by group of youth to fit the table dimensions.

Procurement of workshop inputs and their on-site delivery
Materials were purchased according to the guidebook, "*Participatory 3-Dimensional Modeling: Guiding Principles and Applications*". An updated supply list is available online at http://www.iapad.org/supplies/items.htm.

Consulting and mobilizing students and stakeholders
IWMI has a long-term relationship with local government officials and the local community members. A similar mapping workshop took place in 2014 on a smaller, *kebele* level. Therefore, the project did not require an extensive introductory workshop with community members and government officials. However, IWMI representatives and consultants traveled to the Meja watershed on two separate occasions to explain the specific process to officials from each *kebele*, to facilitate participant selection, and to organize logistics.

Phase II – COMMUNITY MAPPING PHASE
The preparatory phase was followed by the community-mapping phase. All activities under this phase were carried out at Jeldu Secondary School. It involved the following key activities:

(i) Introducing and orienting the local use on the techniques and participatory 3D modeling
This was a critical part of the process as it is crucial that the students understand the concept of participation and the purpose of participatory modelling. Therefore, practical explanation was given to the participants on the importance of P3DM and on what is expected of them.

(ii) Assembling the blank model
Students and facilitators were involved in the assembly process.

Two models, each 148 cm x 191 cm, were assembled, one for women and the other for men. Models were painted white and placed in two rooms so that men and women could create their models separately.

(ii) Preparation of the draft legend
A draft legend was prepared before the construction of the map. Twenty elders, ten men and ten women, participated in the legend making. The community added and elaborated the draft legend at a later stage. Prioritizing and achieving consensus among mapmakers on which items are relevant and what should be featured on a map is the first step in a participatory process aimed at addressing community-based issues related to the territory and its resources.

(iii) Drafting and fine-tuning the map legend
A draft legend was made prior to building the model. After the students assembled the model, local

elders participated in the creation of the map legend. Selected community members who participated in the mapping were invited to add additional information, but in most cases all legend items were accepted by the larger group. A longer discussion of the legend follows in Annex 1.

(iv) Local Knowledge

P3DM participants used points, lines, and polygons to represent their local knowledge on the model maps. They identified sacred sites, water points, rivers, forestlands, agricultural lands, natural springs, etc. As the map was not large enough to adequately accommodate representatives from all 11 *kebeles* each day of the workshop, participants came in shifts during the four days of mapping.

(v) Discussion after the mapping

The creation of the two maps was followed by a concluding discussion held with the participating community members. Community members expressed changes in natural resources and cultural practices in recent years. A longer explanation of the discussion can be found in the detailed account of Day 7.

(vii) Extracting data using digital photography

Process of Digitalization of Completed Model (Courtesy of IWMI)

Photographs were taken of the model. By tilting the model perpendicular so that it rested on its hinges, photos were taken with a digital camera at a distance of two meters. Information written about each of the points and rivers on the model was fixed on the pin to be clearly seen when the

photo is digitized at a later stage. Thematic GIS maps may be produced by IWMI for various purposes including planning, implementation, communication and monitoring and evaluation. The product can be used to calculate forested areas, agricultural outputs, landmarks, and local sites.

Phase III - Handing over of the model

The map handover ceremony was held on 1 February 2013 in the presence of members of the local government officials, representatives of IWMI, community members, and participants of the mapping workshop. Over 50 community members and 30 invited guests also took part in this ceremony. The Vice Administrator of the Jeldu *woreda* and Head of the Agricultural Bureau, and Dr. Liza Debevec made opening speeches at the ceremony. This was followed by a presentation from the students, in which two female students read a poem about environmental degradation and plans for the future. Next, female and male community representatives explained their participation in the mapping workshop. This was followed by a presentation from Dr. Million Belay, who explained the importance of the model for the community. The ceremony was concluded with a feast for all attendees.

Reflections

1. The large size of the area modeled and the subsequent increase in number of participants from 11 *kebeles* allowed a deep examination of the socio-ecological history of the area. Participants were able to reflect about the social and ecological changes they have observed and the reason behind these changes. Participants suggested, among other reasons, regime change, poor governance, ineffective law enforcement, and increase in population as causes for social and ecological changes.
2. The model construction was gender disaggregated. On several occasions, female participants consulted their male equivalents landscape identification. This may be due to the fact that men usually travel far and have a better understanding of the larger landscape, while women are generally confined to a much smaller area surrounding their homes.
3. Intergenerational transfer of knowledge: Four students remained for the entirety of the workshop to assist the facilitator. They engaged actively in the cognitive mapping and stated that they learned much through this experience. The students expressed great interest to continuing to work together in an environmental club at their school. Dr. Liza Debevec has promised to explore the option of supporting the students to start and strengthen the club. This will greatly contribute to continued intergenerational learning leading and increased awareness of environmental protection. It will also create an opportunity for students to become future champions of NRM in Jeldu *woreda* and beyond. It is expected that the physical model built by the elders will be used by high school students during the school year. We also expect there to be informal conversations generated by the map and the fact that 27 students participated in the closing ceremony, during which further importance was given to the issue of NRM in this watershed.
4. As gender was a driving force behind the rationale for the workshop, the creation of the maps was gender disaggregated.

TECHNICAL ASPECTS

Base map:

A base map of 193 cm by 151 cm was used for the P3DM workshop. The base map depicted Meja watershed and its adjoining *kebeles*, covering an area of 328 Sq.km in total. The map was prepared from 30m ASTER GDEM v2 (METI/NASA, 2009) using ArcMap 10.0 at a scale of 1:10,700. The DEM was resampled using ArcGIS focal statistics tool with two cell circular radius. Then the DEM used as an input in ArcGIS contour tool to generate the contours with contour interval of 30m. The Contour lines were drawn in a sequence of ten different colors; Black, Blue, Brown, Gray, Green, orange, Pink, Purple, Red and Yellow to facilitate the work of the student tracers and map builders.


Sample contour lines

Table:
The table was constructed to match the map, 193 by 151 cm. The table was built with hinges on one side; thereby allowing the 3D model to be held vertically during final 3D model photographs.

Cardboard:
Although the cardboard was ordered to match the table and the map, the product received didn't match the specifications. The cardboard was incorrect in both size and width, measuring 191 cm by 149cm and significantly thinner than desired. Therefore it did not fit well with the map and the table, and as a result, 2cm was cut from one side of the base map (upstream side of the watershed) to match. The thinness of the cardboard negatively impacting the model building process and made it more difficult to see the landscape contour differences in the final maps.

3-D Model:
Fourteen female and fourteen male students from Jeldu Secondary School built two 3-D models over the course of three days. The students were divided into three groups: tracers, cutters, and builders.
The responsibilities were unique for each main group. The tracer group was responsible to trace each elevation contour value on individual cardboard sheets, starting from the lowest contour value (2100m) up to the highest contour value (3180m). The group had to trace one elevation contour value twice to give two input carton boards for two models. On several occasions, students forgot to trace contour lines twice.

The cutting group was responsible to cut out each elevation contour value independently from the carton boards by following the traced contour lines. This group was sometimes idle due to delays in the tracing group.
The group used more nails than expected during material purchase, as students tried to complete the model construction as quickly as possible and therefore used nails in lieu of glue. The facilitator

and all the technical assistants repeatedly instructed the students to use glue, however they did not follow these instructions. It is significant to note that in the previous P3DM activity in Kolu Galan, the mapping consultant was assisted by two of his assistants whose primary responsibility was to supervise the students during the model creation. This is significant to note as there were more students involved in this workshop than the previous one, and the lack of extra support made this part of the workshop more difficult to execute correctly.

Data Capture Using Digital Photography: A geometric grid of string was created on top of the map, with intersection lines at every 40 cm. Photographs were taken at each 40 cm interval using a plumb line to center the camera on the vertical lines.

PARTICIPANTS

- 35 Participants
- 18 Elders
- 29 Students: 12 male and 17 female

FACILITATORS & OBSERVERS

• Dr. Liza Debevec	Observer (IWMI Project Leader)
• Dr. Million Belay	P3DM Consultant
• Yenenesh Abebe	Observer/Photographer/Videographer (IWMI)
• Tsehay Regassa	Observer/Photographer/Videographer (IWMI Consultant)
• Noa Gutterman	Observer (IWMI Intern)
• Mercy Adem	Facilitator/Translator (IWMI Intern)
• Girma Hundessa	Facilitator/Translator (IWMI Consultant)
• Geda Tadesse	Facilitator/Translator (IWMI Field assistant)
• Segni Bekele Deribsa	Facilitator/Translator (IWMI Field assistant)
• Daba Dandema	Logistical Support

WORKSHOP PREPARATION

In a discussion of the methodology, it is necessary to explain the technical aspects of the preparation and workshop, and offer recommendations for best practices for the future. Firstly, the materials necessary for the workshop are costly, and can be difficult to find in certain countries. Supplemental supplies that were not available in Ethiopia had to be purchased abroad by IWMI staff in preparation for the workshop. Secondly, it is necessary to train facilitators in P3DM theory and practice before the workshop is conducted. The mapping consultant trained five IWMI staff members and consultants for this workshop. Thirdly, it is necessary to consider the effectiveness and worth of facilitators who do not speak the local language. Despite having 5 trained staff, the IWMI team was unable to facilitate and participate in much of the workshop because the majority of the team did not speak the local language, Oromiffa. Fourthly, the time and resources necessary for the workshop depends on the size of the map. The large scale of the model used in the Meja

watershed made it difficult to collect enough necessary supplies and increased the overall cost of the workshop. It is critically important to select a map size that corresponds with the time constraints, budget, and available facilitators. Please refer to relevant links in the annex.

In conducting a P3DM workshop, it is essential to hire a consultant trained in P3DM. As discussed above, it is also crucial to hire and train facilitators who can also act as translators of local languages. The participation and training of staff members should be decided upon in consideration of language abilities and subsequent necessity. It may be advisable for IWMI to hire the consultant and have him/her provide all the technical equipment necessary.

DIFFICULTIES IN EXECUTION

- Difficulties in purchasing correct materials
- Time-consuming logistics of workshop
- Training of facilitators
- Limited expertise available in Ethiopia (only one mapping consultant)
- In this particular community, workshop could only be conducted during school holidays because school space is only available during the summer months (made more difficult because this is the rainy season) or during one week in January (for school semester break).
- Need for participants to travel to and from school site

LANGUAGE AND LITERACY LEVEL

- Language constraints of participants
- Difficulties in communication between facilitators (of several different language abilities) and farmers
- Pose the question of necessity of certain facilitators based on complete lack of language comprehension

WORKSHOP DETAILS

(i) Main Issues Raised:

- Environmental degradation
- Transfer of indigenous knowledge
- Transfer of intergenerational knowledge
- Loss of cultural practices
  Future planning

(ii) Major Conflicts:

- Difficulty in observing ground rules of workshop
- Issues between religious groups
- Disagreements between members of different *kebeles* on the representation of lands

(iii) Social Aspects:

- Differences in men's and women's groups
- Interference of men in women's workshop
- Conflict between men and women over correct representation of landmarks

(iv) Positive Aspects:

- Transfer of intergenerational and indigenous knowledge
- Growth in community awareness of environmental changes
- Wide-reaching outputs: involving students
- Look to the future: environmental club

(v) Negative Aspects:

- Conflict and conflict resolution
- Lack of communication between facilitators and women's group
- Lack of communication between participants
- Technical constraints

(vi) Summary:

- Excellent workshop for intergenerational knowledge transfer
- Good tool for gender disaggregated data
- Very time and money consuming but could be useful in the right context in the future (model photos are available for digitizing and large amount of raw unprocessed data is available for researchers to use in related projects in the area and beyond).

(vii) Workshop Schedule:

Day 1: 11:00-17:00: Model Construction
Day 2: 8:30-17:00: Model Construction
Day 3: 8:30-17:30: Model Construction (half day)/Legend Making (half day)
Day 4: 9:00-17:00: Legend Making (half day)/Map Making (half day)
Day 5: 8:30-17:30: Map Making
Day 6: 8:30-16:30: Map Making
Day 7: 8:30-11:30: Map Making (half day)
Day 8: 10:00-13:30: Map Handover Ceremony

Each day, a morning coffee break, lunch, and an afternoon coffee break were provided for the participants.

1. Student Participation

The purpose of the map building process was explained to the students by the lead facilitator, the mapping consultant. In this discussion, he stressed the importance of student responsibility and commitment for the success of the entire mapping activity. As the model map construction is a

prerequisite for the later participation of farmers, strict guidelines were set to ensure the success of this initial phase of the process. The facilitator emphasized that the map construction is the most critical aspect of the entire workshop and that students needed to be careful and meticulous in their work. He also explained to the students that the mapping process is a tool for communities to identify and understand local problems and plan for solutions.

Model Cutting (Courtesy of IWMI)

It is a process through which all stakeholders, including students, elders, and government officials can better understand cultural practices and natural resource management and environmental degradation. The mapping consultant split the students into three groups of cutters, drawers, and builders for the map building process.

The mapping consultant tried to ensure that each group had at least one student who had participated in last year's mapping activity. The drawing group was primarily composed of female students, as the mapping consultant believed that female students would be better at this activity. In a similar fashion, by the mapping consultant's design, the cutting group was composed only of male students. The building group was composed of both male and female students. Several technical issues were encountered in the map building process, most importantly that the size of the cardboard sheets was inconsistent.

Model Construction (Courtesy of IWMI)

As each cardboard sheet had to be cut down appropriately to fit the size of the contour map, the process was very time consuming. Students participated very actively in all aforementioned roles, and there were significant amounts of both male and female participation.

2. Legend Making

a. Introduction to Legend Making

At the outset of the legend making discussion, the 18 participants, who were elders from each *kebele*, watched a short film about the P3DM process[5]. The film was intended to explain that P3DM is an invaluable tool that helps communities address problems and discuss solutions. The facilitator stressed that the participants were leaders in their respective communities, and that they were chosen by their *kebele* leaders to participate in this workshop because they have extensive indigenous knowledge of the land and resources. One male elder said that the film showed him how the 3D mapping process demonstrates resource degradation and that by creating a map of their community, farmers will be able to tangibly see the effects of local environmental problems.

b. Legend Making

The process of legend making was based on the legend from last year's P3DM in Kolu Galan and was explained by several famers who had participated in the previous mapping activity. The entire legend making process took two days to complete. Following the explanation, a spirited discussion of proper symbol representation took place.

Participants advocated including several legend items that were not included in the previous mapping activity in Kolu Galan. The mapping consultant agreed with several of these, but did advise the community not to include others, such as a commune site, as this is a future government development project and does not yet exist in the watershed.

The mapping consultant also detailed the color representation for the four main map elements; asphalt roads, feeder roads, major rivers, and minor rivers. As these color representations are internationally recognized, their representations were not up for debate.

[5] Giving Voice to the Unspoken. Dir: Giacomo Rambaldi. ASEAN Regional Centre for Biodiversity Conservation (ARCBC), the Social Forestry Conservation Project in Nghe An Province, Vietnam, The Environmental Broadcast Circle (EBC)- Philippines affiliated to the International Television Trust for the Environment (TVE), 2001.

Final Map Legend (Courtesy of IWMI)

3. Map Creation

On the fourth day of the workshop, four farmers from Chobi, Gojjo, Tullu-Gurji, Edansa-Galan and Kolu Galan *kebeles* began depicting their watershed on the map. The mapping consultant gave a brief orientation to the entire group in order to explain the scale of the map, the legend created by their own community elders, and the conflict-resolution strategies inherent in the map creation. He also laid out basic rules of the workshop; especially emphasizing that respect of individual opinions is key to conflict management and successful map creation. Participants, however, did not always follow these rules, and the resulting unconstructive behavior caused conflict in both

mapping groups. He suggested that the participants seek clarification or guidance from the facilitator whenever necessary. Together, the community members identified the major river and asphalt road in the watershed, and then split into gender disaggregated groups to being creating the map.

a. Male Group

Map Creation in Male Group (Courtesy of IWMI)

The male group was composed of ten participants, two from the *kebele* that were present. Initially, participants struggled to identify the *kebele* boundaries on the blank model, however one farmer who also participated in last year's P3DM workshop in Kolu Galan was able to guide his fellow farmers to identify the relevant boundaries, major rivers, and minor rivers by using his *kebele* as a reference point. When compared to older farmers, younger farmers seemed to have an easier time identifying these key features of the map. The Kolu Galan farmer played a very dominant role in the creation and discussion surrounding the men's map.

Due to a general lack of understanding in both the men's and the women's group, all participants were brought together in the late morning. The male farmer who had participated so actively in his group tried again to assert his dominance, however one female participant challenged his opinions, arguing that she had more indigenous knowledge of the local landscape. The majority of participants accepted her opinion. This discussion helped both groups understand the process for identifying key landmarks and boundaries. Following the discussion, the male group was able continue to identify more rivers, however the younger participants dominated the conversation.

Some male participants were invited to assist the women resolve a boundary dispute. Female participants from Tullu-Gurji *kebele* believed that their territory had been annexed by the surrounding *kebeles* on the map. Furthermore, the female participants from Chobi *kebele* enlarged their land area, enclosing portions of both Tullu-Gurji and Bicho *kebeles*. The male farmers helped the female farmers resolve these conflicts and returned to their separate map. This conflict helped both groups understand and evaluate their own work. The female participants who believed their land had been annexed into another *kebele* spoke as if they truly believed the map represented an actual loss of land. This issue will be analyzed in depth later in the report.

Female Group:

The participants utilized different strategies for conflict resolution. Some gave each other constructive criticism and advice, however others tried to assert their social or political dominance in order to take control of the mapping activity.

Some participants believed that individuals should only focus on creating representations of their specific *kebeles*, but most participants tended to interfere when they believed that something had been misrepresented.

Map Creation in Female Group (Courtesy of IWMI)

The interactive creation of the map acted as a catalyst for female participants to discuss pressing social and cultural issues, such as health, marriages, and livelihoods. Most *kebele* representative groups chose a leader to identify landmarks and natural resources and the rest of the participants completed tasks at the behest of the leader. Some women also sang traditional songs while creating the map. Women used the land of socially privileged community members, feeder roads, and bridges as reference points to identify other areas on the map. Exposure of participants to previous mapping trainings affected this mapping process. Women who had previously participated in similar projects were more likely to agree among themselves and complete work in a quicker fashion than those who had not. For the most part, female participants also tried to empower one other. One woman stated:

> *"You are strong, you are doing it right…we are better than men, we are models for each other, we are mothers of educated people…"*

Day 5

Day 5 began with an orientation, given by the mapping consultant, for the new participants that represented the remaining *kebeles* in the watershed. He explained the work of the preceding days

and explained that the creation of the map was an opportunity not for disagreements, but for conflict management and resolution. This conversation was especially relevant given the disputes in the women's group the previous day.

Male Group:

The participants were joined by representatives from the six remaining *kebeles* in the watershed: *Tullu-Gurra, Galessa, Ento-Dalle, Bicho, Chilanko,* and *Sariti*. Following the group orientation, participants who were present for the initial days of map making gave the new participants more specific explanations and instructions. These new participants began by identifying their *kebeles* on the map, however they discovered that in a similar fashion to the women's group, *kebele* boundary identification had decreased the territory of their *kebeles*. The new participants strongly believed that certain areas of Chobi and Tullu-Gurra *kebeles* had been 'lost' to the neighboring *kebeles,* Tullu-Gurji and Bicho. Furthermore, participants from Tullu-Gurra claimed that their *kebele* doesn't even share a border Tullu-Gurji and the Bicho *kebele* lies between the two. The participants from these two *kebeles*, however, argued that they could not change their boundary demarcations, as it would invalidate their preexisting work. Furthermore, they added that the new participants needed to gain a better understanding of the project before making quick judgments about the work of others.

The farmers from the new *kebele* of Tullu-Gurra argued that misrepresentation on the map could have serious consequences for both the present and the future. As an immediate consequence, it could skew the placement of key environmental features, such as mountains, rivers, and other *kebele* boundaries. Perhaps more serious, was their concern that if boundaries were left incorrect, the map would misinform future generations and lead to a loss of indigenous knowledge.

The convincing arguments made by the new participants from Tullu-Gurra and Chobi persuaded the larger group to change the boundaries demarcated in the previous day. The participants from Tullu-Gurji were not, however, pleased with this decision, as they still believed that the Bicho *kebele* was a part of their territory. This debate was waged primarily between the dominant participant from the previous days of mapping and a vocal participant from Tullu-Gurra, who had

served as a local representative of the *Derg* government and therefore had significant understanding of the watershed boundaries and sizeable ecological knowledge. Following the resolution of the argument, participants tended to focus only on the depiction of their individual *kebeles* rather than the larger map.

This debate illuminated several contemporary issues of critical importance in community mapping. Firstly, the disputes over *kebele* boundaries reveal the increase of local boundary conflicts. Secondly, the debate demonstrated that strong disagreements over map borders stems from the fear that loosing territory on the map could cause the actual loss of said territory through border violations by community members. Thirdly, and perhaps most importantly, it demonstrated the concern and trepidation that if local government officials use the map for official purposes, incorrect boundaries could be used as an accurate reference for government activities and programs.

It is also important to mention the participation of the farmer who was previously a member of the local *derg* government. He gave constructive criticism and praise not just to the farmers from his *kebele*, but also to all participants. He did not participate directly in the physical creation of the map, rather, using his walking stick as a pointer, instructed his fellow farmers where and how to place specific areas and sites.

Female Group:

After all *kebele* groups finished their sections of the map, the entire group discussed each section and identified any misplaced or missing areas. For instance, at this stage the map was missing several identification points for sacred trees, and the group was able to identify and resolve this oversight.

Day 6

Issues in the Female Group:

The men's group received much more expert support than the women's group. The mapping consultant only visited the women's group when they specifically requested help or conflict arose that could not be solved without outside help. Continual conflict among female participants and a lack of simple ground rules also had negative effects on the success of the project. Clear ground rules were not communicated until the fifth day of the mapping process. Introducing female participants from the second wave of *kebeles* also impeded the success of the project. It was very time consuming to orient these new participants, and serious conflict arose when the new participants questioned the work of the initial participants. Some new participants identified soil types and landmarks that were not included in the original legend, such as boreholes, sport training centers, and government offices, and despite a discussion of these areas, they were not ultimately included on the final map. Conflict also arose with the introduction of these new participants when they realized that certain areas in their *kebeles* had already been mapped in the previous days without their consent. Continuous intervention of male participants in order to check the progress of the women's map also impeded the progress of the project. As a result, certain women in the group began to defer to their male counterparts each time they faced conflict. Furthermore, receiving incorrect advice from their male counterparts, two of these participants even suggested that the group paint several areas of *kebeles* that did not belong to them.

Day 7

Following the completion of maps, men and women joined together for a group discussion. First, each group presented their finished work. Then, the mapping consultant facilitated an in-depth discussion of the process of participatory 3-D maps and how they reveal important information on culture, natural resources, and livelihoods.

Female Presentation:

The presentation began with several women presenting the work they had done on their individual *kebeles*, which emphasized the dangers of environmental degradation and the need for reforestation, in order to combat water, livestock, and food related problems. All female participants said that they enjoyed the mapping process and suggested that it be replicated in other

places so that many more Ethiopian farmers could discuss their local environment and the challenges it faces. In particular, one participant spoke at length to the many uses of and for the forested area, and the danger that came with its loss. As she explained it, these forested areas provided food for livestock, food sources in times of famine, and a home for indigenous species, especially baboons. The name Jeldu derives from the Oromo name for baboon, *jaldesa*, and thus without a home for the baboons, there is a huge loss of indigenous knowledge. Despite its money generating capabilities, the expansion of eucalyptus has threatened the remaining forested areas and depleted adjoining springs.

Male Presentation:

The presentation began with an overview by an elderly participant in which he explained the cultural and environmental history of the watershed. He also explained that the process of creating the map was very informative for the participants, and enabled them to identify which particular soils, lands, and resources are present in both the 11 *kebeles* and the entire watershed. He stated that, until recently, dense forests maintained an ecological balance, but that deforestation has drastically decreased these forests. The mapping workshop helped the participants to remember past resources in the context of present resource depletion, and thus become more aware of the current pressing environmental problems.

Another elderly participant from Bicho *kebele*, who had been less active in the technical aspects of the map, gave a fascinating speech about land and resource degredation. He said,

> *Lafti keenya kaleessa uffata magariisa qabdi ture, amma garuu uffanni ishee dhumee foon isheeyyuu nyaatamaa jira* (Yesterday, our land wore green cloth [forest] but now the cloth has been torn off and the flesh of the land is being eaten [e.g. by erosion]).

Furthermore, he added that the loss of forested areas is a serious problem, as it directly causes a subsequent loss of wild meat, honey, and fruits, and exposes the land to destructive soil erosion. In other words, loss of these areas has a direct implication on the livelihoods of the local farmers.

Group Discussion

Environment and Resources:

The male participant who was *woreda* governor under the *Derg* regime[6] dominated this section of the discussion. This participant stated that land tenure issues were the underlying cause of land and resource degradation. He said that under the rule of Emperor Haile Sellassie (1930-1974), landlords were responsible for all resources. As a result, individual farmers had little to no access to natural resources and had to get permission from these landlords to cut down even a single tree. Under this system, natural resources were preserved. However, as the regime began to lose traction and eventually was overtaken by the *Derg* regime, farmers cut down many trees, and sometimes cleared whole forests, to protest the preexisting land tenure system. The 1975 land reform declared that land and all its resources belonged not to individuals, but again, entirely to the state. In order to cut down a single tree, an individual had to plant five to ten trees as compensation. He said that resource degradation increased under the *Derg* regime, especially in Tigray, Wollo, and North Showa. However, compared to those regions, Jeldu suffered little during this time. Again, the government protected natural resources, but when the *Derg* regime fell, farmers asserted their dominance over the land and retaliated against the strict laws, and massive amounts of resources were destroyed. Forests were cleared for house construction, fencing, expansion of agricultural lands, and many other purposes. In particular, farmland expansion was the most prevalent of these actions, not necessarily for cultivation purposes, but because farmers wanted to assert their dominion over the land. Forested areas were also given to returned veterans, who in turn cleared the areas and used them for farmland. He concluded that this land degradation has severely damaged the community, especially highlighting the pollution of natural water resources due to soil erosion. In the past, this watershed had been classified as a baddaa climactic zone, but at present, the majority of the area in the watershed could be considered in the gammojii climactic zone (desert zone).

[6] The *Derg* regime was a military, socialist regime that exerted a strict fascist control from 1974 to 1987.

Culture:

The group discussed that traditional cultural practices have disappeared in recent years, specifically highlighting a break in religious heterogeneity, a lack of respect for elders, an abandonment of traditional rituals, and a disregard for respectful land resource use. In the past natural resources flourished and agricultural productivity was high. Farmers commented that they used to be able to find lunch by foraging in the forest for local fruits, but now they must return to their homes to eat lunch, as the forest resources have all but completely disappeared. Many participants agreed that the break in traditional religious and cultural practices has caused the destruction of available natural resources. Farmers placed much of the responsibility for this cultural loss on the younger generation, but placed the blame on the local school system. One male participant stated:

> In the context of Jeldu, a young woman wearing pants goes against cultural practices. A young with long hair is seen as an abnormal person. Both do not accept the orders of their family. They don't have environmental ethics. We do not know what our children are learning in the school. The school should be blamed for this case.

This idea of improper socialization of children also related to alcohol consumption. Participants stated that in the past, children used to consume milk with their families, but that now, they tend to consume alcohol alongside their parents.

Group Discussion (Courtesy of IWMI)

The loss of traditional cultural elements in this community is also observed in the decline in use of local resources for spiritual protection. In the past, traditional plants and wood smoke were applied as perfumes and rubbed on clothes to grant protection. With the decline of traditional religions, partially caused by the rise of Protestantism, these traditions have suffered, as Protestants believe that only Christian God can give protection. Female participants were especially concerned about this loss of traditional practices, and many stated that they still believed in the spiritual power of medicinal plants and wood smoke, especially in regard to protection their children against harm.

The mapping consultant and IWMI project leader suggested the establishment of natural resource management education into the public schools through outdoor education clubs. The community responded positively to the idea of a club such as this in their school district.

Livelihoods:

All participants agreed that natural resource degradation has a direct effect on livelihoods. One female participant said that she is only able to collect 20 quintals of wheat (2 metric tons

or 74 bushels) from a plot of land where, 30 years ago, her mother used to collect 60 quintals of wheat (6 metric tons or 222 bushels). Furthermore, livestock is affected by this degradation. Another female participant stated that her cows used to produce 6 liters of milk but today they cannot even produce one. All farmers said that their economic resources have depleted in recent years and they struggle to obtain profit from their agricultural products and struggle to rise above subsistence farming. The money that is gained from selling agricultural products is used to purchase other necessary resources, such as oil, coffee, sugar, and fertilizer. Farmers continued by explaining that in the past, their diet was protein-rich, but with a decrease in natural resources and therefore livestock, they have access to this type of nutrition. Eucalyptus groves that have replaced forests do not provide nearly the same opportunities for nutrition as the forests of years past. Although some participants argued that the expansion of government infrastructure, such as schools and health centers, is an indication of economic progress, however most participants disagreed, stating instead that the health centers were created not as a proactive initiative, but rather as a reactive measure to the increasing environmental degradation.

Predictions for the Future:

Elders emphasized that in the past, the community conceived of natural resources as important aspects of their cultural identity, and that there was even a monetary punishment for the destruction of culturally respected trees. However, in recent years, this practice has entirely disappeared. In order to rejuvenate these natural resources, participants had several suggestions. Firstly, the reforestation of indigenous tree species was the cornerstone of their argument, and they recognized that in order for this initiative to be successful, support would have to come from both governmental and non-governmental organizations. Secondly, the elimination of harmful eucalyptus groves in the area surrounding the springs will improve both water and soil quality. They suggested replacing these groves with bamboo, as this plant advances the health of natural springs. Thirdly, farmers recognized that restoring natural forests in their original location was impossible, and rather, they suggested that some farmlands might have to be converted into forested areas. This would, in principle, be possible, as land is technically controlled by the state.

There was a strong element of nostalgia in the discussion, with participants suggesting that in the not so recent past these areas were much more fertile and forests dense and green. There is no real evidence for this and in fact some studies show that some areas of Ethiopia the effects of deforestation are exaggerated. It would be advisable to do a more detailed comparative study to cross check and triangulate this data.

Day 8

Map Handover Ceremony:

In the handover ceremony, the two maps were officially presented to the community. This ceremony was attended by all workshop participants, as well as other invited community members. The ceremony began and concluded with traditional Oromo blessings by three different community leaders. The vice chairman of the *woreda*, the *woreda* administrator, Dr. Liza, and the mapping consultant gave speeches about the value of the map, the purpose of the workshop, and thanked the community members for participating so actively during the workshop.

Traditional Oromo Blessing to Begin the Ceremony (Courtesy of IWMI)

Two male and two female participants presented their individual maps and explain the 3-D representations of their communities. One female participant remarked, "We did the map of eleven *kebeles*. Last year we only did for one *kebele*…we need to be very concerned about areas and work towards changing them. The team (IWMI staff, consultants, and mapping consultant) are outsiders but they feel responsible for our problem. Therefore, we should also have the courage to work hard to create a better environment. The mapping exercise gave the opportunity for parents and children to come together to talk about environmental and cultural issues and ways of solving the problems that are persistent in our communities." This section of the ceremony was followed by a presentation by two female students, who recited a poem they had written on environmental degradation and community involvement in environmental protection efforts. It is significant to note that this ceremony, and presentations of this kind, contains a certain amount of political speech. In the presence of government officials and outside organizations, people are likely to present a discourse that agrees with the opinions of the ruling political party. As with the overly romanticized state of the forests in past, researchers should be cautious when analyzing the speeches and other official discourse.

ANNEXES

Annex 1: List and Explanation of Legend Items

School: A flat green pin was selected to symbolize these points on the map. The majority of participants accepted this color, agreeing with an explanation given by one of last year's participants who said that, "green is just a growing plant," thereby referring to the developmental and transformative nature of schools.

Orthodox Church: The small light green pin was selected to symbolize these points on the map. Both the blue pin that was used for the previous mapping activity in Kolu Galan and a substitute white pin were rejected, because of the complex symbology of both colors. Green was eventually selected for its significance as a place of life, death, and renewal.

Protestant Church: The large white pin was selected to symbolize these points on the map. Both Protestant participants and Orthodox participants disagreed on the appropriate color, as white has

many meanings, such as purity, spirituality, and holiness, and participants were hesitant to apply all these meanings to one religious entity.

Galma Warra Ayyana (Oromo Church): The large black pin was selected to symbolize these points on the map. Believers of this religion advocated for this color as black is considered to be the color of God in this faith. Some participants from other religious backgrounds also agreed to this color representation, however, their consent to the black color was based on their prejudice against this religion. These participants openly expressed their dislike of this religion and that they supported the color choice because, in their opinion, black represents darkness and sin.

Bridge: The small yellow pin was selected to symbolize these points on the map. Participants expressed that yellow traditionally symbolizes transit from one point or event to the next in the Oromo culture, even to symbolize the change from rainy season to dry season. As a bridge serves to transport people from one location to another, this color was easily agreed upon.

Peasant Administration Center: The very small light green pin was selected to symbolize these points on the map. As this site is the place where community members come together to discuss problems, foster reconciliation, purchase fertilizer, discuss resource management, and more, the green pin was selected to symbolize development and discussion.

Health Center (Human and Animal): The flat white pin and the small white pin were selected to symbolize these points on the map. Participants emphasized that health is the most important aspect of their lives, and thus chose white for both human and animal health centers. As white symbolizes both cleanliness and purity and is the color of health professional's uniforms, there was an easy consensus on this decision.

Police: The large red pin was selected to symbolize these points on the map. Many participants expressed their discomfort with, and fear of, police actions and advocated for the red pin because it represented their conflicting feelings on police actions. In the end, those who expressed negative feelings towards the police convinced the rest of the group to select this pin.

Residence Area: The large blue pin was selected to symbolize these points on the map. This color was selected as residence areas signify both cleanliness and family life. There was no disagreement on this color selection.

Mill: The medium white pin was selected to symbolize these points on the map. There were no mills included in the previous mapping activity, and as such, participants had no example to guide their decision. The introduction of modern mills has greatly lessened the workload of female farmers, who previously had to grind grains using locally made stone tools. Community members were very happy about this technological innovation, and thus chose white to symbolize the technological shift from difficulty to ease, from darkness to light.

Ford: The large yellow pin was selected to symbolize these points on the map. This was the representation used in the last legend model, and participants were widely in support of maintaining its previous representation. Yellow was the appropriate color for these points both because prayer ceremonies are conducted at these points at which people hold yellow flowers and because these ceremonies traditionally take place in autumn, when yellow grass grows at these points.

Ritual Site: The flat black pin was selected to symbolize these points on the map. In years past, many holy trees existed in these sites, however environmental degradation and overuse of the land has led to depletion of these resources. Furthermore, many community members who had previously practiced the traditional religions that revered these holy sites have since converted to other religions. Participants agreed to represent these sites with a black pin because black is the color of the God in this traditional religion.

Local Court: The flat yellow pin was selected to symbolize these points on the map. These centers are the sites of power transfer ceremonies and each site is home to sacred trees. Gadaa[7] is a system

[7]Edossa, D. C.; Babel, M. S.; Das Gupta, A.; Awulachew, Seleshi Bekele, "Indigenous Systems of Conflict Resolution in Oromia, Ethiopia," in Volume 5 of Comprehensive Assessment of Water Management in Agriculture Series, ed. Van Koppen, Barbara; Giordano, Mark; Butterworth, John (CABI, 2007), 149.

of social organization and conflict management based on an 8-year cycle of male age sets. This system covers economic, social, military, and political responsibilities in the local community and assigns specific obligations to each group of men. At the gadaa sites, conflicts ranging from injury to homicide are presented in front of a court. Thus, this pin was selected to symbolize the idea that these sites are the heart of resolution and pacification in the local communities.

Spring: The flat blue pin was selected to symbolize these points on the map. The proximity of natural resources to the spring and the dependency of the community's vitality on water resources led the participants to select this pin.

Horse Arena: The small black pin was selected to symbolize these points on the map. This pin was chosen because horse riders tend to wear black clothing.

Store: The small dark green pin was selected to symbolize these points on the map. With very little discussion, the community members chose this pin because stores distribute resources to people.

Farmer Training Center (FTC): The large pink pin was selected to symbolize these points on the map. There was much debate about this pin selection. Some participants advocated for a green pin, as farmers learn new skills at these sites and it is thus similar to a school. Others argued for pink, as it symbolizes a new development in the community. These farmers were eventually successful in changing the opinions of the others.

Small Factory: The small brown pin was selected to symbolize these points on the map. This was selected because the color matches the colors of the materials produced at these sites.

Holy Water: The small white pin was selected to symbolize these points on the map. There was minimal discussion for this pin, as almost all participants could agree that the pure nature of white made it the appropriate color for these sites.

Quarry: The small black pin was selected to symbolize these points on the map. This color was chosen because it matches the color of the quarry itself.

Forests: The green pin was selected to symbolize these points on the map. In order to correspond with actual color, medium green was chosen to represent eucalyptus, light green was chosen to represent grazing areas, bright green was chosen to represent natural forest, and dark green was chosen to represent bushes.

Soil Types: Several different soil types and corresponding depictions were debated in this discussion. The exact color for each soil was a combination of several colors, created by The mapping consultant to exactly match the desires of the participants. The participants rejected conventional soil classification because they argued that they have specific types of local soil that do not necessarily match general standards. Six soil types and three sandy soil types were identified during the discussion. Following the mapping workshop, researchers from IWMI took soil samples from Chobi Sirba *kebele*, as this area contained all types of aforementioned soil.

Soil Sample: Economic and Socio-Cultural Value of Soil

Borile: This type of soil serves for crop growth, house building, floor material, and a cement-like adhesive. This soil is especially productive when used for lentil growth, but can also be used for teff growth when sufficient fertilizer is present.

Nooraa: This type of white soil is used as a wall decoration in rural areas and as a factory paint base in urban areas. This soil is infertile; no crops can grow in it.

Borborii: This type of soil is used for oil crop growth, such as *nug*. Grasses cannot grow in it. It is also widely found in Chobi Sirba *kebele*.

Diimillee: This type of red soil is found beneath the brown and black topsoil and is used as a cementing agent in house building and can be productive for wheat growth.

Biyyoo Diimaa: This type of red soil exists in the topsoil. It is more fertile, but less useful as an adhesive than *dimillee* soil.

Kaljii: This type of black soil is a very productive and requires minimal fertilizer. Crops such as wheat, barley, teff, bean, pea, and barley grow well in this soil.

Kotichaa: This type of black soil is less productive and requires more fertilizer than *kaljii* soil. Teff is the best crop for this soil.

Biyyoo Magaala: This type of brown soil has both economic and cultural significance. It is both the most productive type of soil and the best liked by community members. For example, in the past, pregnant women have symbolically eaten this soil to imbibe some of its productivity into their own life-giving force.

Akko Manoyyee: This type of sandy soil is named after a historic female leader of Oromo society, Akko-Manoyye. This soil is used primarily for building and construction purposes.

Annex 2: Participant and Student List

Male:

1. Hirpa Debela
2. Kidane Shunka
3. Galisa Tolesa
4. Bekele Gosoma
5. Moges Takele
6. Abera Mengistu
7. Berihanu Deresa
8. Nuguse Aduna
9. Teshome Delasa
10. Gedefa Gutane
11. Megersa Gutama
12. Tadese Balcha

13. Legese Emana
14. Chala Tura
15. Desta Bayisa
16. Beyene Fayise
17. Tifare Megarsa
18. Balcha Beyene
19. Regasa Godana
20. Berihanu Sori
21. Tamene Afomsa

Female:

22. Keneni Bayisa
23. Tsige Tefese
24. Worki Bato
25. Dawi Bayisa
26. Tolashi Gudisa
27. Dinkitu Dida
28. Ajamu Mamicha
29. Ajamu Haile Mariam
30. Aster Bekele
31. Tajitu Asefa
32. Berihane Tsege
33. Adanech Tadesa
34. Debritu Gutama
35. Bersise Deneke
36. Chaltu Tujo
37. Dibaba Gadissa
38. Urge Gonfa
39. Dibaba Kumsa
40. Warkitu Megersa

Student List

Male:

1. Chala Lamesa
2. Getu Bekele
3. Olana Tujo
4. Kebede Hiskisa
5. Birhanu Taddese
6. Worku Dandesa
7. Lemma Furgasa
8. Regasa Jifara
9. Daniel Sisay
10. Sisay Temama
11. Gelana Bekele
12. Jirafa Negasa

Female:

13. Tigist Mekonon
14. Tamirat Negasa
15. Birane Diroo
16. Keneni Chala
17. Tsehay Feyisa
18. Serkalem Cheru
19. Bontu Gizaw
20. Birtukan Belete
21. Adisu Teshome
22. Kibi Biranu
23. Kabane Gidisa
24. Meseret Diro
25. Tajitu Gedafa
26. Bayise Gudisa
27. Mestu Daba

28. Tujare Guta
29. Kibe Boche

Annex 3: Further Reading on P3DM and Participatory Mapping- Annotated Bibliography

Abbot, J, et al. (1999) 'Participatory GIS: opportunity or oxymoron?' PLA Notes 33, 27-34, IIED.
This article questions the widespread use of GIS to help bring about desirable change. It especially questions the use of GIS for the mapping of tacit indigenous knowledge and the realistic expectation of participation when using this technology.

Alcorn, B.J. (2000) 'Border, Rules and Governance: Mapping to catalyze changes in policy and management', Gatekeeper Series, 91, IIED.
This article highlights the use of participatory mapping methods for use in governance. In a workshop, participants create a 3-D model of their community from memory, and this process can help elucidate the similarities and differences between official border demarcations and locally accepted boundaries.

Alzrooni, Saad Aqeel (2011) 'Using Participatory Mapping Methods to Visualize the Cultural Resources: A Case Study of Dalton, GA, MFA Design Management, SCAD.
This article explores the use of cultural mapping as a tool for essential planning and economic development. The author stresses the importance of the consolidating of data and information from various sources for this purpose to create the best possible, holistic representation of a community.

Baker, T.J., B. Cullen, L. Debevec, and Y. Abebe (forthcoming). 'Incorporating gendered perceptions into biophysical models and implications for water resources planning.' *Applied Geography.*
This article details the significant differences in the ways in which men and women use and interact with water resources and landscapes. The authors explore the challenges and benefits of using P3DM as a tool to create an approach that incorporates these differences in an interdisciplinary manner. Presenting the case study of a gender disaggregated P3DM workshop in Ethiopia, the authors assert that the maps developed as a product of this workshop were successfully used as

the principal land input for a SWAT model and the subsequent results confirm that this strategy not only promotes scientific knowledge, but also improves the understanding of communities and landscapes.

Baker, Tracy J., Miller, Scott, N., Prager, Steven D., and Legg, David, E. (2010) 'Disaggregating human population for improved land use management in Kenya', Journal of Land Use Science, 5: 4, 237-257.
This article states that understanding the spatial distribution of populations helps inform critical decision-making processes on resource allocation and management. The advantages and disadvantages to several measurement methods are discussed, and it is suggested that census data may not be a sufficient representation of populations for research management decisions, as per the new population estimate derived for the River Njoro watershed in Kenya.

Corbett, Jon, (2009) 'Good Practices in Participatory Mapping: A Review Prepared for the International Fund for Agricultural Development (IFAD), IAFD.
This article details the many benefits to participatory mapping, most significantly that it can provide an invaluable visual representation of what a community perceives as its place and importance. Participatory mapping projects can also act as drivers of change, advocating for land tenure, protection of indigenous knowledge, and defense of natural resources.

Chapin, Mac, Lamb, Zachary, and Threlkeld, Bill. (2005) 'Mapping Indigenous Lands', Annual Review of Anthropology, 34: 619-638.
This article describes the many methodologies that have been used to map indigenous lands in order to secure tenure, manage natural resources, and facilitate the transfer of intergenerational indigenous knowledge. The power of this knowledge transfer should not be underestimated for both the vitality of communities and the health of environments. GIS laboratories and other mapping resources have become widespread among tribes in the United States and Canada, but have yet to become available to groups in Africa, Asia, and Latin America.

Chambers, R. (2006) 'Participatory Mapping and Geographic Information Systems: Whose Map? Who is Empowered and Who Disempowered? Who Gains and Who Loses?' Electronic Journal on Information Systems in Developing Countries, 25: 2, 1-11.
This article discusses the ethical and social issues to and benefits from participantory mapping. In particular, it focuses on questions of empowerment and ownership in regard to both the practice of mapping and the final product itself.

Crawhall, Nigel. (2008) 'The role of participatory cultural mapping in promoting intercultural dialogue- "We are not hyenas"', UNESCO, Division of Cultural Policies and Intercultural Dialogue, February 2007.
This article asserts that cultural mapping, if carried out in an effective and appropriate manner, can help reach the objectives of the UNESCO Universal Declaration on Cultural Diversity (2001). It further explores how the practice of cultural mapping can become a mechanism for intercultural exchange. This article is intended to assist groups in evaluating how mapping could be a useful tool in cultural practices.

ESRI. (1995). Understanding GIS, the ARC/INFO Method. Self Study Workbook, Version 7 for Unix and Open VMS, Environmental System Research Institute, Inc., New York.
This article details in the fundamentals of GIS mapping methods. This is useful in participatory mapping if the map(s) produced in a workshop are later used in a GIS model.

Gaillard, JC, Montiel, Charlotte, Perrillat-Collomb, Anais, Chaudhary, Sukhdev, Chaudhary, Mamta, Chaudhary, Omhant, Giazzi, Franck, Rom D. Cadag, Jake. (2013) 'Participatory 3-dimension mapping: A tool for encouraging multi-caste collaboration to climate change adaptation and disaster risk reduction', Applied Geography, 45, 158-166.
This article depicts the advantages of participatory mapping for disaster risk reduction and climate change adaptation, especially between different castes. Unequal relationships between members of upper and lower castes are cited as a major driver of people's vulnerability to natural hazards, and participatory 3-dimensional modeling (P3DM) is one of the only explored methodologies that work between castes to address these issues on a societal basis. P3DM is cited

as being especially effective because it is a proactive methodology that allows communities to plan for future risk reduction, rather than merely respond to existing crises.

McConchie, J. and Mckinnon, J. (2002) 'MIGIS- using GIS to produce community-based maps to promote collaborative natural resource management', Asean Biodiversity 2, 27-34.
This article portrays benefits to participatory mapping for natural resource management, especially in the fact that the process creates a meaningful, clear and attractive map that can be applied to development. Participatory mapping is especially useful in light of past development projects because it values indigenous knowledge as a critical information source for resource management.

Pathways through Participation (2010) 'Using Participatory Mapping to Explore Participation in Three Communities', Pathways Through Participation Project, UK.
This article discusses three different participatory mapping projects and highlights the role of community history in the application of these methods. The article stresses that in all three communities, transfer of cultural knowledge truly influences the success and impact of mapping workshops.

Rambaldi, Giacomo. (2010). Participatory Three-Dimensional Modelling: Guilding Principles and Applications, CTA Wageningen, the Netherlands.
This article lays out the guiding principles and fundamental arrangement of participatory three-dimensional modeling. This also includes an important section on monitoring and evaluation of P3DM workshops and highlights the best ways to promote their success in a community.

Rambaldi, Giacomo, Kwaky Kyem, Peter A., McCall, Mike, Weiner, Daniel. (2006) 'Participatory spatial information management and communication in developing countries', The *Electronic Journal of Information Systems in Developing Countries, 25:1, 1-9.*
This article describes the spread of PGIS and its applications, especially to integrate local knowledge with modern scientific knowledge.

Rambialdi G., Mendoza, M., and Ramirez, F. (2000) 'Adding the Fourth Dimension to Participatory 3-D Modelling', PLA Notes 39, IIED.

This article details the tool of P3DM, highlighting the value of PGIS in the overall process, especially useful when mapping large areas. Regular revisions of a map allow for a continued relationship between the community and the researchers, continued transmission of intergenerational knowledge to a wider audience than the individuals who originally participated in the map-making process, and the addition of the fourth dimension, time, to the model.

Rambialdi, G., Muchemi, J., Crawhall, N., and Monaci, L. (2007) 'Through the Eyes of Hunter-gatherers: Participatory 3D Modelling among Ogiek Indigenous Peoples in Kenya', Information Development 23:2-3, 113-128.

This article explains the benefits of a 2006-2008 project conducted in the Mau Forest Complex in which participatory mapping was used as a tool for strengthening a community against vulnerability, land loss, and resource degradation. In particular, it highlights the creation of a map legend in the participatory mapping process, and key value of this process in understanding and contextualizing the process of mapping and the outputs it creates.

Rom D Cadag, Jake; Gaillard, JC. (2011) 'Integrating knowledge and actions in disaster risk reduction: the contribution of participatory mapping', Area: Royal Geographical Society, 44:1, 100-109.

This article deals with the benefits that are derived from including participatory mapping methods in disaster risk reduction. Using the case study of the authors' experiences in the Phillipines, it strongly advocates for these methods to increase resiliency through the transfer of intergenerational knowledge.

Sletto, Bjorn Ingmunn (2009) '"We Drew What We Imagined" Participatory Mapping, Performance, and the Arts of Landscape Making', Current Anthropology 50:4, 443-476.

This article details the observation of mapping projects conducted in the Trinidad in 1998 and in Venezuela in 2001-2004. It states that these projects demonstrate the immense value of participatory mapping as a venue for the negotiation of identities, revealing the complex relations between local and global, social and political, and individual and community. This article suggests

the need for greater reflexivity in the approach to and application of participatory-mapping techniques.

Vajjhala, Shalini P. (2006) '"Ground Truthing" Policy: Using Participatory Map-Making to Connect Citizens and Decision Makers', Resources, Summer (162).
This article describes how researchers can use participatory mapping as a tool to examine the impact of this methodology as a policy tool or a driver of change. Ultimately, the researchers assert that using participatory mapping in tandem with GIS, planners and policy makers should be able to merge their views and practices with local realities and perceptions.

WaterAid (2005) 'Community Mapping: A Tool for Community Organizing', WaterAid, London.
This article details the structure and methodology behind participatory mapping, especially as a tool for empowerment and as a mechanism for change. It highlights the advantages to participatory mapping over other similar methodologies because, unlike other projects, the product remains within the community and is managed, built upon, and evolves as the community undergoes change.