Hidden Aspects of Participation: Reflections on the Costs and Benefits of a Participatory Mapping Process for Communities and Researchers Alike in Afar, Ethiopia

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Participatory mapping with community members in the Afar region (Ethiopia). Photo courtesy of M. Luizza.

Abstract:
With research agendas often driving participatory mapping activities, building trust with participants is essential to the participatory mapping process, especially if it is initiated and/or facilitated from outside of the community. Without trust, the mapping will not be authentic and may never happen at all. However, despite the best intentions, participatory mapping processes initiated by outsiders can still result in an extractive undertaking of knowledge co-option, even when local communities receive some measure of benefits. This reflection piece offers a postscript to published research on a participatory mapping project in Ethiopia's Afar region (Luizza 2015; Luizza et al. 2016) but provides added context and critical reflection on the participatory mapping process not fully addressed in these previous works. This effort highlights a well-intentioned research project that through a narrow focus on "knowledge integration" at the expense of "knowledge co-production", overlooked important opportunities for building trust with community participants, leading to a level of misalignment of research goals and community

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needs. Although outsiders caring about community concerns and amplifying their voices was appreciated, what participating communities really needed were tangible resources and guidance for removing problematic invasive species that I as the researcher and participatory mapping facilitator was there to learn about from them. Honesty, transparency, and reliability are key attributes that a participatory mapping facilitator should always strive to embody throughout the mapping process, which should not be rushed (i.e., pre-mapping community engagement, onsite participatory mapping process, and post-mapping actions). This includes communities and facilitators being on the same page, as co-equal partners, about what participatory mapping is and the purpose and goals of this important approach.

Background:

Participatory mapping is an approach where diverse stakeholders discuss and draw places of significance related to their livelihoods, communities, and resources (Fagerholm et al. 2019 and 2021). This process can entail a variety of data collection and mapping tools and is centered on local spatial knowledge and interests (McCall 2021). Local Ecological Knowledge (LEK)[2] (frequently used interchangeably or in concert with Indigenous Ecological Knowledge, or IEK) is central to participatory mapping, with these activities often focusing on the integration of LEK with complex spatial information (Ernoul et al. 2018).

In recent years, there has been a growing interest in cataloging local knowledge of rural pastoral and agro-pastoral communities in the Afar Regional State (also referred to as Afar or Afar region) of northeastern Ethiopia (Figure 1) to better assess and inform conservation, natural resource management, and local adaptation strategies in this remote part of the country that is experiencing increased challenges related to climate change, land use conversion for industrial agriculture, invasive species, and communal conflict. Such local community-focused efforts have included the use of participatory and LEK data collection approaches (e.g., Balehegn 2016; Schmidt and Pearson 2016; Rogers et al. 2017; Teklehaymanot et al. 2017; Belete et al. 2018), including participatory mapping (e.g., Luizza et al. 2016; Wakie et al. 2016a; Treydte et al. 2017; Jones et al. 2020). Various international NGOs and U.S. Government Agencies have a history of engagement on development and humanitarian relief projects in the Afar region (e.g., USAID, CARE International, Oxfam, Farm Africa, etc.) Moreover, western and Ethiopian scientists have been conducting research in Afar, focused on pastoralists and livestock husbandry, since at least 2003; however, few (if any) research studies used participatory mapping in their projects before the efforts of our Colorado State University (CSU) project spanning 2012 to 2014[3].

[2] LEK entails understandings, beliefs, and practices developed over time by human communities in relationship to their natural environment, and which are dynamic and co-evolving with social and ecological changes (Aswani et al. 2018). More specifically, LEK involves site-specific, contextualized knowledge generated by local users through local observations and experiments, in contrast to knowledge developed through professional scientific endeavors (Gadgil et al. 2003).

[3] This reflection piece focusing on the work conducted in 2014 (see Wakie et al. 2016a and 2016b for additional research details).

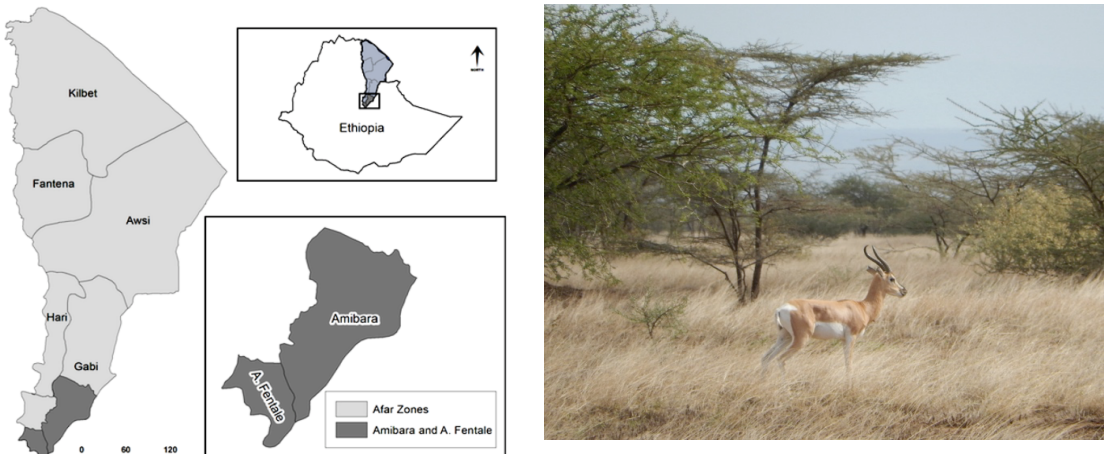

Figure 1. Left: Afar region of Ethiopia, including zoom-in of the two districts (*woredas*) where participatory mapping activities were conducted. Right: Soemmerring's gazelle (*Nanger soemmerringii*, Vulnerable, IUCN Red List) in Afar's Alledeghi Wildlife Reserve. Map courtesy of T. Wakie. Photo courtesy of M. Luizza.

As part of a larger PhD dissertation research agenda (Figure 2) supported in part by U.S. Department of Agriculture (USDA), National Institute of Food and Agriculture, U.S. Geological Survey (USGS), the National Science Foundation (NSF), and the Murulle Foundation, the initial goals of this research included gaining a better understanding of: 1) the greatest threats to pastoral livelihoods in the region, 2) landscape-scale changes that community members have observed during their lifetime, 3) local perceptions of the impacts of the globally invasive mesquite tree/shrub *Prosopis juliflora*, and 4) use and access of important provisioning ecosystem services (i.e., the benefits people receive from the environment, specifically the products obtained from ecosystems, such as food, fresh water, fuelwood, fiber, etc. See MEA 2005).

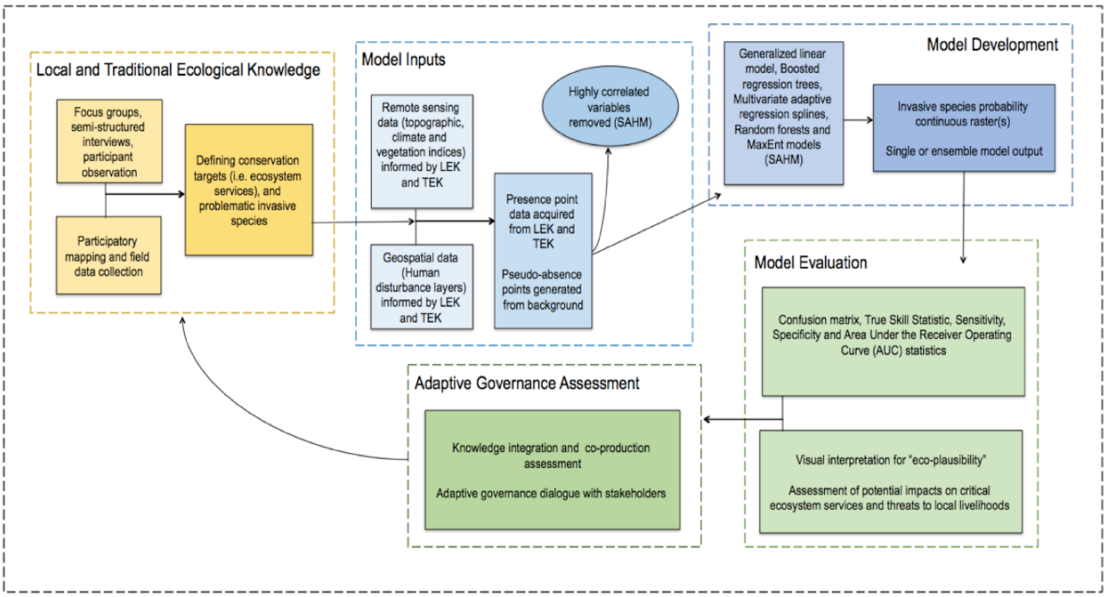

Figure 2. Conceptual model for PhD research design (Luizza 2015). Process included (1) cataloguing LEK to define ecosystem services and problematic invasive species (IS), (2) assessing IS threat with geospatial tools, and (3) validating/calibrating maps with local communities and beginning dialogue about adaptive conservation planning.

The geographic extent of this study centered on village lands and the surrounding landscape used by pastoralists in two districts (*woredas*) located within the Afar region, which is one of Ethiopia's ten regional states (see Figure 1). The Afar region covers some 95,000 square kilometers and is split into five administrative zones, which are further subdivided into 29 districts (*woredas*) and 355 *kebeles* (the smallest administrative unit in the country). This region is geologically and topographically diverse, and although considered one of the hottest habitable places on the planet, it is home to unique wildlife, including the African wild ass (*Equus africanus asinus*) and Grevy's zebra (*Equus grevyi*; Kebede et al. 2012 and 2014) and approximately 1.5 million people of which the majority are pastoralists (Sonneveld et al. 2009) (Figure 3). For additional description of the Afar region see Luizza et al. (2016), Wakie et al. (2014), Davies and Bennett (2007), and Getachew (2001).

Figure 3. Afar pastoralists in village with invasive mesquite (*Prosopis juliflora*) in the background. Photo courtesy of M. Luizza.

Participatory mapping process:

Semi-structured focus group interviews, participatory field data collection, and participatory mapping using satellite imagery (see Appendix 1 for sample image) were used to identify the greatest threats to pastoral livelihoods in the Afar region, landscape-scale changes that community members have observed during their lifetime, local perceptions of the impacts of the globally invasive mesquite tree/shrub *Prosopis juliflora* and use and access of important provisioning ecosystem services. Focus group interviews and participatory mapping activities, were conducted with 7 villages located across the Amibara and Awash-Fentale districts (Table 1). Stakeholder groups were made up of interested and willing participants from the seven villages in question and included both single and mixed gender groups with participants spanning various primary and secondary occupations.

Table 1: Villages where research was conducted.

Village	Number of Participants	Men/Women	Age Range	Primary Occupation (#)
Beduleale	5	5/0	26-40	Agro-pastoralist (4), Development agent (1)
Boloyta	5	4/1	21-45	Pastoralist (5)
Buri	9	8/1	21-45	Pastoralist (9)
E'eble	6	6/0	15-40	Pastoralist (4), Pastoralist/Teacher (1), Pastoralist/Religious leader (1)
Sabure	10	6/4	21-50	Agro-pastoralist (9), Agro-Pastoralist/Teacher (1)
Serkamo	5	5/0	15-35	Pastoralist (5)
Udelesi	6	5/1	15-45	Pastoralist (6)

Permission from each village chairperson (all men) was sought before engaging in any data collection. The project goals were explained to each chairperson and all participants, and they were additionally informed that participation was voluntary (see Appendix 2 for sample consent scripts in English and Amharic). Translation was facilitated by a local translator who is fluent in the Afar dialect and the national language Amharic, in addition to being conversant in English, and one of the researchers who is fluent in Amharic and English. Research questions and the translation process itself were piloted before going to the seven villages.

Discussions not explicitly linked to the mapping activities proved important in providing social and ecological context, confirming participants' leading role in defining the research focus, and setting the stage for subsequent participatory mapping activities. For example, the structure of the pre-mapping focus groups provided participants space and freedom to control the direction of the discussion, which ultimately resulted in the research being re-defined to focus on the recently established invasive species, rubber vine (*Cryptostegia grandiflora*), based on participants' concern about the plant's negative impacts to their livelihoods (Figure 4) (see Atia and Doherty 2021 for mor on the "emergent research" process. See Appendix 3 for a list of trees negatively impacted by rubber vine in the Afar region). Data from the participatory mapping activities and field validations were incorporated with habitat suitability modeling to assess the risk of rubber vine and to conduct a relative invasion risk assessment map (Figure 5. See Appendix 4 for list of rubber vine occurrence points used in the modeling).

Figure 4. Left: Rubber vine (*Cryptostegia grandiflora*). Right: Mesquite (*Prosopis juliflora*). Both are invasive species to Ethiopia's Afar region. Photos courtesy of M. Luizza.

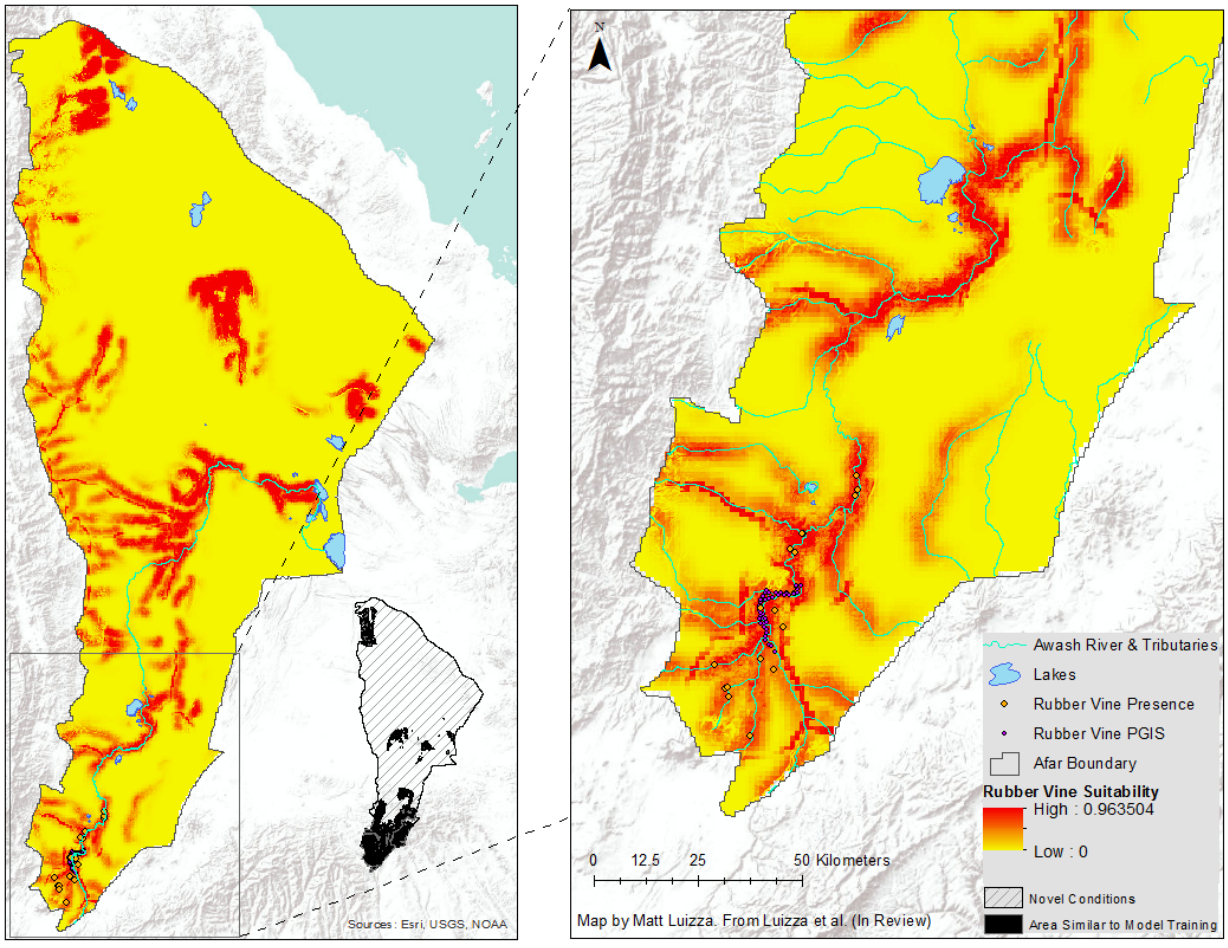

Figure 5. Rubber vine relative risk map for Ethiopia's Afar region. Areas in red denote high probability of habitat suitability for rubber vine, noticeably concentrated along the Awash River. Figure adapted from Luizza et al. (2016).

Reflections:
The following section relays my reflections on the process of participatory mapping for this project, the costs and benefits to the community participants and myself as a researcher, in addition to targeted recommendations for conducting participatory mapping activities. This project was a major learning experience for me as a fledgling interdisciplinary researcher. I gained much as an academic but ultimately question the degree to which community participants equally benefitted from the process.

Community members were keen to share and conduct mapping exercises. Regarding mapping exercises, the focus on invasive species offered a seemingly less contentious, easier entry point to engage with communities as an outsider. Generally, all participants agreed that the invasive species in question (i.e., *Cryptostegia grandiflora* (rubber vine), *Prosopis juliflora* (mesquite)), in addition to others (i.e., *Parthenium hysterophorus* L. (whitetop weed)) posed major threats to the landscape and local livelihoods and were eager for assistance in addressing growing challenges associated with their establishment and spread. It became clear through the participatory mapping process that this gap in technical expertise was the most needed output for community wellbeing. Most participants felt strongly that the former two plants (rubber vine and mesquite), individually and in concert, were linked with a number of critical direct threats to their livelihoods, including reduction and loss of important native plant species (grasses and trees that provide essential provisioning ecosystem services), increased human-wildlife conflict, with invasive species noted to provide added cover for predators, including hyenas and leopards, and reduction in livestock health, among others.

Originally, a water point mapping activity was included with the invasive species participatory mapping activity. It quickly became apparent that participants were uncomfortable sharing this sensitive information. Only government constructed boreholes were ever drawn on the map despite community constructed boreholes and ephemeral springs being frequently discussed, so the activity was removed after attempts with two villages. A similar dynamic occurred during the focus group interviews when medicinal plants were discussed. Only a few participants were comfortable discussing specific plants and their medicinal uses, but not their locations, and only one village offered to show me the exact location of a specific plant in the field, to highlight how much further they had to travel to find it due to invasive species encroachment and climate change. The plant, locally called *Laabneba*, was noted to be used for treatment of a range of stomach ailments. I added the observation to my iNaturalist account[4] but the scientific name has yet to be identified through this citizen science platform, in part, because the plant was not flowering when I took the photos.

Detailed discussions took place spanning the depth and breadth of LEK, such as observed changes to the landscape over time and connections with the loss or reduction of wildlife, especially grazers that co-occur with livestock (e.g., zebra, hartebeest, Oryx, gazelle, African wild ass), increased flooding and drought, increased prevalence of livestock diseases, in addition to a reduction in livestock herd sizes. This was noted to have compounding impacts to the Afar culture of sharing centered on camel milk, which is considered common property that all can access. Sharing was stated to still occur, but milk was not nearly as plentiful and for animals known to browse on invasive whitetop weed, the taste of their milk was different, often leaving a

[4] https://www.inaturalist.org/observations/4834513.

bitter aftertaste. Moreover, pastoralists lamented having to travel longer distances to access suitable grazing for livestock (often more than 10 km, which was not always the case). Such endeavors were noted to increase the risk of attack from predators and could lead to conflict with other clans. These challenges were said to be linked with changes to historically predictable rains associated with communal bounding of seasonality (i.e., pastoralists noted four historically consistent rainy seasons: *kerma*, *detrob*, *dedaa*, and *segum*), including the shortening of two rainy seasons and the disappearance of two others entirely, and the detrimental impact of invasive species on beneficial provisioning ecosystem services (see Appendix 3). Participants also noted the loss of ephemeral water sources, with some of the villages increasingly reliant on obtaining diesel to run generators to pump water, in addition to the loss of native vegetation, including grasses and trees due to invasive species, charcoal production, and commercial irrigated farming (primarily sugar cane in the Awash River valley).

The opportunistic nature of this research did not facilitate building in the most effective pre- and post-mapping engagement with community stakeholders. My PhD research efforts in Alaska, where I originally planned to do all my dissertation work, were stalling, and an opportunity to conduct similar work in Afar opened through my PhD co-advisor (Dr. Paul Evangelista). However, the longstanding research presence of my co-advisor in Ethiopia and the trust he and his lab have built with Ethiopian communities over the years, was critical for gaining any entry to conduct this project. Additionally, my colleague and fellow member of my PhD cohort, Tewodros Wakie's ongoing project in Afar for his PhD research, focused on *Prosopis juliflora*, further facilitated my access to specific villages and participants. Yet, I overlooked building in designated funding for concerted follow-up work with local communities (a key component of my proposed dissertation conceptual model), and this became problematic.

Working in the context of unstable environments for the first time also quickly taught me to prepare for the unexpected and for setbacks due to factors out of your control (e.g., armed conflict, political upheaval, etc.) and to have contingency plans. My project's next steps were hampered by local and regional instability, including the cancelation of a planned return trip and seeming inaction by federal government authorities when project outputs were shared by fellow research colleagues (likely because of my naivete about the complex and contentious relationship between the regional states and ruling party in the capital, Addis Ababa). In hindsight, I should have brought my results first to the Afar regional state capital (Semera) and not solely to the national capital, Addis Ababa. Multiple return trips and more concerted dialogue with communities about regional and national political dynamics, and the most effective entry points with decision makers may have avoided some of these missteps. I also learned the importance of being explicit with community stakeholders regarding what they should expect of a project, even if you are optimistic and pushing for big impacts. Creating space so everyone's expectations can be clearly articulated and on the table is essential and requires extensive pre-planning with communities, including one or more pre-participatory mapping trips to unpack participant needs, set expectations for all contributors, and have the communities really shape the project goals.

Some participation issues arose, specifically around the contribution of women. Space was often not given for them to contribute until I requested to hear their direct responses to the questions. Recruitment of women was also a challenge, as it was dependent on each village chairperson (all men) facilitating. Adding to this complexity was the challenge of language and translation. Although I was prepared for this (in theory) through the Social, Behavioral, and Education

Research Institutional Review Board (IRB) at Colorado State University (Protocol # 14-5049H). In practice, I did not commit enough pre-trip bandwidth to this important piece of the research. For example, many of the community participants were illiterate, so written consent forms proved unhelpful, even though they were translated to Amharic (but not the regional Afar language). To adapt to this reality, the consent form was read aloud in English or Amharic and translated to Afar. Despite this adaptation, language use was prioritized to accommodate my research team (English and Amharic speakers) and not the participants, which likely impeded the natural flow of discussion as all community participant input had to be captured and translated in real time by the project's sole community team member, who spoke Afar and Amharic, and some English, but often required multiple layers of translation.

Outcomes and products resulting from this research included the identification of rubber vine (*Cryptostegia grandiflora*) as a recently established invasive species that poses a growing threat to local pastoral livelihoods, including evidence of a level of positive mutualism between it and invasive *Prospois juliflora*. The presence of rubber vine in Afar was previously unknown to the CSU research team and was receiving little to no attention by the Ethiopian government, U.S. government agencies (e.g., USAID) or NGOs (e.g., CARE Ethiopia) active in the region at the time. Additionally, this effort provided an example of successful integration of LEK through participatory mapping for invasive species vulnerability assessment (i.e., a refined methodological approach) and evidence of local knowledge as important early detection tool for invasive species establishment. I was not sure the local community members would be comfortable working with satellite imagery or have an easy time recognizing landscape features and orienting themselves based on an aerial 2-D image of their landscape (some had not ever seen one before). However, I was elated (and humbled) with how quickly participants could spatially orient themselves, triangulate key landscape features, and tell distance with high accuracy, exposing some of my own problematic biases as a western researcher. For me, this process reinforced how universal and powerful maps are, in particular, that they can spark discussions and reveal insights that otherwise may go overlooked. Project products included a rubber vine habitat suitability model and relative invasion risk assessment map (Figure 5), which was shared with Ethiopian government and NGO representatives in Addis Ababa, a peer-reviewed publication (Luizza et al. 2016), and a PhD dissertation chapter (Luizza 2015).

Benefits of this project were most apparent for me as the researcher, however, additional voices advocating on behalf of the participating communities with government and civil society organizations was welcomed by participants. Additionally, this research sought to give a control and ownership of the project to the communities, centering the research on their concerns. Other benefits to the communities may exist that I am unaware of, and granted, the aforementioned are assumed benefits. This highlights limitations in the project design not creating space for participants to evaluate the project and participatory mapping process, whether directly following the mapping activity, or during a separate, follow-up trip to validate and disseminate project results. The project further confirmed the important contribution of LEK for conservation management and planning, specifically, invasive species early warning and detection and enhancing habitat suitability models. Moreover, it afforded me an enhanced knowledge and understanding of the ecology and biology of rubber vine in Ethiopia and the multi-faceted threat it poses. I also gained an increased publication presence through a peer-reviewed journal and dissertation chapter, both of which acknowledged the contributions of participating communities

but did not include them as co-authors, even though the research could not have happened without their support. This was another missed opportunity to build trust and treat community members as co-equal partners. Additionally, I gained invaluable experience managing field research projects and the unique opportunity to travel to a region that is rarely visited by foreigners (including exposure to Afar pastoral culture and wildlife viewing in Awash National Park). Furthermore, I was personally enriched through my engagement with local community members (during research, around the campfire, etc.), while fulfilling the requirements of my advanced degree and research fellowship.

Costs of this research effort varied but included a commitment of 3-6 hours at each village for participants in addition to the potential risk of sharing sensitive information with foreigners (e.g., results could be used against their interests). Moreover, the project may have heightened expectations of local assistance, including invasive species eradication and other local development assistance from researchers and/or the Ethiopian government. For me, costs included potential damage to the reputation of foreign researchers in the eyes of the local community stakeholders, based on the lack of complete follow through, as the project planned to bring maps back to each village for a series of validation and targeted monitoring sessions, share the maps with Ethiopian government officials and NGO representatives, and foster a dialogue between villages regarding the threat of rubber vine. Funding for follow-up visits was not built into the project from the start, in part, due to opportunistic nature of research and a lack of understanding by me the lead researcher regarding the critical nature of this piece of the planning process.

Equity was not an explicit goal of the Ethiopia project and the concept of "equity" (i.e., providing everyone what they need to succeed, considering historical and other factors that play into an uneven playing field) was never addressed or unpacked in the research proposal, IRB application, etc.; however, putting local communities in the driver's seat of the research process in addition to amplifying their voices were goals of the study. When reflecting on equity in the research approach, an attempt was made to ensure participants had a comfortable setting, trusted local intermediary, agency and flexibility to determine where the discussion (and research for that matter) went, while also acknowledging and seeking to upend the traditional "researcher-subject" power dynamic. That being said, I never grappled on the front end of my project design with the idea of equity in the benefits/outputs/outcomes of the research. I needed to include myself in that equation but continued to separate myself from that assessment. At the end of the day, most of the clear and tangible benefits were received by me, not the communities that participated. A simple question I never asked but should have incorporated into my IRB approved interview guide was something along the lines of: "what do you as individuals and as a community need to get out of this process for it to be worth your time?"

Looking ahead, more training and resources are needed for western researchers and graduate students (and requirements via IRB, core course/training, etc.) on justice, equity, and inclusion in scientific research. Additionally, there is a great need for building trust through co-equal partnerships and building the capacity of academic and research institutions and community-based organizations in the countries where participatory mapping activities are happening (i.e., investments of time and money). I cannot overstate the importance of building in multiple return visits to share results and validate participatory mapping outputs. Although valuable, an overt focus on knowledge integration within participatory mapping approaches can run the risk of merely paying lip service to community engagement, keeping embedded power imbalances

between researchers and participants firmly in place (whether intended or not), and prioritizing community consultation over collaboration, the latter or which is more likely to be a catalyst for or product of knowledge co-production (Table 2). My efforts focused on knowledge integration (the publications associated with this work have it clearly stated in their titles) rather than knowledge co-production, which seemingly led to a level of misalignment of research goals and intentions and the most pressing community needs. Some of the missed opportunities to build trust could have been remediated by building in meaningful community participation into all stages of the project (from design to dissemination of results), moving away from knowledge integration to knowledge co-production.

Table 2. Knowledge integration vs. knowledge co-production (adapted from Luizza 2015).

Concept	**Description**	**Selected Key References**
Knowledge integration	Multiple evidence-based approaches that deal with the synthesis and validation of different knowledge systems. Different knowledge forms are viewed as distinct, yet complementary and provide new insights to a given environmental problem.	Gadgil et al. 1993; Fernandez-Gimenez et al. 2006; Brown 2009; Blythe & Dadi 2012; Tengo et al. 2014
Knowledge co-production	The collaborative process of generating new knowledge that brings a plurality of knowledge sources and types together to address a defined environmental issue. Collaborative and participatory processes occur at all stages of knowledge generation.	Pohl et al. 2010; Armitage et al. 2011; Dale & Armitage 2011; Fazey et al. 2012; Tengo et al. 2014

This case offers important lessons learned regarding a range of community access issues (e.g., physically getting to rural villages, gaining a measure of trust with politically marginalized people, facilitated through boundary-spanning individuals connected to the community and outsiders, and using technology-based tools such as remote sensing and ecological modeling algorithms), and unintended consequences, including engaging to some extent in an extractive process of knowledge co-option that predominantly benefits research goals, despite good intentions and the achievement of some measure of community benefits (e.g., reinforcement of the legitimacy of community knowledge, shifting traditional "subject-researcher" roles, creating new avenues to advocate for community concerns with decision-makers). The best intentions behind participatory mapping processes initiated by outsiders can still result in a fairly extractive undertaking of knowledge co-option even when it provides some benefits to local communities. This reflection does not change my view of the value and importance of participatory mapping but highlights how critical it is to be thoughtful and thorough when deploying these tools. Building trust is essential to the participatory mapping process, especially if it is initiated or facilitated from outside of the community. Without trust, the mapping will not be authentic and may never happen. Trust building cannot be forced, and the actual mapping process cannot be rushed. Honesty, transparency, and reliability are key attributes that a participatory mapping facilitator should always strive to embody throughout the mapping process (i.e., pre-mapping community engagement, participatory mapping process, and post-mapping actions). This includes communities and facilitators being on the same page about what participatory mapping is and the purpose and goals of the process.

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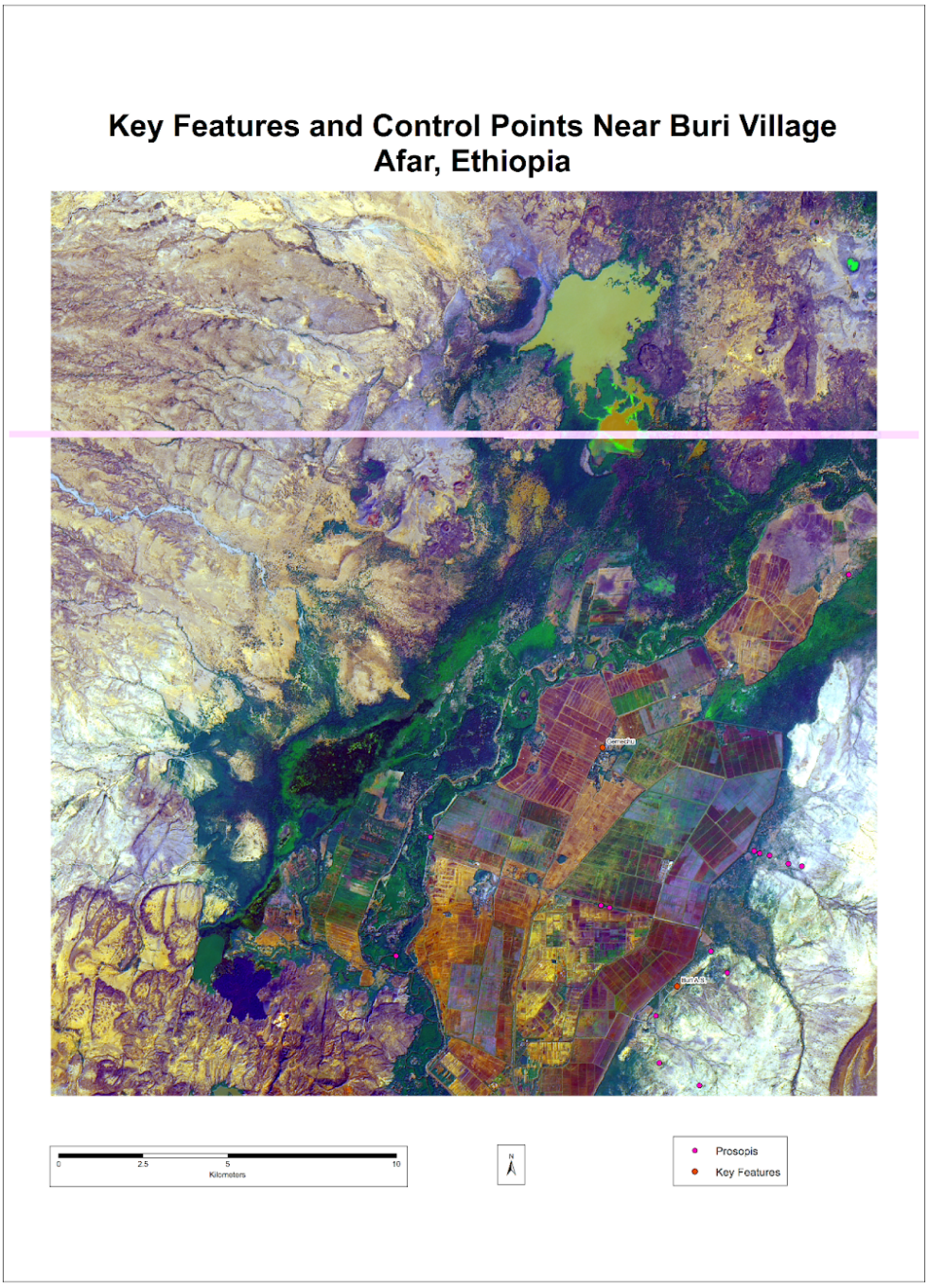
Appendix 1. Example of mosaicked, pan-sharpened (to 15m resolution) Landsat 8 imagery used during participatory mapping activities.



Appendix 2. Consent forms (scripts) English and Amharic.

April, 16, 2014

The Research Study

Hello. My name is (*interviewer state name*). Thank you for speaking with me today. I am from Colorado State University in the United States of America. We are inviting you to take part in a research study. Please ask me to explain anything you do not understand. You can ask questions now or anytime during the study. You will have a chance to ask questions before you make your decision. We are looking for local men and women to help with our research project. For this research we are collecting information about the beneficial economic uses and local perceptions of negative impacts of the globally invasive mesquite tree/shrub *Prosopis juliflora*, in addition to understanding use and access of other important ecosystem services (meaning the benefits people receive from the environment), including water and wildlife.

Your Help

I am asking you to be in a group interview (or we can talk talk privately) to help name local plants and what you use them for. The interview will take around two hours and is voluntary. You may stop at any time. And you may skip any question that you do not want to answer. We will share our research results with you. You may or may not benefit from being in the study. But we hope it will help your community with local concerns about plants and animals in the area. Knowledge we gain from this study may benefit others in the future.

Risks

There are no known risks to being a part of this study. Our team will do everything possible to protect the health and safety of everyone helping us with this project. Your name will not be written down or used in our reports. No personal information of yours will be shared with other people of groups outside of our team.

Questions

If you have any questions please ask me. I will also give you the name and contact information for local team members, and team members at the university in the United States: Tewodros Wakie (Colorado State University, United States of America): [redacted] Matthew Luizza (Colorado State University, United States of America): mwluizza@rams.colostate.edu, Paul Evangelista (Colorado State University, United States of America): [redacted] Addis Ababa): [redacted] Addis Ababa) [redacted] For information about your rights as a participant you can contact the Colorado State University Institutional Review Board Coordinator at RICRO_IRB@colostate.edu or [redacted]

አፕሪል ምር

ጥናታዊ ምርምር

ሠላም. ሥም(የጠያቂው ሥም). ዛሪ ለመነጋገር ፈቃደኛ ሥለሆኑ አመሰግናለሁ
እኒ የመጣሁት ከዐሜሪካ አገር ከኮላራዶ ስቴት ዩኒቨርሥቲ ነዉ.በዚሕ ጥናታዊ ምርምር ላይ ተሣታፊ ዕንዲሆኑ ዕየጋብዝንዎት ነዉ. ዕባክዎትን ያልገባዎትን ማንኛውንም ነገር ይጠይቁኝ.ጥያቄዎትን አሁንም ሆነ በየትኛወውም የጥናቱ ጊዜ መጠየቅ ይችላሉ.ዉሳኔ ክመወሰንዎ በፊት ጥያቄ ለመጠየቅ እድል ይኖርዎታል. ነዉ.በዚሕ ጥናት ላይ የሚሣተፉ የዐካባቢዉ ተወለላጅ ወንዶችና ሴቶችን እየፈለግን ነዉ.ይሕ ጥናት በዚሕ ዐካባቢ ያሉ ተከከሎችን ስም፡ለምን እንደሚያገለግሉ፡በተጨማሪም ሰወች የሚያገኙትን ጥቅም ዕና ስለ የዱር ሕይወት ይመለከታል.ጥናቱ በዐሜሪካ አገር ያለ ብህራዊ የምርምር ተቁአም የሚደገፍ ነዉ.

የዕርሥ ዕርዳታ
በዚሕ ጥናታዊ ምርምር ላይ ተሣታፊ ዕንዲሆኑ ዕየጋብዝንዎት ነዉ. በዚሕ ዐካባቢ ያሉ ተከከሎችን ስም፡ለምን እንደሚያገለግሉ፡በተጨማሪም ሰወች የሚያገኙትን ጥቅም ዕና ስለ የዱር ሕይወትና የዉሃን ዐገልግሎት ዕንዲንግሩን ነዉ. መጠይቁ አራት ሰዓታትን ይወስዳል. የጥናቱን ዉጠየት እንጋራለን. እርሶ በዚሕ ጥናት ሊጠቀሙም ላይጠቀሙም የችላሉ. የጥናቱን ዉጠየት ግን በዚሕ ዐካባቢ ያሉ ሰወችን ይጠቅማል ብለን ዕናምናለን. ነዉ.በዚሕ ጥናት የሚገኘዉ ዕዉቀት ለሌሎች ተከታይ ጥናቶች ይጠቅማል.

ሥጋቶች
በዚሕ ጥናታዊ ምርምር ላይ ተሣታፊ ከመሖን ጋር የተያያዘ ሥጋት የለም. የጥናቱ ቡድን በዚሕ ጥናታዊ ምርምር ላይ ተሣታፊ ሆነዉ የሚያግዙንን ሠወች ጠየንነትና ደህንነት ለመጠበቅ የሚቻለንን ሁሉ እናደርጋለን.ስምዎን በዚሕ ጥናት ላይ ዐንገልሥም.የትኛዉም የግል መረጃ ከጥናቱ ቡድን ዉጪ ላሉ ሰወች ዐይገለፅም.
ጥያቄዎች
ዕባክዎትን ያልገባዎትን ማንኛውንም ነገር ይጠይቁኝ. የጥናቱ ቡድን ዐባል የሖኑትን የህገር ዉሥጥና :ከዐሜሪካ የኮላራዶ ስቴት ዩኒቨርሥቲ ተወካዮች ስም ዐሳውቅዎታለሁ mwluizza@rams.colostate.edu, Paul Evangelista (**ከኮላራዶ ስቴት ዩኒቨርሥቲ**): [redacted]
((አዲሥ አበባ): [redacted] (አዲሥ አበባ) [redacted] **እናደርጋለንተሣታፊ ከመሖን ጋር የ ነዉ.በዚሕ** RICRO_IRB@colostate.edu or [redacted]

Appendix 3. Afar Fuel Wood Species Information Sheet: Pastoralists noted that all are threatened by *Prosopis juliflora* and *Cryptostegia grandiflora* expansion. Photos courtesy of M. Luizza.

Above: "Keselto" (*Acacia nilotica*) provides firewood, charcoal, construction, livestock & wildlife forage, medicinal, and other services (shade).

Above: "Ehebto" (*Acacia tortilis*) provides firewood, charcoal, construction, food, livestock & wildlife forage, and other services (shade).

Above: "Adado" (*Acacia senegalis*) provides firewood, charcoal, construction, food, livestock & wildlife forage services.

Above: "Kilaito" (*Combretum aculeatum*) provides firewood, charcoal, medicinal, cosmetic, livestock fodder and livestock & wildlife forage services.

Above: "Mederto" (Cordia *spp*.) provides firewood, construction, food, and other services (walking/herding/fighting sticks and rope).

Above: "Maka'arto" (*Acacia mellifera*) provides livestock & wildlife forage, firewood, charcoal, construction, and other services (shade).

Above: "Adayto" (*Salvadora persica*) provides firewood, medicinal, forage, and other services (toothbrush).

Left: "Adengeli" (*Cadaba rotundifolia)* provides firewood, medicinal, veterinary, livestock forage (particularly during drought) and other services (milk storage).

Appendix 4. Rubber vine (*Cryptostegia grandiflora*) occurrence points collected through participatory mapping and field sampling efforts.

Rubbervine PGIS Points

Species	FID	Shape	X	Y
Cryptostegia grandiflora	0	Point	621422.9	1020646
Cryptostegia grandiflora	1	Point	619672.9	1026146
Cryptostegia grandiflora	2	Point	620172.9	1027896
Cryptostegia grandiflora	3	Point	620172.9	1026396
Cryptostegia grandiflora	4	Point	620422.9	1024896
Cryptostegia grandiflora	5	Point	626172.9	1030146
Cryptostegia grandiflora	6	Point	624922.9	1030396
Cryptostegia grandiflora	7	Point	621172.9	1018896
Cryptostegia grandiflora	8	Point	620922.9	1028646
Cryptostegia grandiflora	9	Point	619922.9	1027146
Cryptostegia grandiflora	10	Point	621672.9	1030146
Cryptostegia grandiflora	11	Point	621422.9	1021396
Cryptostegia grandiflora	12	Point	620922.9	1022146
Cryptostegia grandiflora	13	Point	626422.9	1029896
Cryptostegia grandiflora	14	Point	628922.9	1031146
Cryptostegia grandiflora	15	Point	620672.9	1029396
Cryptostegia grandiflora	16	Point	628672.9	1031646
Cryptostegia grandiflora	17	Point	629672.9	1031896
Cryptostegia grandiflora	18	Point	628422.9	1029896
Cryptostegia grandiflora	19	Point	621172.9	1030146
Cryptostegia grandiflora	20	Point	628922.9	1030146
Cryptostegia grandiflora	21	Point	619922.9	1024646
Cryptostegia grandiflora	22	Point	620672.9	1025146
Cryptostegia grandiflora	23	Point	627922.9	1030146
Cryptostegia grandiflora	24	Point	623672.9	1030396
Cryptostegia grandiflora	25	Point	620922.9	1022896
Cryptostegia grandiflora	26	Point	620672.9	1028646
Cryptostegia grandiflora	27	Point	628672.9	1031896
Cryptostegia grandiflora	28	Point	622172.9	1028896
Cryptostegia grandiflora	29	Point	620672.9	1024396
Cryptostegia grandiflora	30	Point	624172.9	1029646
Cryptostegia grandiflora	31	Point	621422.9	1023146
Cryptostegia grandiflora	32	Point	619922.9	1025396
Cryptostegia grandiflora	33	Point	622172.9	1017646
Cryptostegia grandiflora	34	Point	627922.9	1029896
Cryptostegia grandiflora	35	Point	621422.9	1030896
Cryptostegia grandiflora	36	Point	622172.9	1030396
Cryptostegia grandiflora	37	Point	619922.9	1022896

Cryptostegia grandiflora	38	Point	626922.9	1029646
Cryptostegia grandiflora	39	Point	620422.9	1023896
Cryptostegia grandiflora	40	Point	625672.9	1029646
Cryptostegia grandiflora	41	Point	621172.9	1019646
Cryptostegia grandiflora	42	Point	622672.9	1017396
Cryptostegia grandiflora	43	Point	619672.9	1023896
Cryptostegia grandiflora	44	Point	620172.9	1028646
Cryptostegia grandiflora	45	Point	622922.9	1029146
Cryptostegia grandiflora	46	Point	621172.9	1024146
Cryptostegia grandiflora	47	Point	623422.9	1016146
Cryptostegia grandiflora	48	Point	619672.9	1027146
Cryptostegia grandiflora	49	Point	621172.9	1028646

Rubbervine Field Occurrence Points

Species	FID	Shape	X	Y
Cryptostegia grandiflora	0	Point	623172.9	1011896
Cryptostegia grandiflora	1	Point	642922.9	1053646
Cryptostegia grandiflora	2	Point	628422.9	1039896
Cryptostegia grandiflora	3	Point	611422.9	1007146
Cryptostegia grandiflora	4	Point	630422.9	1044396
Cryptostegia grandiflora	5	Point	617422.9	995896.3
Cryptostegia grandiflora	6	Point	608922.9	1012896
Cryptostegia grandiflora	7	Point	643422.9	1055146
Cryptostegia grandiflora	8	Point	619922.9	1026646
Cryptostegia grandiflora	9	Point	612172.9	1007396
Cryptostegia grandiflora	10	Point	643172.9	1058396
Cryptostegia grandiflora	11	Point	627172.9	1040896
Cryptostegia grandiflora	12	Point	623422.9	1026146
Cryptostegia grandiflora	13	Point	625422.9	1021896
Cryptostegia grandiflora	14	Point	620172.9	1026646
Cryptostegia grandiflora	15	Point	629922.9	1044646
Cryptostegia grandiflora	16	Point	612422.9	1005146
Cryptostegia grandiflora	17	Point	619922.9	1014396