

Norwegian University of Life Sciences
Faculty of Environmental Sciences
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Socioeconomics and governance of exclosures in Tigray, Northern Ethiopia

Sosiale og økonomiske sider ved forvaltning
av områder avstengt for folk og husdyr
i Tigray, Nord-Etiopia

Dawit Gebregziabher Mekonen

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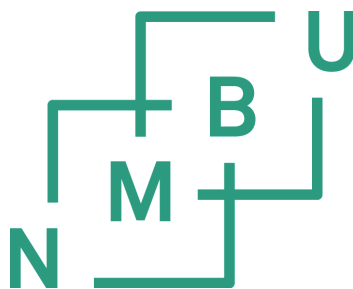
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Appendix papers I-III

List of papers

This PhD thesis is based on the following papers referred to by their roman numerals (I-III):

Paper I

Gebregziabher, D., Soltani, A., Hofstad, O., 2017. Equity in the distribution of values of outputs from exclosures in Tigray, Ethiopia. *Journal of Arid Environments* Vol. 146:75–85

Paper II

Dawit Gebregziabher & Arezoo Soltani, 2018. Exclosures in people's mind: perceptions and attitudes in Tigray. Submitted to the *Journal of Forest Policy and Economics* (Revised version)

Paper III

Dawit Gebregziabher, Arezoo Soltani and Ole Hofstad. 2018. Learning from the local communities: Institutions for environmental rehabilitation in Tigray Region, Ethiopia. Manuscript

Summary

Land degradation and deforestation problems exist across sub-Saharan Africa in general and these remained as the major environmental problems in the Tigray region for many years. The joint effort of the regional government and the local communities had started to rehabilitate the degraded lands by closing it from human and animal interferences that is termed as enclosure. Even though there are a number of studies on enclosures, many of them are mainly focusing on biophysical dimensions of enclosures. Therefore, this thesis was designed to address the following objectives. To examine how values of outputs from enclosures are distributed and identifying factors that influence its distribution (Paper I), to assess perception and attitude of the household heads' towards enclosures (Paper II) and to learn from local communities on the institutions for environmental rehabilitation in the Tigray Region (Paper III).

The study was conducted on nine enclosures in the Tigray region. Data collected using the household survey (Papers I and II), group discussions (Paper III) and secondary data were used for the analysis (Papers I, II and III). In Paper I, Gini coefficient was used to measure the distribution of values of outputs on adult equivalent basis among households adjacent to the selected enclosures, probit model was used to identify factors that influence whether households collect outputs from enclosures and multiple linear regression model was also employed to analyze factors influencing households' share of values of outputs from enclosures. The Gini coefficient result revealed that the distribution of values of outputs varied from fairly equal to quite unequal. Households with larger herd sizes and those who reside far from the district market had both higher probability to collect and larger share of outputs from the enclosures.

In Paper II, descriptive statistics was used to analyze on how household heads perceive the various impacts of exclosures and their attitudes towards existing exclosures and expansion of exclosures. Moreover, factor analysis was used to reduce 17 perception statements into four meaningful components, using these four extracted factors, multiple linear regression model was used to analyze factors that influence household heads' perception towards exclosures and the binary logit model was used to analyze factors that determine household heads' attitude towards exclosures and expansion of exclosures. As a result, the local community had good perception towards ecological improvement or the potential to rehabilitate the degraded area while their perception to the economic benefit was less as compared to ecological improvement. Farmers who are often visited by the development agents had negative influence on household heads' perception of economic improvement but positive influence on both equal access and ecological improvement. Farmers who collect outputs from exclosures and frequently visited by development agents had negative attitude towards expansion of exclosures. Therefore, in order to improve household heads' attitudes towards expansion of exclosures the economic benefits from exclosures should be enough to outweigh costs associated with its expansion. Moreover, the information disseminated through development agents should give due attention to the economic benefit rather than prioritizing only the ecological rehabilitation.

In Paper III, group discussions were recorded using voice recorder and later the information was transcribed into written format. Thereafter, the written document was used to address the research questions of the study. As a result, with regard to the type of land used for exclosures, out of the three exclosures two of them (Tensuka and Abel Dega) were established on degraded communal grazing lands while the third one (Adi Gedaw) was established on hillside cultivated land. The idea of exclosure was introduced to the local community through the joint effort of

Bureau of Agriculture and Rural Development, respective district offices of BoARD, village administration and development agents. The governance of hizaeti was compared with that of exclosures. In hizaeti the local community were able to make autonomous decision making on the management of resources, however, on exclosures they did not have such autonomous decision making power. Therefore, there is a need to enhance the autonomous participation of local community on the decision making process towards rehabilitation of degraded lands. In general, the local policy makers with regard to natural resources such as exclosures should consider alternative options and revise the management strategies of exclosures so as to benefit poor households from exclosures in the Tigray Region.

Sammendrag

Avskoging og forringelse av landressursene er et generelt problem i mange deler av Afrika sør for Sahara og dette har vært det største miljøproblemet i Tigray regionen i lang tid. I en felles innsats fra regionale myndigheter og lokale bygdelag har man begynt å rehabilitere degraderte landområder ved å stenge dem for mennesker og husdyr. Slike avstengte områder har fått betegnelsen «exclosures» på engelsk. Det er gjort mange studier av slike avstengte områder, men de fleste av dem handler om de biofysiske dimensjonene av områdene. Derfor ble denne avhandlingen innrettet for å studere sosiale og økonomiske aspekter av slik rehabilitering. Artikkel I viser hvordan verdiene som hentes ut av de avstengte områdene fordeles i landsbyene og hvilke faktorer som påvirker denne fordelingen. Artikkel II viser hvordan de lokale innbyggerne ser på de avstengte områdene og hvilke holdninger til slike områder som er utbredt i lokalsamfunnet. Artikkel III gjør et forsøk på å hente lærdom fra lokale bønder om hvordan de uformelt har organisert forvaltningen av felles beiteressurser, og å vurdere om dette kan ha overføringsverdi til forvaltning av «exclosures».

Studien ble gjennomført i ni «exclosures» i Tigray. Data ble samlet inn gjennom en survey blant husholdningene (Artikkel I og II), gruppediskusjoner (Artikkel III), og sekundær statistikk fra ulike kilder. I artikkel I ble Gini koeffisienten brukt til å måle fordelingen av verdier som høstes i de avstengte områdene blant husholdningene som holder til i nærheten. En probit-modell ble brukt til å identifisere faktorer som påvirker om en husholdning deltar i uttaket av verdier eller ikke. En multippel regresjonsmodell ble benyttet for å analysere hvilke faktorer som påvirker en husholdnings andel av de samlede verdiene som høstes. Analysen viser at fordelingen av verdier varierer mellom ulike bygder – fra ganske jevn fordeling i noen, til nokså skjev fordeling i andre. Husholdninger med mange husdyr og husholdninger som bor

langt fra bygdesenteret hadde begge større sannsynlighet for å høste gras og frukt i de avstengte områdene, og deres andel av samlet uttak var også høyere enn andre husholdninger.

I artikkel II ble deskriptiv statistikk brukt for å analysere hvordan familieoverhodene oppfatter effektene av at det er etablert «exclosures» i nærheten. Deres holdninger til eksisterende og potensielt nye «exclosures» ble også analysert. Videre ble faktoranalyse brukt for å redusere 17 persepsjonsuttrykk til fire meningsfulle komponenter. Disse fire komponentene ble benyttet i en lineær regresjonsanalyse av faktorer som påvirker familieoverhodenes holdninger til eksisterende og eventuelle nye «exclosures». Lokalsamfunnet oppfattet de stengte områdene som en klar forbedring av den økologiske tilstanden, men endringen av den økonomiske tilstanden ble ikke oppfattet like positivt. Bønder som ofte får besøk av veiledningspersonale hadde dårligere oppfatning av de stengte områdenes bidrag til økonomisk utvikling, men bedre oppfatning av økologisk utvikling og lik adgang til områdene, enn resten av lokalbefolkningen. Bønder som høster mer og som ofte besøkes av veiledere, hadde negativ holdning til ytterligere ekspansjon av stengte områder. Hvis familieoverhodenes holdning til ekspansjon av stengte områder skal forbedres, må de økonomiske fordelene av slike områder bli store nok til å veie opp for de ulempene som forbindes med slik ekspansjon. Videre må den informasjonen som formidles av veiledningstjenesten legge større vekt på økonomiske forbedringsmuligheter heller enn å konsentrere seg kun om økologisk rehabilitering.

For artikkel III ble det gjennomført gruppediskusjoner med berørte bønder og andre i lokalbefolkningen for å belyse forvaltningen av stengte områder og andre fellesarealer i tilknytning til tre av de ni områdene. To av de stengte områdene (Tensuka og Abel Dega) ble etablert på forringet felles beiteland mens det tredje (Adi Gedaw) ble etablert på dyrket mark i en åsside. Ideen om «exclosures» ble introdusert til lokalsamfunnet gjennom en samordnet

innsats fra landsbyadministrasjonen og veiledningspersonale fra «Byrået for Jordbruk og Bygdeutvikling» (BoARD). Forvaltningen av «Hizaeti» (felles beitearealer som forvaltes etter uformelle regler) ble sammenlignet med forvaltningen av «exclosures». «Hizaeti» forvaltes slik at lokalsamfunnet kunne gjøre autonome beslutninger om ressursutnyttelsen mens dette ikke var mulig for de stengte områdenes («exclosures») vedkommende. Det synes derfor å være behov for å utvide mulighetene for autonom lokal forvaltning og rehabilitering av degraderte landareal i Tigray. Myndighetene burde vurdere alternative forvaltningsmuligheter for degraderte naturressurser og endre forvaltningsstrategiene for «exclosures» slik at de i større grad kommer fattige deler av lokalsamfunnet til gode.

Synopsis

1. Introduction

Land degradation is a common problem in many parts of the globe (Al-Dousari et al., 2000, Gisladottir and Stocking, 2005). The degradation problem exists across sub-Saharan Africa (Yayneshet et al., 2009, Nedessa et al., 2005) and it is the major environmental problem in the Tigray region of Ethiopia (Babulo, 2007, Hailelassie et al., 2005, Mekuria et al., 2007, Girmay et al., 2009). This problem in the region has been attributed to the expansion of cultivated land at the expense of forests and other vegetation, unsustainable utilization of forest products for several purposes such as fuelwood and construction materials, and overgrazing (Babulo, 2007, Berhane et al., 2007, Gebremedhin, 2003, Gebremedhin and Swinton, 2002, Nyssen et al., 2004).

A remedial strategy to combat the land degradation problem was to engage in rehabilitation of degraded areas. Rehabilitation of degraded lands has been implemented as a common practice in a number of countries around the world (Chokkalingam, 2006, Lamb and Gilmour, 2003), and in African countries such as Ghana (Blay et al., 2008), Tanzania and Kenya (Lamb and Gilmour, 2003). Besides, land rehabilitation is common in many parts of Ethiopia (Aerts et al., 2008, Reubens et al., 2011). For instance, the practice known as exclosure is applied on degraded dryland areas in East Africa to enhance environmental rehabilitation, and it is also used to allow growth of young trees in the Sahel (Chirwa et al., 2017).

Moreover, the Tigray region has exerted rehabilitation efforts to combat the land degradation problem for the last three decades (Balana et al., 2010, Gebremedhin et al., 2003). To this effect, the regional government together with the local communities in the rural areas of the region implemented several natural resource management strategies to combat land degradation caused by either natural or anthropogenic factors (Seyoum et al., 2015). One

strategy was the establishment of exclosures (Balana et al., 2010, Descheemaeker et al., 2006c, Gebremedhin, 2003, Gebremedhin and Swinton, 2002, Nedessa et al., 2005, Mekuria et al., 2007, Seyoum et al., 2015). Exclosure is defined as degraded land where livestock and human interventions are restricted in order to enhance natural restoration (Aerts et al., 2009).

The main purpose for the establishment of exclosures in the region was for ecological rehabilitation (Mekuria et al., 2011a). Nonetheless, the increased expectation of the local community towards economic benefits from exclosures created a great challenge to the management of exclosures (Gebremedhin et al., 2003). Berhane et al. (2007) reported that the main purpose for the establishment of exclosures was to enhance ecological conditions that in turn increases the economic benefits to the local community. Descheemaeker et al. (2006c) also reported that considering economic benefits is a necessary condition for exclosures to continue enhancing their environmental condition. Babulo (2007) recommended that exclosures should not only consider environmental rehabilitation of the degraded areas but also economic benefits. Taken together, these studies show that even though the primary purpose for the establishment of exclosures was to rehabilitate the degraded land, the economic benefit from exclosures should also be considered as a necessary condition for the management of exclosures.

1.1. Exclosure establishment and development in the Tigray region

In the literature, various stakeholders involved in the establishment of exclosures are mentioned. For example, Descheemaeker et al. (2006c) revealed that the establishment of exclosures was made with joint effort of local community, governmental and non-governmental organizations. Mekuria (2013b) also reported the efforts made by stakeholders such as development agents, local administration and local community, during the

establishment of exclosures. Development agents from Bureau of Agriculture and Rural Development and the local administration/village administration were engaged in the identification of the degraded areas to be closed, and the final decision was made at a general meeting with the local community.

There are different reports on when the first exclosures were established in Tigray. Nedessa et al. (2005) reported that the inception of exclosures, which occurred together with the large scale land rehabilitation and soil and water conservation programs in Ethiopia was started around 1980. It was also reported that the establishment of exclosures in the region was started in 1980 (Descheemaeker et al., 2006a; 2006b). Contrary to these reports, Gebremedhin et al. (2003) reported that there was limited experience with exclosures before 1991. Others mention that the initiative to construct exclosures was started in the semi-arid lowlands of Tigray region in 1991 (Mekuria, 2013b, Mekuria and Aynekulu, 2013). The exclosure management before 1991, i.e. during the Derg regime, was top-down. Tigray People's Liberation Front (TPLF) has contributed to the participatory management of exclosures (Mekuria, 2013a) since 1991, which is after the fall of the Derg regime. A case study on community based natural resource management in the region also reported that the change in the management of natural resources resulted from the change in political regime (Chisholm, 1998). Even though different scholars have reported differently about the year when the establishment of exclosures started, there is regime change in between the reported years. The nature of participation was also reported to be different on the management of exclosures and this could lead to different outcomes. Moreover, one study emphasized that the effective establishment of exclosures to rehabilitate degraded areas in Tigray was started in 1991 (Babulo, 2007). Therefore, the nine exclosures that we considered in our study were all established since 1991- or after the fall of the Derg regime.

New exclosures have been established during the last three decades, and the Bureau of Agriculture and Rural Development (BoARD) reported that the area of land that was covered by exclosures only in the Tigray region was about 1.3 million hectares in 2013 (BoARD, 2013). The area coverage of this land use type, that is exclosure, was 12.5 % of the total area of the region.

1.2. Statement of the problem

The thesis on socioeconomics and governance of exclosures in the Tigray Region had the following three interlinked components. (i) How economic values of outputs from exclosures are distributed? (ii) How household heads' perceived the various impacts of exclosures and what is their attitudes towards exclosures? (iii) What we can learn from local communities on institutions for environmental rehabilitation in the Tigray Region? We have presented the rationale for each of the components as follows.

Since the establishment of exclosures a number of studies have been conducted especially on the biophysical dimension (Descheemaeker et al., 2006b, Yami et al., 2006, Yayneshet et al., 2009, Berhane et al., 2007, Mekuria et al., 2011b, Mekuria and Aynekulu, 2013, Mekuria, 2013b). Moreover, there were also studies on economic contribution of forests to the livelihood of the local community in different parts of the country and beyond (Adhikari et al., 2004, Cavendish, 2002, Mamo et al., 2007, Soltani et al., 2012, Soltani et al., 2014, Tesfaye et al., 2011) and that of exclosures in the Tigray region (Babulo et al., 2009, Mekuria et al., 2011a). However, the issue of benefit sharing of outputs from exclosures did not receive much attention despite its importance for the management of exclosures. Besides, Nedessa et al. (2005) suggested further study on the distribution of values of outputs from exclosures. Mekuria et al.

(2011a) reported that the rehabilitation of degraded communal lands such as enclosure is dependent on its economic contribution to the local community. Equally important, it is also vital to analyze on how the economic value of outputs is distributed among households since a distribution that is perceived as unfair may hamper participation in and support for the management of enclosures. The information obtained from this study may inform policy makers at different levels on how to adjust the existing management systems and design of future management options for enclosures in the Tigray Region (Paper I).

Mekuria et al. (2011a) reported that the perception of local communities is important to enhance the effectiveness of natural resource management. Belkayali et al. (2016) reported that assessing the perception of local residents and identifying factors that influence perception are imperative to enhance participation of local community towards rehabilitation of degraded areas. Understanding people's perceptions and attitudes towards rehabilitation of degraded areas is a path to develop good management plans (Allendorf, 2006) likewise, it is vital to sustain the protected areas (Htun et al., 2012). Furthermore, attitude and perceptions studies are being used as a means to monitor the acceptance and the impact of rehabilitation of degraded areas (Kideghesho et al., 2007). A number of studies were conducted to examine perceptions and attitudes of local community on conservation and protected areas in Ethiopia (Bessie et al., 2014, Moges and Taye, 2017, Tadesse and Teketay, 2017, Tesfaye et al., 2012, Tessema et al., 2010, Urgessa, 2003, Mekuria et al., 2009, Mekuria, 2013a). However, most of these studies were not supported with theoretical orientation with the exception of (Tefaye et al., 2012). Moreover, the studies conducted in the Tigray Region by Mekuria et al. (2009) and Mekuria (2013a) assessed the perception of local community on the effectiveness enclosures to control soil erosion and restoring vegetation, respectively. These studies mainly dealt with perception of local community on environmental elements without giving due attention to other

factors that could influence perception. Therefore, to address these shortcomings, the current study was designed to assess household heads' perceptions on the various impacts of exclosures, their attitudes towards existing and future expansion of exclosures and factors that influence both perceptions and attitudes towards exclosures. We have used social exchange theory to support our study with a theoretical orientation. Addressing these shortcomings can add knowledge to the existing literature on exclosures (Paper II).

Even though there are many common features of exclosures in Tigray, only limited research was conducted to study the history of establishment and social arrangements governing access (Yami et al., 2009, Yami et al., 2013). Thus, conducting a study on this matter may shed light on whether the exclosure is a homegrown idea in local communities in Tigray, or an imported technology from other parts of Ethiopia or abroad. Such a study can also enrich the existing knowledge on the social arrangements of exclosures through illustrating management practices of the selected exclosures. In addition, there is scant information on the management practices of exclosures and *hizaeti* - the local term for protected grasslands (Shylendra, 2002). Therefore, conducting such study could add knowledge to the existing literature on how resources are managed, the type of institutions practiced and autonomy of local communities to make decision under the two management practices (Paper III).

1.3. Objectives and research questions of the thesis

The general objective of the study was to analyze socioeconomics and governance of exclosures in the Tigray Region.

Based on available literature referred above and own observations in the field the broad research questions are:

- 1) Who is capturing the economic benefits harvested from exclosures?
- 2) Are local people happy with the exclosures and the way they are managed?
- 3) What is the relationship between state organisations and local communities in the management of exclosures?

Having asked these questions, the following two hypotheses were also formulated:

1. Differences in income and wealth are maintained in most societies through inequality in people's ability to capture economic benefits (Sen and Foster, 1997) – better off individuals or families are able to capture more (a larger share) of the economic output than poorer people (Magalhaes and Santaaulàlia-Llopis, 2017). Even though the output from exclosures in Tigray may seem very limited, it would not be surprising if better off household are able to capture most of what is harvested there.
2. Land tenure in most sub-Saharan countries is based on private user rights to cultivated land, while non-cultivated areas are considered common-pool resources (Adams et al., 1999). Local communities in Tigray have developed informal institutions to manage protected grazing areas (Shylendra, 2002), but such institutions were not imitated for the management of exclosures. In Africa, e.g. Zambia, Zimbabwe and Tanzania, the state is the *de jure* owner of such land, but does not have the resources to control use and exploitation of these resources in remote areas (Sjaastad and Cousins, 2009). The hypothesis for Tigray was that the establishment of exclosures is a way for the state to claim *de facto* ownership of non-cultivated land.

The first hypothesis could be tested quantitatively, but the second hypothesis was not easy to test in a similar strict sense. However, qualitative methods were applied in order to understand the governance of both exclosures and informally protected grazing areas in Tigray.

The specific objectives along with the research questions are presented as follows:

1. To analyze how values of outputs from exclosures are distributed and identifying the factors that influence its distribution (Paper I). The research questions were:
 - a) How are the economic values of outputs from exclosures distributed among households adjacent to the exclosure?
 - b) What factors influence whether a household collects outputs from exclosures?
 - c) What factors influence a household's share of economic values of outputs from the exclosures?
2. To assess perception and attitude of household heads towards exclosures and their influencing factors (Paper II). The research questions were:
 - a) How do local household heads living adjacent to the selected exclosures perceive the various impacts of exclosures?
 - b) What are local household heads' attitudes towards existing and further expansion of exclosures?
 - c) Which factors influence local household heads' perceptions of exclosures?
 - d) Which factors determine local household heads' attitudes towards existing and further expansion of exclosures?
3. To learn from local communities on institutions for environmental rehabilitation (Paper III). The research questions were:
 - a) How does the governance of the studied exclosures differ?
 - b) What are the differences between the governance of exclosure and hizaeti?

Concepts and theories

Management of common pool resources and the distribution of outputs

Exclosures are established on degraded lands considered as common pool resources. Hence, the exclusion of individuals who do not make a contribution towards establishment and management of exclosures from accessing and having any benefits is difficult and costly. To

protect and maintain enclosures, similar to other common-pool resources, depend on the joint efforts of individuals and collective actions (Ostrom, 1990, Sandler, 1992). If rules are well established, then the users are able to allocate resource benefits equitably, over long periods and in an efficient manner (Agrawal, 2001, McKean, 1992, Ostrom, 2005). Creating rules is associated with specification of rights and duties of participants. This makes a public good for those involved (Ostrom, 2005). Everyone who is a part of the community can get benefits from this public good irrespective of their contribution to maintain the resource (Ostrom, 2005). The free riders' problem (Baumol, 2004) is the main challenge facing common pool resources. If the free riders' problem is not resolved, the tragedy of commons may result (Hardin, 1968).

The literature on common pool resources have specified influencing factors and variables which can enhance the likelihood that resource users organize themselves by creating and following rules which will avoid the free riders' problem and the tragedy of common (Agrawal, 2001, Baland and Platteau, 1996, Ostrom, 1990, Wade, 1988). These variables are classified into two broad sets as those describing the attributes of the common pool resources and those of users. These variables affect the basic cost-benefit calculations of a group of users when they aim to utilise a resource (Ostrom, 2005). Each user compares the expected net benefits of harvesting from a resource in current situation without any rules (B_{nr}) to the benefits they may achieve if the rules are established (B_{wr}) considering all transaction costs associated with establishment of rules. If the users realized that B_{wr} is greater than B_{nr} , this means that the difference of the two benefits ($B_{wr}-B_{nr}=D$) is positive, then they establish institutions and commit to rules. These influential variables were further discussed in Paper I.

2.2. Perceptions of, and attitudes to environmental rehabilitation and social exchange theory

Based on conservation and protection aspects we considered establishment of any protected area as an exchange. Cropanzano and Mitchell (2005) reported that based on social exchange theory, an exchange has associated costs and benefits associated with it. The framework of the study is based on the balance between positive perception of benefit flows from protected areas and negative perceptions caused by the costs. The core of the framework is household heads' evaluation of benefits and costs associated with enclosures. Several variables affected the way household heads evaluated benefits in relation to the costs. The variables were identified through a literature review of studies examining local communities' perceptions of and attitudes towards protected areas.

Local communities' perceptions and attitudes seem to depend on the tangible benefits obtained from protected areas (Allendorf, 2007, Allendorf et al., 2006, Baral and Heinen, 2007, Bauer, 2003, Fiallo and Jacobson, 1995, Htun et al., 2012, Infield and Namara, 2001, Kuvan and Akan, 2005, Mehta and Heinen, 2001, Tessema et al., 2010, Vodouhê et al., 2010, Walpole and Goodwin, 2001, Xu et al., 2006) compared with the cost of living adjacent to such areas (e.g., Fiallo and Jacobson, 1995, Walpole and Goodwin, 2001, Xu et al., 2006). The balance between positive perceptions of benefit flows from protected areas and negative perceptions caused by the costs will determine whether people support the establishment of protected areas.

The impacts of socio-economic variables on local communities' perceptions and attitudes have been found ambiguous (Allendorf et al., 2006, Baral and Heinen, 2007, Fiallo and Jacobson, 1995, Kaltenborn et al., 2006, Kideghesho et al., 2007, Mehta and Heinen, 2001, Shibia, 2010, Tessema et al., 2010, Vodouhê et al., 2010, Xu et al., 2006). For example, the impact of

education and gender on local perceptions and attitudes seems to be site-specific and inconsistent. While some scholars have reported that education has a strong impact on local attitudes (e.g., Allendorf et al., 2006, Mehta and Heinen, 2001, Shibia, 2010, Xu et al., 2006), others have not found a correlation between education and local perceptions and attitudes (Baral and Heinen, 2007). Some studies have revealed that gender is a predictor of attitude, as women more likely have negative attitudes (Allendorf et al., 2006, Mehta and Heinen, 2001, Xu et al., 2006), whereas others have not found a correlation between gender and attitude.

The social exchange theory assumes that power in social exchanges lies with those possessing greater resources. Household's socio-economic profile indicates the resources possessed by the household that indeed influence household's ability to take advantage of enclosures. The ability to take advantage of enclosures have impacts on household head's evaluation of benefits and costs associated with enclosures as having positive economic impacts. In our analysis, the variables describing socio-economic context were "gender of the household head," "log of age of the household head," "household's average years of education," "household's labor force," "household's cropland area," and "household's herd size."

Perceptions and attitudes are likely to differ among people living in different geographical situations (Hein et al., 2006, Muhamad et al., 2014). For example, local communities living closer to protected areas tend to perceive there are many ecosystem services (Sodhi et al., 2010) and consequently hold positive attitudes towards their protected surroundings (Macura et al., 2011). At the same time, local communities living closer to protected areas and further from market are more dependent on natural resources for their livelihoods (e.g., Mamo et al., 2007, Soltani et al., 2012). Economic dependence has emerged as a significant factor influencing perceptions and attitudes (Kuvan and Akan, 2005). Furthermore, the size of the protected area and the number of people with access rights could influence perceptions and attitudes

(Allendorf, 2007). If the area under enclosure is small and many households have access to it, the households' share of outputs from enclosures will be smaller. This might cause household heads to perceive that there are fewer ecosystem services, and consequently develop negative attitudes towards enclosures.

Some studies have shown that knowledge affects behavior (Zelezny, 1999) and perceptions and attitudes (Aipanjiguly et al., 2003, Alkan et al., 2009, Htun et al., 2012, Lepp and Holland, 2006, Xu et al., 2006). Also, Aipanjiguly et al. (2003) argue that households with more knowledge of protected areas will have positive attitudes, while social exclusion and lack of knowledge lead to negative attitudes towards protected areas (Paraskevopoulos et al., 2003). In the Tigray Region, local communities gain knowledge about their adjacent enclosures through either participating in training activities or interacting with development agents.

It is assumed that if ecological condition improve, local communities are more likely to perceive the ecological and economic impacts of enclosures as beneficial. Consequently, they might have positive attitudes towards their adjacent enclosures. In our analysis, we used two categorical variables to represent ecological conditions: "agroecological zone" and "age of enclosure."

Governance of enclosures – community versus state

The conventional theory described the users of common pool resources (CPRs) as short-term, profit maximizing actors that behaved independently based on their own self-interest (Feeny et al., 1996). The theory was rather pessimistic about sustainable management of CPRs and predicted overharvesting and resource depletion as outcomes. Thus, private property (Simmons et al., 1996) or centralized state intervention (Ribot et al., 2008) were recommended as solutions to avoid degradation of CPRs.

The applicability of conventional theory was challenged by the explosion of empirical studies on CPRs e.g. (Ostrom, 1990, Pagdee et al., 2006, Soltani and Eid, 2013). The theory was criticized for overlooking the fact that the resource users are often able to create institutional arrangement that help them to distribute the resources outcomes equitably, and to govern and manage CPRs over long period of time (Agrawal, 2001, Ostrom, 2005). As a consequence of such critique, the management of CPRs has been analyzed by scientists from various disciplines and several theories such as common property theory, theory of collective actions, and game theory were developed (Olson, 1965, Ostrom, 2000). However, it is difficult to find a universal solution and single widely accepted theory for sustainable management of CPRs (Agrawal, 2001). Under certain circumstances private, governmental and community institutions can be effective in avoiding resource degradation or can simply fail (Young, 2007).

The paradigm of “new institutionalism theory” (North, 1990) was used by several scholars to provide an alternative and rather optimistic view to understand the management of CPRs (Yami et al., 2009) . Institutions are defined as ‘rules of the game of the society, humanly devised constrains to shape human interactions (North, 1990) or mechanism to restrict irrational and undesirable practices (Ostrom, 1990). Institutions are categorized as formal or informal (North, 1990), based on few criteria: (i) the degree of formalization, (ii) their emergence and change and (iii) the enforcement of rules. According to North (1990), informal institutions are codes of behavior, culture and customs that do not necessary have a written form while the formal institutions are provided in written form. North argues that the informal institutions are part of culture in which knowledge of rules is transferred through generations, via oral traditions or the teaching of traditions while formal institutions are invented in a certain time. North (1990) describes the emergence of informal institutions as spontaneous and that of formal institutions as a process planned by political actors. Informal institutions are not enforced by official

sanction mechanism, while formal institutions are safeguarded by court or state (Helmke and Levitsky, 2004). The existence of formal institutions depends on the support of state where the sanction for breaking rules are clearly determined (Theurl and Wicher, 2012).

Informal institutions have received considerable attention in the literature because of their contributions in preventing degradation of CPRs (Yami et al., 2009, Bryan, 2004, Soltani and Eid, 2013, Negi, 2010). Informal institutions evolved internally to secure local communities' livelihood and consequently create a sense of commitment and responsibility among the appropriators which indeed enhance their collective action (Yami et al., 2009), and regulate their access to CPRs at a low cost. However, there are some shortcomings associated with informal institutions as they are not able to offer a solution to all problems of management of common pool resources (Banana et al., 2007). It is argued that both formal and informal institutions are influential to achieve sustainable management of CPRs (North, 1990), and to prevent outsiders and free-riders from benefiting the communities' collective actions (Pagdee et al., 2006). Yeboah-Assiamah et al. (2017) concluded based on literature review that both formal and informal institutions can strengthen natural resource governance. A study conducted by Lambini and Nguyen (2014) revealed an urgent need to integrate formal and informal rules as recipe to achieve sustainable forest management in developing countries.

In Tigray enclosures are governed through formal institutions, while *hizaeti* are governed through informal institutions. The state has more influence over the management of enclosures, while the local community has developed its own informal institutions to regulate grazing in *hizaeti*. It seems that enclosures are more effective in the rehabilitation of land and vegetation, while *hizaeti* are more efficient in the production and distribution of benefits of animal husbandry. However, this impression has not been empirically tested here.

2. Study sites, data collection and data analysis

2.1. Study sites

The current study was conducted in the Tigray Region, northern Ethiopia. The region has three broad agroecological zones, which are lowland, midland and highland (Bishu et al., 2016, SFM_NORHED, 2014, Hadgu et al., 2015). The region is bordered by Eritrea to the north, to the east, it is bordered by the Afar region, the Amhara region to the south and it is bordered to the west by Sudan. The average rainfall and temperature of the region were 400–700 mm and 21.6 °C respectively. The rain season in the region goes from June to August or early September (Mekuria and Aynekulu, 2013).

The establishment of exclosures was started since the last three decades, to be exact it was since 1991 (Balana et al., 2010, Gebremedhin, 2003, Gebremedhin and Swinton, 2002, Mekuria et al., 2007, Seyoum et al., 2015). Thus, the exclosures in the region are found in different age groups since their establishment. For the present study we have grouped exclosures into three based on years since their establishment, that are new, middle age and old age exclosures. The years of these groups since establishment was about 10, 15 and 20 years respectively. The 9 exclosures were selected based on agroecological zones and years since establishment. Each age category was represented in the three agroecological zones. Nine exclosures were used for Papers I and II, while Paper III used three of them (namely Abel Dega, Tensuka and Adi Gedaw) exclosures. These three exclosures are adjacent to Hayelom, Koraro and Debre Genet villages, respectively.

Households in the selected areas were basing their livelihood on crop and livestock mixed farming strategy. The main animals that exist in the region include cow, oxen, goat, sheep, donkey and chicken. Moreover, the main crops grown in the region were teff (*Eragrostis tef*),

wheat (*Triticum*), maize (*Zea mays*), sorghum (*Sorghum bicolor*), barley (*Hordeum vulgare*), and faba bean (*Vicia spp.*) (Birhane et al., 2017a).

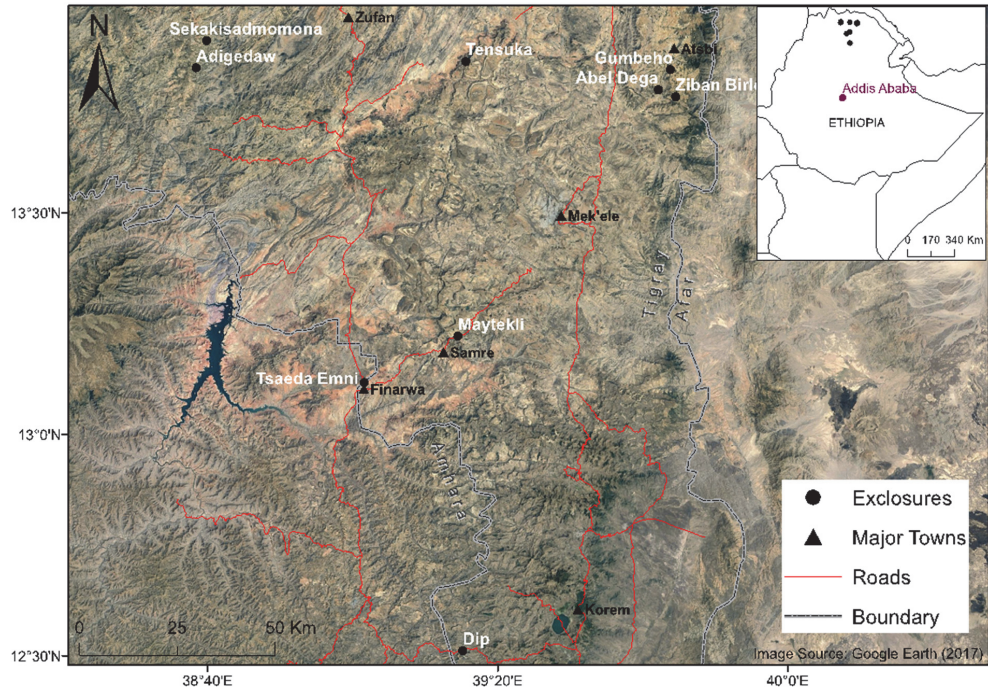


Figure 1. Map of Ethiopia and the selected exclosures in the Tigray Region

2.2. Data source

The study has considered both primary and secondary data. To collect the primary data semi-structure questionnaire was developed. This questionnaire was pretested before the start of the formal data collection. The pretest was a good exercise to modify the questionnaire by applying one or more of the following procedures: removing that are less important, including what was left and making the language more clear to be understood by the respondents.

The author visited each of the villages adjacent to the selected exclosures to understand the overall situation of the area and gather background information about the exclosures. As a prerequisite for the formal data collection, list of the target population from each of the villages

was collected from the extension workers or development agents. The data collected through the household survey include household socioeconomic, household knowledge about exclosures, ecological conditions of exclosures, and geographical attributes.

To administer the actual primary data collection, 450 households were sampled from the 9 villages. Next, four research assistants were nominated based on their previous experience on data collection to support the author with data collection in the selected villages. Moreover, these research assistants had the knowledge of the local language that allows them to ask the sampled households in the way they understand the questions in particular and easily socialize the local community in general. The author has supervised the data collection. The data collection was held from October to November 2015. From the total 450 questionnaires, 4 of them were with incomplete information and hence were not included in our analysis. Therefore, the remaining 446 sampled households were used for our analysis (Papers I and II).

Moreover, the sampled farmers who were living adjacent to the selected exclosures were interviewed with 17 perception statements, which could address their perception on the selected exclosures. They were asked to rate their perception based on the five-point Likert scale with one, indicating “strongly disagree” and five indicating “strongly agree.” Factor analysis was used to reduce the 17 perception statements into four factors. The four extracted factors were named according to the loadings of their associated statements. Therefore, factor 1 was named “Economic improvement,” factor 2 was named “Equal access” along with factors 3 and 4 were named “Local involvement,” and “Ecological improvement” respectively. Moreover, the household heads were asked whether they felt happy with the existing exclosures (code 1 if the answer was ‘Yes’, otherwise code 0). In the same way, household heads were asked whether they would support the expansion of exclosures (code 1 associated with a ‘Yes’ response, otherwise code 0) (Paper II).

Participatory Rural Appraisal (PRA) approach was employed to collect data from the selected exclosures and hizaeti. Group discussions were used to collect the data from individuals within the villages who had first-hand information about exclosures and guards. Voice recorder was also used to record the data upon the consent of the discussants (Paper III).

The distance between the sampled households' residence and the district markets, and the distance from the sampled households' residence to the exclosures were measured using GPS during the household survey. Secondary data was also used to support the primary data source. The data collected using secondary source were years since establishment for the exclosures, agroecological zones and area of exclosures (SFM_NORHED, 2014). These data were used for Papers I, II and III.

2.3. Data analysis

In Paper I, inequality measures were used to assess how the values of outputs from exclosures are distributed among the households. Probit model was also employed to identify the attributes of exclosures and those of appropriators and external context that influence the probability that a household with access rights collects any outputs from the adjacent exclosure (dependent variable). Moreover, multiple linear regression model was used to identify attributes of resources and those of appropriators and external context that influence on the share of the value of outputs from exclosures. The same list of independent variables were used for both models.

In Paper II, the means of the Likert scale with five levels were used to assess the perception of the local community for 17 questions related to exclosures. Percentages of those who agreed and those who disagreed were also used to examine the perception and attitude of local community towards exclosures. Furthermore, factor analysis was used to reduce 17 perception

statements into four meaningful factors. This was done by using the principal component extraction method and varimax rotation. As a follow up to the factor analysis, a multiple linear regression model using the extracted factors as dependent variables was employed to identify factors that influenced the household heads' perceptions of selected exclosures. A binary logit regression was used to determine factors that influenced household heads' attitudes towards exclosures.

In Paper III, once the data was recorded through the voice recorder it was transcribed into written format. Draft report was developed from the written format and it was paraphrased to make sense. Moreover, the draft report was discussed with researcher and experts from Mekelle University and Bureau of Agriculture and Rural Development respectively. Thereafter, the modified draft report was used to address the research questions raised in this paper.

3. Results

In Paper I, the result from inequality measure revealed that four out of nine exclosures had Gini coefficients greater than 0.5 whereas for the other 5 exclosures the value ranged from 0.39 to 0.45. The percentage share of the value of outputs from exclosures for households in the lowest quintile was equal to zero (except for that in the Abel Dega exclosure), while the percentage share of value of outputs from exclosures obtained by the highest quintiles varied from 41 % to 68 %. Probit model showed that household's herd size, distance from residence to the district market and number of extension visit had positive influence on both probability of obtaining and on the share of output from exclosures. Nonetheless, the distance between the residence and the exclosure had negative influence on both probability of obtaining and share of outputs from exclosures. The other set of variables that are age group of exclosures, number of households per hectare of exclosure, and agro-ecological zone of exclosures had positive

influence on the probability of obtaining output from exclosures while their influence on the share of outputs from exclosures was negative. The variables that had positive influence on the probability of obtaining resource from exclosures but not on the share of outputs from exclosure were household's training on exclosure management, and assigned duty on management of exclosures.

In Paper II, the 17 perception questions about exclosures was reduced into four components which were named according to the loadings of their associated statements. The first and second factors were named "economic improvement" and "equal access", and the third and fourth factors were named "local involvement" and "ecological improvement". About 97 %, 93 % and 89 % of the sampled households either agreed or strongly agreed with the statements under the headings "ecological improvement", "local involvement", and "equal access", respectively. However, the percentage of the sampled households who strongly agreed or agreed with the statements under "economic improvement" was 58 %. With regard to the local attitudes towards exclosure, we found that 377 (85%) of sampled households agreed with the idea of exclosure prior to its establishment, 97 % (431 households) felt happy because of existing exclosures, and 76 % (338 households) would support further expansion of exclosures.

The multiple linear regression model showed that households' harvest status had positive influence on perceptions of economic improvement, equal access, and local involvement. Farmers with higher assigned duty on exclosures management had positive perception of local involvement. Households with large active labor force had positive perception of equal access and the ones who own large herds had positive perception of economic improvement. Farmers who reside far from the exclosures had negative perception of economic improvement and those who are far from the district market had positive perception of ecological improvement. Farmers with higher number of extension visits had negative perception of economic

improvement, but positive perception of equal access and ecological improvement. Farmers who got trained in exclosure management had positive perception on economic improvement. Farmers who lived adjacent to exclosures in intermediate and highland as compared to the lowland had positive influence on household heads' perception of ecological improvement.

The binary logit model revealed that household's harvest status and perception of economic improvement had positive influence on attitude towards exclosures. Households with higher assigned duty on exclosure management and perception of local involvement had negative influence on attitude towards existing exclosures. In addition, farmers who collected more resources from exclosures and are visited more often by development agents had negative attitude towards expansion of exclosures. Nevertheless, distance between residence and district market, number of households per hectare of exclosure area, being the exclosure on highland as compared to midland and lowland, perception of economic improvement and equal access had positive influence on the attitude towards expansion of exclosures.

In Paper III, with regard to the land type chosen for exclosures, two of the exclosures, Tensuka and Abel Dega, were established in degraded communal land. However, the third exclosure at Adi Gedaw was established on hillside cultivated land. Although this hillside cultivation may not have been environmentally sustainable, the establishment of an exclosure on land that was considered private property (or with private user rights) generated more social tensions than exclosure establishment in communal grazing land. Issues of proper compensation and exclusive harvesting rights arose after cropland was designated as exclosure.



Adi Gedaw Exclosure, an exclosure established on farmland

The question whether environmental rehabilitation by exclosures is a local invention or a technology introduced from outside Tigray may be of interest to social scientists and managers of natural resources. Despite variation in the details, the idea of exclosures was introduced to the local community through joint effort of village administration and development agents representing the district office of Agriculture and Rural Development.

Villagers harvested grass within the exclosure boundaries and then carried it to homesteads where they stored it for feeding their livestock. Local informants mentioned that the cut and carry fodder system was more labour demanding than livestock husbandry based on grazing system. Therefore, they were sceptical about the extension of existing exclosures. Several tree species, including eucalyptus, have been planted in Abel Dega exclosure since its establishment. The development agents of BoARD presented the idea of planting eucalyptus to the village community and provided them with the necessary inputs. In all the study sites, BoARD employed guards to protect the exclosures.

In Hayelom village local community followed a traditional management system to protect grasslands (locally named *hizaeti*). It was aimed at protecting the grasslands against human interference and livestock grazing by closing them during the rainy season for about three months. The village community assumes responsibility for protecting the grassland by nominating two villagers, known as ‘*Meajas*’, each year. The *Meajas* are responsible to assign guards to protect *hizaeti* and schedule the time of guarding. The guards are selected among villagers holding grazing rights in the *hizaeti*. The *Meajas* were also responsible to punish those who grazed their livestock in *hizaeti* during rainy season. Importance of *hizaeti* for livestock husbandry was highlighted during the group discussions, and the village community was not willing to convert *hizaeti* into enclosure.

Some important differences between the governance of exclosures and *hizaeti* are illustrated in Table 1. The local community has autonomous decision making power on the management of natural resources in *hizaeti* while the decision making power on the management of exclosures to some extent is a top-down approach.

Table 1. The difference between governance of exclosures and protected grasslands

	Exclosures	<i>Hizaeti</i>
Innovator	DoARD	Local communities
Main decision maker	DoARD and village community	Local communities
History of management system	24 years	Several decades
Protection	Guards employed by DoARD	Local communities on rotational basis
Sanction system	Village court – Formal system	Informal sanction system implemented by <i>meajas</i>
Length of management	Throughout the year	Rainy season
Harvesting system	Cut and carry system for grass	Grazing

DoARD: District Office of Agriculture and Rural Development

4. Discussion

About 28 % of the sampled households did not collect any tangible output from nearby exclosures. Multiple regression (Table 4, Paper I) showed that households who own larger herd were more likely to collect output, and they collected higher share of outputs than households with smaller herds. The major output from exclosures is grass and it was not sold, but used for own consumption. In agreement with our result, previous studies by Narain et al. (2008) and Soltani et al. (2014) reported that total income and dependence on fodder had positive relationship while the relationship between income and firewood was negative. Based on our results and the findings of the previous studies, the relationship seems to differ with the type of output that is collected from the forest or protected areas. Therefore, rather than simply concluding on the relationship that existed between share of outputs collected from exclosures or forest and socioeconomic factors such as herd ownership of households, reporting the type of output collected can make the relationship more understandable.

In addition, distance between exclosures and settlements had negative association on probability to collect output and share of output collected from exclosures. This can be explained by the positive relationship between opportunity cost of collecting outputs, and the distance between residence of households and resource location (Köhlin et al., 2001, Robinson and Lokina, 2011). Thus, households located far from the resource would prefer to spend their time on activities other than collection of outputs from exclosures. However, the distance between district markets and settlements had positive association on the probability of collection and share of output collected from exclosures. In areas that are far from the markets individuals have less access to job opportunities and the opportunity cost of labor is low. Therefore, it is cheaper for those who live in remote places to spend time on grass collection

in exclosures. This result is also supported by previous studies (Mamo et al., 2007, Fisher, 2004, Adhikari et al., 2004, Narain et al., 2008, Soltani et al., 2012).

In Paper II, we saw that the local community perceived ecological improvement or the potential to rehabilitate the degraded area as better than the economic benefit resulting from exclosures. Three attitude questions were asked to the sampled households. These questions were: 1) Did you agree with the idea of exclosure prior to its establishment? 2) Do you feel happy with the existing exclosures and 3) Do you support future expansion of exclosures? About 85 % of the sampled households agreed with the idea of exclosure prior to its establishment. This shows that the majority of sampled households had favourable expectations for exclosures. Almost all of the sampled households, about 97 %, responded that they were happy with the existing exclosures. Here it must be clear that, the respondents who replied that they were happy were not only those who collected resources from exclosures, but also those who did not collect. That is, almost all of those who collected outputs from exclosures and 90 % of those who did not collect outputs from exclosures replied that they were happy with the existing exclosures. Therefore, the reason why they were happy was not that they were satisfied with the direct economic benefit obtained from exclosures alone, but because of the combined effect of the direct benefits (mainly collection of grass using cut and carry system) and indirect benefits (e.g. good microclimate of the area, reduction of soil erosion, reduction of gully formation) observed from exclosures. The reason given by the respondents who collected resources was a combination of direct and indirect benefits while for those who did not collect resources it was mainly the indirect benefits.

However, as the years since establishment of exclosures increases, trees replace grasses and there will be less grass to collect for animal fodder (Yayneshet et al., 2009). There will be less land remaining for grazing and this might reduce the support of local community for future

expansion of exclosures. Our survey result showed that 76 % of the sampled households supported expansion of exclosures, which is 21 % less than those who were happy with the existing exclosures. Other scholars reported possible reasons that can reduce local community support for expansion of exclosures. For example, Mekuria et al. (2011b) reported that expansion of exclosures caused increased pressure of grazing on the remaining grazing lands. Similarly, Muys et al. (2014) reported that the establishment of exclosures especially near forest area increased the pressure of the local community to collect fuelwood from national forest.

Household's harvest status had positive association with perception of economic improvement and it was in agreement with the findings of previous studies conducted in Ethiopia (Birhane et al., 2017b, Mengistu et al., 2005). Moreover, it was positively associated with attitude towards exclosures and this result concurs with the findings of previous studies (Allendorf, 2007, Allendorf et al., 2006). This association can be explained by the positive relationship between collection of outputs from protected areas and favourable attitude towards it. However, household's harvest status had negative and significant influence on the attitude towards expansion of exclosures. The main reasons for this association could be either one or both of the following statements. 1) The preference of local community for hizaeti over exclosures due to its labor saving and prolonged grazing opportunity for the animals. 2) A concern about the shortage of grass for animal fodder when grass is replaced by trees following expansion of exclosures (Birhane et al., 2017b).

The distance between household's residence and the exclosures had negative and significant impact on household heads' perception of economic improvement. This can be explained by the positive relationship between opportunity cost of collecting outputs, and the distance between residence of households and resource location (Robinson and Lokina, 2011). Thus,

households who are living far from resource location would prefer to spend their time on activities other than collection of outputs from exclosures. However, distance between district markets and household's residence had positive attitude towards expansion of exclosures. In areas that are far from the markets, which are relatively remote, due to limited access to job opportunities to generate income they depend more on resources that are found nearby (Mamo et al., 2007, Soltani et al., 2012). These associations are in line with the social exchange theory, which asserts the positive impact of economic dependence on perceptions (Kuvan and Akan, 2005, Rahman et al., 2017).

Extension visits had negative and significant impact on household heads' perception of economic improvement and attitudes towards expansion of exclosures. However, it had positive influence on household heads' perception of ecological improvement. The probable explanation for this association could be that the development agents who are hired by the Tigray Bureau of Agriculture and Rural Development are disseminating information mainly by giving priority to the ecological rehabilitation over the economic benefit from exclosures. Therefore, there is an urgent need to adjust the type of information disseminated through development agents to include knowledge about economic benefits in addition to the ecological rehabilitation.

Moreover, household heads' perception of economic improvement and local involvement had positive and negative association with attitudes towards exclosures, respectively. Household heads' perception of economic improvement and equal access had positive association with attitude towards expansion of exclosures. This shows how the attitude towards exclosures can be influenced by the household heads' perception. Allendorf (2006) reported that people's perception of protected areas play an important role in shaping their attitudes.

An enclosure is defined as degraded land where livestock and human interventions are restricted to enhance natural restoration (Aerts et al., 2009). Though this makes sense from the ecological point of view, however, it was difficult to use the same term for all enclosures from a social or institutional point of view. Governance of enclosures is much more varied, and it is more difficult to come up with a unified social definition of how an enclosure is governed. For instance, the grass collection in Tensuka was commonly managed, eucalyptus plantation and harvest of mature trees as poles in Abel Dega enclosure resembles state managed. The governance of hizaeti is based on the informal institution that was developed by the local community, and the community has autonomous decision making power concerning the use of the hizaeti. However, the governance of enclosures was a non-autonomous process, dependent on the formal institutions that were mainly developed by external organizations such as Bureau of Agriculture and Rural Development. Through its district offices the bureau had the decision making power on the management and collection of natural resources from enclosures. These district offices were responsible for hiring and paying salaries for guards of the enclosure.

Previous studies indicated that the support of local community is a key element for sustainable management of protected areas (Vodouhê et al., 2010, Dolisca et al., 2007). Our results revealed that the local community did not want to change land use governance from hizaeti to enclosure. Thus, it seems that local communities would prefer enclosures to be managed in a similar way to that of hizaeti. Here we are referring to the practices of governance. However, the effectiveness of hizaeti as a means to rehabilitate degraded lands was not addressed in our study. Furthermore, even though enclosures are governed by the state through Bureau of Agriculture and Rural Development, the majority of the sampled households were happy for the existing enclosures. However, it must be clear that the positive attitude of the local

community was not only attributed through the direct benefit obtained from the exclosures, but also due to other indirect benefits.

Hypothesis 1: In line with our hypothesis, our model results (Table 4, Paper I) revealed that households who owned larger herds, and are relatively better off, were more likely to collect output, mainly grass for animal fodder, and obtained a greater share of outputs from exclosures.

Hypothesis 2: The government is the *de jure* owner of the degraded communal grazing lands, but before the establishment of exclosures in the region no money was allocated for guards to control state owned grazing land. For this reason, the farmers were able to exploit resources in these areas. However, since the establishment of exclosures the Bureau of Agriculture and Rural Development through its respective district offices has allocated money to hire guards and become more involved in the management of exclosures, e.g. choice of species to plant and when to harvest outputs. The employed guards are there to enforce the rules for management of exclosures and to apprehend those who violate the rules. This policy has allowed the government to develop more practical control over the areas where exclosures were established. Therefore, the establishment of exclosures and the allocation of money in governance of exclosures can be considered as indicators of the shift from *de jure* to *de facto* ownership of degraded communal grazing lands by the regional government.

5. Conclusions

The main conclusions from the thesis are:

In Paper I, equity and factors affecting distribution of values of outputs from exclosures in Tigray were analysed. The main output collected from exclosures was grass used as fodder for domestic animals. The results showed that households with larger herds were more likely to

collect output from exclosures and collected a larger share of outputs from exclosures. Thus, the better-off households have benefited most from the exclosures. For this reason, it is important to find ways how to benefit the poorer segment of the local community from the exclosures. This could be done by allowing households with smaller herds to collect outputs such as mushrooms, honey and medicinal plants. These outputs might be important for the poor households and their impact on the degradation potential of the exclosures is minimal. Therefore, local policy makers should consider this alternative option and revise the management strategies of exclosures so as to benefit poor households in the Tigray Region.

In Paper II, perceptions and attitudes of household heads on exclosures were assessed and their influencing factors were also identified. A large majority of the sampled households had positive perceptions of ecological, social and economic impacts, but the latter received lower score. More of the sampled household heads had positive attitudes towards existing exclosures, but there is some resistance towards future expansion of exclosures. Household heads' perception of economic improvement and equal access had positive association with attitude towards expansion of exclosures. This shows how the attitude towards exclosures are influenced by the household heads' perception. Therefore, in order to improve household heads' attitudes towards expansion of exclosures the economic benefits from exclosures should be enough to outweigh costs associated with its expansion. The number of extension visits had negative and significant impact on attitudes towards expansion of exclosures. Thus, the information disseminated through development agents should give due attention to the economic benefit rather than prioritizing only the ecological rehabilitation.

In Paper III, two land rehabilitation systems to manage common pool resources, which are exclosures and hizaeti, were investigated and compared. Local communities use informal institution to balance utilization of natural resources and carrying capacity. The management

of exclosures involves limited community participation and follows a top-down decision-making process. However, this decision-making process could jeopardize the rehabilitation process of the degraded lands for two reasons. First, if the local communities do not have autonomy to make decision, they may not develop a feeling of ownership to the management of resources. Second, if communities could not get any tangible benefit from exclosures, they will hardly support the management of exclosures and may engage in illegal collection of outputs from exclosures. Therefore, there is a need to enhance the participation of local communities in the governance of exclosures. The socioeconomic and institutional setting of the selected exclosures were diverse and hence using existing traditional or informal institutions might be a suitable option for rehabilitation of degraded common pool resources.

Here are the main concluding remarks: 1) Households with larger herd of animals collected more grass for animal fodder. Therefore, little of the output from exclosures was collected by households who owned smaller or no herd. 2) The local people were happy because of the existing exclosures. However, the reasons that make them happy were a combination of direct benefit obtained and indirect benefits observed for those who collected outputs from exclosures and the indirect benefits observed for those who did not collect outputs from exclosures. 3) The relationship between regional organization and local communities in the management of exclosures was to some extent a top-down process. In most of the exclosures the permission on what type of resources to be collected, recruitment and salary of exclosure guards were managed by the district office of Agriculture and Rural development.

A narrative of success has dominated the discourse of exclosures in Tigray (Birhane and Hadgu, 2014, Reij, 2014, Whiting, 2017, WeForest, 2018). The story goes like this: Local communities together with rural development organisations have established exclosures all over the province, and the results are very encouraging. The environment is improving to the

benefit of people's livelihoods. At the end of the thesis it may easily be concluded that the social experiment that is called "exclosure" is a much more complex undertaking with mixed results. The impact of exclosures on poor people's livelihoods is not as clearly positive as in the case of the environment in spite of local communities expressed support. The authorities must improve the governance of exclosures such that local conditions are better accommodated. One way of achieving this is by allowing local communities more autonomy in the management of exclosures.

6. References

- ADHIKARI, B., DI FALCO, S. & LOVETT, J. C. 2004. Household characteristics and forest dependency: evidence from common property forest management in Nepal. *Ecological Economics*, 48, 245-257.
- AERTS, R., LEROUGE, F., NOVEMBER, E., LENS, L., HERMY, M. & MUYS, B. 2008. Land rehabilitation and the conservation of birds in a degraded Afromontane landscape in northern Ethiopia. *Biodiversity and Conservation*, 17, 53-69.
- AERTS, R., NYSSSEN, J. & HAILE, M. 2009. On the difference between “exclosures” and “enclosures” in ecology and the environment. *Journal of Arid Environments*, 73, 762-763.
- AGRAWAL, A. 2001. Common property institutions and sustainable governance of resources. *World Development*, 29, 1649-1672.
- AIPANJIGULY, S., JACOBSON, S. K. & FLAMM, R. 2003. Conserving Manatees: Knowledge, Attitudes, and Intentions of Boaters in Tampa Bay, Florida. *Conservation Biology*, 17, 1098-1105.
- AL-DOUSARI, A., MISAK, R. & SHAHID, S. 2000. Soil compaction and sealing in Al-Salmi area, western Kuwait. *Land Degradation & Development*, 11, 401-418.
- ALKAN, H., KORKMAZ, M. & TOLUNAY, A. 2009. Assessment of primary factors causing positive or negative local perceptions on protected areas. *Journal of Environmental Engineering and Landscape Management*, 17, 20-27.
- ALLENDORF, T., SWE, K. K., OO, T., HTUT, Y., AUNG, M., ALLENDORF, K., HAYEK, L.-A., LEIMGRUBER, P. & WEMMER, C. 2006. Community attitudes toward three protected areas in Upper Myanmar (Burma). *Environmental Conservation*, 33, 344-352.
- ALLENDORF, T. D. 2006. Residents’ attitudes toward three protected areas in southwestern Nepal. *Biodiversity and Conservation*, 16, 2087.
- ALLENDORF, T. D. 2007. Residents’ attitudes toward three protected areas in southwestern Nepal. *Biodiversity and Conservation*, 16, 2087.
- BABULO, B. 2007. *Economic valuation and management of common-pool resources: The case of exclosures in the highlands of Tigray, Northern Ethiopia*. Ph. D. Thesis, Catholic University of Leuven.
- BABULO, B., MUYS, B., NEGA, F., TOLLENS, E., NYSSSEN, J., DECKERS, J. & MATHIJS, E. 2009. The economic contribution of forest resource use to rural livelihoods in Tigray, Northern Ethiopia. *Forest Policy and Economics*, 11, 109-117.
- BALANA, B. B., MATHIJS, E. & MUYS, B. 2010. Assessing the sustainability of forest management: An application of multi-criteria decision analysis to community forests in northern Ethiopia. *Journal of environmental management*, 91, 1294-1304.
- BALAND, J. M. & PLATTEAU, J. P. 1996. *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?*, Oxford: Clarendon Press.
- BANANA, A. Y., VOGT, N. D., BAHATI, J. & GOMBYA-SSEMBAJJWE, W. 2007. Decentralized governance and ecological health: why local institutions fail to moderate deforestation in Mpigi district of Uganda. *Scientific Research and Essays*, 2, 434-445.
- BARAL, N. & HEINEN, J. T. 2007. Resources use, conservation attitudes, management intervention and park-people relations in the Western Terai landscape of Nepal. *Environmental Conservation*, 34, 64-72.
- BAUER, H. 2003. Local perceptions of Waza national park, northern Cameroon. *Environmental Conservation*, 30, 175-181.
- BAUMOL, W. J. 2004. Welfare Economics and the Theory of the State. *The Encyclopedia of Public Choice*. Springer.

- BELKAYALI, N., GÜLOĞLU, Y. & ŞEVİK, H. 2016. What affects perceptions of local residents toward protected areas? A case study from Kure Mountains National Park, Turkey. *International Journal of Sustainable Development & World Ecology*, 23, 194-202.
- BERHANE, E., TEKETAY, D. & BARKLUND, P. 2007. Enclosures to enhance woody species diversity in the drylands of Tigray. *East Afr. J. Sci*, 1, 136-147.
- BESSIE, S., BEYENE, F., HUNDIE, B., GOSHU, G. & MENGESHA, Y. 2014. Local Communities' Perceptions of Bamboo Deforestation in Benishangul Gumuz Region, Ethiopia.
- BIRHANE, E., AREGAWI, K. & GIDAY, K. 2017a. Changes in arbuscular mycorrhiza fungi spore density and root colonization of woody plants in response to enclosure age and slope position in the highlands of Tigray, Northern Ethiopia. *Journal of Arid Environments*.
- BIRHANE, E. & HADGU, K. M. 2014. Community managed enclosures in Tigray, Ethiopia Pp.123-125 In: DE LEEUW J, NJENGA M, WAGNER B & IYAMA M (eds.) *Treesilience: An assessment of the resilience provided by trees in the drylands of Eastern Africa*. Nairobi, Kenya: World Agroforestry Center (ICRAF).
- BIRHANE, E., MENGISTU, T., SEYOUM, Y., HAGAZI, N., PUTZEL, L., MEKONEN RANNESTAD, M. & KASSA, H. 2017b. *Enclosures as forest and landscape restoration tools: lessons from Tigray Region, Ethiopia*.
- BISHU, K. G., O'REILLY, S., LAHIFF, E. & STEINER, B. 2016. Cattle farmers' perceptions of risk and risk management strategies: evidence from Northern Ethiopia. *Journal of Risk Research*, 1-20.
- BLAY, D., APPIAH, M., DAMNYAG, L., DWOMOH, F. K., LUUKKANEN, O. & PAPPINEN, A. 2008. Involving local farmers in rehabilitation of degraded tropical forests: some lessons from Ghana. *Environment, Development and Sustainability*, 10, 503-518.
- BOARD 2013. Annual Report. *Bureau of Agriculture and Rural Development*. Ethiopia, Mekelle: BoARD.
- BRYAN, T. A. 2004. Tragedy Averted: The Promise of Collaboration. *Society & Natural Resources*, 17, 881-896.
- CAVENDISH, W. 2002. Quantitative methods for estimating the economic value of resource use to rural households. *Uncovering the hidden harvest: valuation methods for woodland and forest resources*, 17-65.
- CHIRWA, P. W., MAHAMANE, L. & KOWERO, G. 2017. Forests, people and environment: some African perspectives. *Southern Forests: a Journal of Forest Science*, 79, 79-85.
- CHISHOLM, N. 1998. "Community-based natural resource management in Tigray, Northern Ethiopia," Washington, DC, USA: The World Bank/WBI's CBNRM Initiative.
- CHOKKALINGAM, U. 2006. *Learning lessons from China's forest rehabilitation efforts: national level review and special focus on Guangdong Province*, CIFOR.
- CROPANZANO, R. & MITCHELL, M. S. 2005. Social exchange theory: An interdisciplinary review. *Journal of management*, 31, 874-900.
- DESCHEEMAEKER, K., MUYS, B., NYSSSEN, J., POESEN, J., RAES, D., HAILE, M. & DECKERS, J. 2006a. Litter production and organic matter accumulation in enclosures of the Tigray highlands, Ethiopia. *Forest Ecology and Management*, 233, 21-35.
- DESCHEEMAEKER, K., NYSSSEN, J., POESEN, J., HAILE, M., MUYS, B., RAES, D., MOEYERSONS, J. & DECKERS, J. 2006b. Soil and water conservation through forest restoration in enclosures of the Tigray highlands. *Journal of the Drylands*, 1, 118-133.

- DESCHEEMAEKER, K., NYSSSEN, J., ROSSI, J., POESEN, J., HAILE, M., RAES, D., MUYS, B., MOEYERSONS, J. & DECKERS, S. 2006c. Sediment deposition and pedogenesis in exclosures in the Tigray highlands, Ethiopia. *Geoderma*, 132, 291-314.
- DOLISCA, F., MCDANIEL, J. M. & TEETER, L. D. 2007. Farmers' perceptions towards forests: A case study from Haiti. *Forest Policy and Economics*, 9, 704-712.
- FEENY, D., HANNA, S. & MCEVOY, A. F. 1996. Questioning the Assumptions of the "Tragedy of the Commons" Model of Fisheries. *Land Economics*, 72, 187-205.
- FIALLO, E. A. & JACOBSON, S. K. 1995. Local communities and protected areas: attitudes of rural residents towards conservation and Machalilla National Park, Ecuador. *Environmental Conservation*, 22, 241-249.
- FISHER, M. 2004. Household welfare and forest dependence in Southern Malawi. *Environment and Development Economics*, 9, 135-154.
- GEBREMEDHIN, B. 2003. *Policies for sustainable land management in the highlands of Tigray, northern Ethiopia: Summary of papers and proceedings of a workshop held at Axum Hotel, Mekelle, Ethiopia, 28-29 March 2002*, ILRI (aka ILCA and ILRAD).
- GEBREMEDHIN, B., PENDER, J. & TEFAY, G. 2003. Community natural resource management: the case of woodlots in Northern Ethiopia. *Environment and Development Economics*, 8, 129-148.
- GEBREMEDHIN, B. & SWINTON, S. 2002. Sustainable management of private and communal lands in northern Ethiopia.
- GIRMAY, G., SINGH, B. R., NYSSSEN, J. & BORROSEN, T. 2009. Runoff and sediment-associated nutrient losses under different land uses in Tigray, Northern Ethiopia. *Journal of Hydrology*, 376, 70-80.
- GISLADOTTIR, G. & STOCKING, M. 2005. Land degradation control and its global environmental benefits. *Land Degradation & Development*, 16, 99-112.
- HADGU, G., TEFAYE, K. & MAMO, G. 2015. Analysis of climate change in Northern Ethiopia: implications for agricultural production. *Theoretical and Applied Climatology*, 121, 733-747.
- HAILESLASSIE, A., PRIESS, J., VELDKAMP, E., TEKETAY, D. & LESSCHEN, J. P. 2005. Assessment of soil nutrient depletion and its spatial variability on smallholders' mixed farming systems in Ethiopia using partial versus full nutrient balances. *Agriculture, Ecosystems & Environment*, 108, 1-16.
- HARDIN, G. 1968. The tragedy of the commons. *Science*, 162, 1243-1247.
- HEIN, L., VAN KOPPEN, K., DE GROOT, R. S. & VAN IERLAND, E. C. 2006. Spatial scales, stakeholders and the valuation of ecosystem services. *Ecological economics*, 57, 209-228.
- HELMKE, G. & LEVITSKY, S. 2004. Informal Institutions and Comparative Politics: A Research Agenda. *Perspectives on Politics*, 2, 725-740.
- HTUN, N. Z., MIZOUE, N. & YOSHIDA, S. 2012. Determinants of local people's perceptions and attitudes toward a protected area and its management: A case study from Popa Mountain Park, Central Myanmar. *Society & Natural Resources*, 25, 743-758.
- INFIELD, M. & NAMARA, A. 2001. Community attitudes and behaviour towards conservation: an assessment of a community conservation programme around Lake Mburo National Park, Uganda. *Oryx*, 35, 48-60.
- KALTENBORN, B. P., BJERKE, T., NYAHONGO, J. W. & WILLIAMS, D. R. 2006. Animal preferences and acceptability of wildlife management actions around Serengeti National Park, Tanzania. *Biodiversity and Conservation*, 15, 4633-4649.
- KIDEGHESHO, J. R., RØSKAFT, E. & KALTENBORN, B. P. 2007. Factors influencing conservation attitudes of local people in Western Serengeti, Tanzania. *Biodiversity and Conservation*, 16, 2213-2230.

- KÖHLIN, G., PARKS, P. J., BARBIER, E. B. & BURGESS, J. C. 2001. Spatial variability and disincentives to harvest: deforestation and fuelwood collection in South Asia. *Land Economics*, 77, 206-218.
- KUVAN, Y. & AKAN, P. 2005. Residents' attitudes toward general and forest-related impacts of tourism: the case of Belek, Antalya. *Tourism management*, 26, 691-706.
- LAMB, D. & GILMOUR, D. 2003. *Rehabilitation and restoration of degraded forests*, Gland, IUCN-The World Conservation Union.
- LAMBINI, C. K. & NGUYEN, T. T. 2014. A comparative analysis of the effects of institutional property rights on forest livelihoods and forest conditions: Evidence from Ghana and Vietnam. *Forest Policy and Economics*, 38, 178-190.
- LEPP, A. & HOLLAND, S. 2006. A comparison of attitudes toward state-led conservation and community-based conservation in the village of Bigodi, Uganda. *Society and Natural Resources*, 19, 609-623.
- MACURA, B., ZORONDO-RODRÍGUEZ, F., GRAU-SATORRAS, M., DEMPS, K., LAVAL, M., GARCIA, C. & REYES-GARCÍA, V. 2011. Local community attitudes toward forests outside protected areas in India. Impact of legal awareness, trust, and participation. *Ecology and society*, 16.
- MAGALHAES, L. & SANTA EULÀLIA-LLOPIS, R. 2017. The Consumption, Income, and Wealth of the Poorest: An Empirical Analysis of Economic Inequality in Rural and Urban Sub-Saharan Africa for Macroeconomists.
- MAMO, G., SJAASTAD, E. & VEDEL, P. 2007. Economic dependence on forest resources: A case from Dendi District, Ethiopia. *Forest Policy and Economics*, 9, 916-927.
- MCKEAN, M. A. 1992. Management of Traditional Common Lands (Iriaichi) in Japan. In: BROMLEY, D. W. (ed.) *Making the Commons Work: Theory, Practice, and Policy*. San Francisco.
- MEHTA, J. N. & HEINEN, J. T. 2001. Does community-based conservation shape favorable attitudes among locals? An empirical study from Nepal. *Environmental management*, 28, 165-177.
- MEKURIA, VELDKAMP, E., HAILE, M., GEBREHIWOT, K., MUYS, B. & NYSSSEN, J. 2009. Effectiveness of exclosures to control soil erosion and local community perception on soil erosion in Tigray, Ethiopia.
- MEKURIA, VELDKAMP, E., HAILE, M., NYSSSEN, J., MUYS, B. & GEBREHIWOT, K. 2007. Effectiveness of exclosures to restore degraded soils as a result of overgrazing in Tigray, Ethiopia. *Journal of Arid Environments*, 69, 270-284.
- MEKURIA, VELDKAMP, E., TILAHUN, M. & OLSCHESKI, R. 2011a. Economic valuation of land restoration: The case of exclosures established on communal grazing lands in Tigray, Ethiopia. *Land Degradation & Development*, 22, 334-344.
- MEKURIA, W. 2013a. Changes in regulating ecosystem services following establishing exclosures on communal grazing lands in Ethiopia: a synthesis. *Journal of Ecosystems*, 2013.
- MEKURIA, W. 2013b. Conversion of Communal Grazing Lands into Exclosures Restored Soil Properties in the Semi-Arid Lowlands of Northern Ethiopia. *Arid Land Research and Management*, 27, 153-166.
- MEKURIA, W. & AYNEKULU, E. 2013. Exclosure land management for restoration of the soils in degraded communal grazing lands in northern Ethiopia. *Land Degradation & Development*, 24, 528-538.
- MEKURIA, W., VELDKAMP, E., CORRE, M. D. & HAILE, M. 2011b. Restoration of Ecosystem Carbon Stocks Following Exclosure Establishment in Communal Grazing Lands in Tigray, Ethiopia *Soil Science Society of America Journal*, 75, 246-256.

- MENGISTU, T., TEKETAY, D., HULTEN, H. & YEMSHAW, Y. 2005. The role of enclosures in the recovery of woody vegetation in degraded dryland hillsides of central and northern Ethiopia. *Journal of Arid Environments*, 60, 259-281.
- MOGES, D. M. & TAYE, A. A. 2017. Determinants of farmers' perception to invest in soil and water conservation technologies in the North-Western Highlands of Ethiopia. *International Soil and Water Conservation Research*, 5, 56-61.
- MUHAMAD, D., OKUBO, S., HARASHINA, K., PARIKESIT, GUNAWAN, B. & TAKEUCHI, K. 2014. Living close to forests enhances people's perception of ecosystem services in a forest-agricultural landscape of West Java, Indonesia. *Ecosystem Services*, 8, 197-206.
- MUYS, B., NYSSSEN, J., DU TOIT, B., VIDALE, E., PROKOFIEVA, I., MAVSAR, R. & PALAHI, M. 2014. Water-related ecosystem services of forests: learning from regional cases. *Forests under pressure: local responses to global issues*. International Union of Forest Research Organizations (IUFRO).
- NARAIN, U., GUPTA, S. & VAN'T VELD, K. 2008. Poverty and resource dependence in rural India. *Ecological Economics*, 66, 161-176.
- NEDESSA, B., ALI, J. & NYBORG, I. 2005. Exploring ecological and socio-economic issues for the improvement of area enclosure management. *A case study from Ethiopia. DCG Report*, 38.
- NEGI, C. S. 2010. Traditional Culture and Biodiversity Conservation: Examples From Uttarakhand, Central Himalaya. *Mountain Research and Development*, 30, 259-265.
- NORTH, D. C. 1990. *Institutions, institutional change and economic performance*, Cambridge, Cambridge University Press.
- NYSSSEN, J., POESEN, J., MOEYERSONS, J., DECKERS, J., HAILE, M. & LANG, A. 2004. Human impact on the environment in the Ethiopian and Eritrean highlands—a state of the art. *Earth-Science Reviews*, 64, 273-320.
- OLSON, M. 1965. *The Logic Of Collective Action: Public Goods and the Theory of Groups*. Harvard University Press; Cambridge, MA.
- OSTROM, E. 1990. *Governing the commons: the evolution of institutions for collective action*, New York, Cambridge University Press.
- OSTROM, E. 2000. Collective action and the evolution of social norms. *Journal of economic perspectives*, 14, 137-158.
- OSTROM, E. 2005. Self-governance and forest resources. *Terracotta reader: a market approach to the environment. Academic Foundation, New Delhi*, 131-155.
- PAGDEE, A., KIM, Y.-S. & DAUGHERTY, P. J. 2006. What makes community forest management successful: a meta-study from community forests throughout the world. *Society and Natural Resources*, 19, 33-52.
- PARASKEVOPOULOS, S., KORFIATIS, K. J. & PANTIS, J. D. 2003. Social exclusion as constraint for the development of environmentally friendly attitudes. *Society & Natural Resources*, 16, 759-774.
- RAHMAN, M. M., MAHMUD, M. A. A. & SHAHIDULLAH, M. 2017. Socioeconomics of biodiversity conservation in the protected areas: a case study in Bangladesh. *International Journal of Sustainable Development & World Ecology*, 24, 65-72.
- REIJ, C. 2014. <http://africa-regreening.blogspot.com/2014/04/regreening-in-tigray-ethiopia-ari.html>.
- REUBENS, B., MOEREMANS, C., POESEN, J., NYSSSEN, J., TEWOLDEBERHAN, S., FRANZEL, S., DECKERS, J., ORWA, C. & MUYS, B. 2011. Tree species selection for land rehabilitation in Ethiopia: from fragmented knowledge to an integrated multi-criteria decision approach. *Agroforestry Systems*, 82, 303-330.

- RIBOT, J. C., CHHATRE, A. & LANKINA, T. 2008. Introduction: Institutional choice and recognition in the formation and consolidation of local democracy. *Conservation and Society*, 6, 1.
- ROBINSON, E. J. Z. & LOKINA, R. B. 2011. A spatial-temporal analysis of the impact of access restrictions on forest landscapes and household welfare in Tanzania. *Forest Policy and Economics*, 13, 79-85.
- SANDLER, T. 1992. *Collective action: Theory and applications*, University of Michigan Press.
- SEN, A. & FOSTER, J. E. 1997. *On economic inequality*, Oxford University Press.
- SEYOUM, Y., BIRHANE, E., HAGAZI, N., ESMAEL, N., MENGISTU, T. & KASSA, H. 2015. *Enhancing the Role of the Forestry Sector in Building Climate Resilient Green Economy in Ethiopia: Strategy for scaling up effective forest management practices in Tigray National Regional State with emphasis on area exclosures*, Addis Ababa, Ethiopia, Center for International Forestry Research (CIFOR).
- SFM_NORHED 2014. Summary Report on Reconnaissance survey to select and study the Exclosures in Tigray. Department of Land Resources Management and Environmental Protection, Mekelle University, Mekelle, Ethiopia. (*Unpublished Report*).
- SHIBIA, M. G. 2010. Determinants of attitudes and perceptions on resource use and management of Marsabit National Reserve, Kenya. *Journal of Human Ecology*, 30, 55-62.
- SHYLENDRA, H. S. 2002. Environmental Rehabilitation and Livelihood Impact: Emerging Trends from Ethiopia and Gujarat. *Economic and Political Weekly*, 37, 3286-3292.
- SIMMONS, R. T., SMITH, F. L. & GEORGIA, P. 1996. The Tragedy of the Commons Revisited: Politics vs. Private Property.
- SJAASTAD, E. & COUSINS, B. 2009. Formalisation of land rights in the South: An overview. *Land use policy*, 26, 1-9.
- SODHI, N. S., KOH, L. P., CLEMENTS, R., WANGER, T. C., HILL, J. K., HAMER, K. C., CLOUGH, Y., TSCHARNTKE, T., POSA, M. R. C. & LEE, T. M. 2010. Conserving Southeast Asian forest biodiversity in human-modified landscapes. *Biological Conservation*, 143, 2375-2384.
- SOLTANI, A., ANGELSEN, A. & EID, T. 2014. Poverty, forest dependence and forest degradation links: evidence from Zagros, Iran. *Environment and Development Economics*, 19, 607-630.
- SOLTANI, A., ANGELSEN, A., EID, T., NAIENI, M. S. N. & SHAMEKHI, T. 2012. Poverty, sustainability, and household livelihood strategies in Zagros, Iran. *Ecological Economics*, 79, 60-70.
- SOLTANI, A. & EID, T. 2013. Organization, practices and performance of community-based traditional forest management-empirical evidence from Zagros, Iran. *Forests, Trees and Livelihoods*, 22, 19-37.
- TADESSE, S. A. & TEKETAY, D. 2017. Perceptions and attitudes of local people towards participatory forest management in Tarmaber District of North Shewa Administrative Zone, Ethiopia: the case of Wof-Washa Forests. *Ecological Processes*, 6, 17.
- TESFAYE, Y., ROOS, A. & BOHLIN, F. 2012. Attitudes of local people towards collective action for forest management: the case of participatory forest management in Dodola area in the Bale Mountains, Southern Ethiopia. *Biodiversity and conservation*, 21, 245-265.
- TESFAYE, Y., ROOS, A., CAMPBELL, B. M. & BOHLIN, F. 2011. Livelihood strategies and the role of forest income in participatory-managed forests of Dodola area in the bale highlands, southern Ethiopia. *Forest Policy and Economics*, 13, 258-265.

- TESSEMA, M. E., LILIEHOLM, R. J., ASHENAFI, Z. T. & LEADER-WILLIAMS, N. 2010. Community Attitudes Toward Wildlife and Protected Areas in Ethiopia. *Society & Natural Resources*, 23, 489-506.
- THEURL, T. & WICHER, J. 2012. Comparing Informal Institutions. *DICE Report*, 10, 52.
- URGESSA, K. 2003. Perceptions of forest cover and tree planting and ownership in Jimma Zone, Ethiopia. *UNASYLVA-FAO*-, 18-20.
- VODOUHÉ, F. G., COULIBALY, O., ADÉGBIDI, A. & SINSIN, B. 2010. Community perception of biodiversity conservation within protected areas in Benin. *Forest Policy and Economics*, 12, 505-512.
- WADE, R. 1988. *Village republics: Economic conditions for collective action in South India*, Robert Wade Cambridge University Press, Oakland : ICS Press.
- WALPOLE, M. J. & GOODWIN, H. J. 2001. Local attitudes towards conservation and tourism around Komodo National Park, Indonesia. *Environmental conservation*, 28, 160-166.
- WEFOREST 2018. <https://www.weforest.org/project/ethiopia-tigray>
- WHITING, A. 2017. Ethiopia's Tigray Region bags gold award for greening its drylands. Reuters, August 22, 2017. <https://www.reuters.com/article/us-land-farming/ethiopia-tigray-region-bags-gold-award-for-greening-its-drylands-idUSKCN1B21CT>
- XU, J., CHEN, L., LU, Y. & FU, B. 2006. Local people's perceptions as decision support for protected area management in Wolong Biosphere Reserve, China. *Journal of Environmental Management*, 78, 362-372.
- YAMI, M., GEBREHIWOT, K., MOE, S. & MEKURIA, W. 2006. Impact of area enclosures on density, diversity, and population structure of woody species: the case of May Ba'ati-Douga Tembien, Tigray, Ethiopia. *Ethiop. J. Nat. Res*, 8, 99-121.
- YAMI, M., MEKURIA, W. & HAUSER, M. 2013. The effectiveness of village bylaws in sustainable management of community-managed exclosures in Northern Ethiopia. *Sustainability Science*, 8, 73-86.
- YAMI, M., VOGL, C. & HAUSERA, M. 2009. Comparing the effectiveness of informal and formal institutions in sustainable common pool resources management in Sub-Saharan Africa. JSTOR.
- YAYNESHET, EIK, L. O. & MOE, S. R. 2009. The effects of exclosures in restoring degraded semi-arid vegetation in communal grazing lands in northern Ethiopia. *Journal of Arid Environments*, 73, 542-549.
- YEBOAH-ASSIAMAH, E., MULLER, K. & DOMFEH, K. A. 2017. Institutional assessment in natural resource governance: A conceptual overview. *Forest Policy and Economics*, 74, 1-12.
- YOUNG, O. R. 2007. Rights, Rules, and Common Pools: Solving Problems Arising in Human/Environment Relations. *Natural Resources Journal*, 47, 1-16.
- ZELEZNY, L. C. 1999. Educational interventions that improve environmental behaviors: A meta-analysis. *The Journal of Environmental Education*, 31, 5-14.

Appendix papers I-III

Paper I



Equity in the distribution of values of outputs from exclosures in Tigray, Ethiopia



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ABSTRACT

Land degradation is a widespread problem throughout the Tigray Region in Ethiopia, and establishing exclosures to restore degraded land has been in practice for many years. The authors examine how outputs obtained from exclosures are distributed among households adjacent to the exclosures and identify factors that influence the distribution of values of outputs. Data were collected from 446 households living next to nine exclosures in Tigray. The Gini coefficient, probit regression, and multiple linear regression were applied to the data sets. The results revealed that the distribution of values of outputs varied from fairly equal to quite unequal, depending on the exclosures' attributes and the appropriators' attributes. A more equal distribution values of outputs from exclosures was found where the density of appropriators was higher or/and in villages next to exclosures that were protected for longer periods. Wealthier households with larger herd sizes obtained a larger share of outputs from the exclosures, while households in the lowest income quantile received almost nothing. This may raise concerns among those interested in pro-poor measures. The authors did not find any evidence that household responsibility for managing and protecting exclosures had significant impacts on the distribution of values of outputs.

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1. Introduction

The problem of land degradation exists throughout sub-Saharan Africa (Yayneshet et al., 2009) and threatens both ecosystem functions and economic production. The rehabilitation of degraded land can be a challenge when managing dry forests and semi-arid environments because these resources shape local communities' livelihoods (e.g., Babulo et al., 2008; Mamo et al., 2007; Soltani et al., 2012, 2014; Tesfaye et al., 2010). Large populations of humans and livestock are heavily dependent on ecosystem goods and services provided by dry forests and woodlands in Africa in general (Chidumayo and Marunda, 2010; Shackleton et al., 2007) and in the Tigray Region in northern Ethiopia in particular (Babulo

et al., 2008, 2009). Therefore, any effort to rehabilitate the degraded dry forests could improve local communities' livelihoods (Shylendra, 2002). The Tigray Region suffers from extreme land degradation (Haileslassie et al., 2005; Mekuria et al., 2007), loss of soil fertility, and moisture stress (Herweg and Stillhardt, 1999).

The authorities in Tigray realized that it is less costly to address land degradation in Tigray by closing off the most badly degraded areas from agriculture and grazing to form exclosures (Aerts et al., 2009). Local communities make bylaws to govern and manage such exclosures (Yami et al., 2006); communities' bylaws are subsidiary laws established and enacted by local communities (Nkonya et al., 2008). Under the bylaws, all interventions that may hinder the regeneration capacity of exclosures, such as grazing, firewood collection, and agricultural uses, are forbidden (Aerts et al., 2009; Mekuria et al., 2007; Shiterek et al., 2001; Wisborg et al., 2000). In most areas, during specific times of the year, villagers are allowed to collect grass from exclosures. However, as some individuals from village communities may be tempted to violate the bylaws by harvesting forest products from exclosures without either permission or unchallenged by other villagers (Babulo et al., 2009;

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Yami et al., 2006), monetary and non-monetary sanctions are imposed as a deterrent (Yami et al., 2006). Following the establishment of an enclosure, guards are assigned by the district office of Agriculture and Rural Development to protect them. The guards are paid on the basis of a food-for-work program administered by the World Food Program (Yaynesht et al., 2009).

It is well documented that the establishment of enclosures in Tigray has been effective in enhancing ecosystem functions (e.g., Descheemaeker et al., 2006; Nyssen et al., 2009; Tefera et al., 2005; Yami et al., 2006; Yaynesht et al., 2009) and increasing the growth of grass and trees (Descheemaeker et al., 2006). However, despite the positive environmental impacts, the introduction of enclosures has limited local communities' access to land. Hence, such communities may consider the land use change from grazing land to enclosures as unfavorable. The success of natural restoration by the establishment of enclosures may depend on the generation of economic gains to local communities. In the absence of such economic incentives, local communities rarely support restoration projects that involve enclosures. Their lack of support becomes even more challenging when there is a growing demand among local communities to use enclosures to generate direct economic value (Gebremedhin et al., 2003). Furthermore, a controlled and moderate use of enclosures may not only provide economic incentives for local communities to participate in the management of the enclosures (e.g., Amede et al., 2007; Babulo et al., 2009; Mekuria et al., 2011) but also enhance the ecological function of those enclosures (Yaynesht et al., 2009).

Many studies have evaluated the economic values of outputs obtained from forests and assessed their impacts on local communities' livelihoods in different parts of the world (e.g., Adhikari et al., 2004; Cavendish, 2002; Fu et al., 2009; Kamanga et al., 2009; Mamo et al., 2007; Narain et al., 2008; Shackleton et al., 2007; Soltani et al., 2012, 2014; Vedeld et al., 2007) as well as in the Tigray Region in Ethiopia (Amede et al., 2007; Babulo et al., 2009; Mekuria et al., 2011). However, the distributional aspects of such values to local communities have received little attention in international literature and in the current forest management scheme in Tigray. Promoting equity in the sharing of valuable outputs is required for the sustainable management of any resources, and the meaning of economic equity has been discussed extensively (Clark, 2003; Sen and Gordon, 2015). Economic equity relates to the distribution of income and property, and is also related to opportunities and efforts. It is also associated with the redistribution of wealth and transfer of income and wealth from some individuals to others by social mechanisms such as taxation, charity, and land reform (Konow, 1996; Rawls, 2001). However, societies and communities may differ in what they consider a fair distribution (Konow, 2001; Leventhal, 1980). Equity is considered to be among the most frequently discussed measures for a successful community forest management (Pagdee et al., 2006). The aim of the present study was to assess the impact of the attributes of enclosures and the households living next to them, as well as the external context in the distribution of the economic values of the outputs from the enclosures. This was achieved by performing an econometric analysis using data from 446 households in Tigray. Despite the existence of illegal and hidden harvests from enclosures in Tigray, we examined only the economic values of legal outputs, specifically grass and fruits, which had been harvested in accordance with bylaws. The study addressed the following research questions:

1. How are the economic values of outputs from enclosures distributed among households adjacent to the enclosure?
2. What factors influence whether a household collects any outputs from enclosures?

3. What factors influence a household's share of economic values of outputs from the enclosures?

2. Conceptual framework

Enclosures are established in degraded forests and on poor grazing lands that are considered common-pool resources. Hence, the exclusion of appropriators, who do not contribute to the establishment and management of enclosures yet access them and collect outputs or other benefits from them, is difficult and costly. Ostrom et al. (1994) defined appropriators as individuals who extract or appropriate resource units from any type of common-pool resource. In this article, we define appropriators as villagers who hold access rights to adjacent enclosures and can withdraw outputs from them. With regard to any other common-pool resources, the joint efforts of individuals and collective actions are required to create management rules to protect and maintain enclosures (Ostrom, 1990; Sandler, 1992). If rules are well established, the appropriators could allocate resource benefits equitably, over long periods and in a more efficient manner than if there were no rules (Agrawal, 2001; McKean, 1992; Ostrom, 2005). The creation of rules is linked to the specification of participants' rights and duties and results in a public good for those involved (Ostrom, 2005). Any member of the community can benefit from the public good, irrespective of their contribution to the maintenance of the resource (Ostrom, 2005). The problem of free riders (Baumol, 1952) is the main challenge facing common-pool resources, and how to avoid this problem creates a dilemma. If the problem of free riders is not resolved, the tragedy of commons (Hardin, 1968) may result.

The conceptual framework of the study is presented in Fig. 1. The literature on common-pool resources specifies influencing factors and variables that can enhance the likelihood that appropriators will organize themselves by creating and following rules that will avoid the problem of free riders and the tragedy of commons (Agrawal, 2001; Baland and Platteau, 1996; Ostrom, 1990; Wade, 1988). These variables are classified into two broad sets of those describing the attributes of the common-pool resources and those describing the attributes of the appropriators. These variables affect the basic cost–benefit calculations of a group of appropriators when they aim to utilize a resource (Ostrom, 2005). Each appropriator compares the expected net benefits of harvesting from a resource in a current situation without any rules (B_{nr}) with the benefits they might achieve if the rules are established (B_{wr}), considering all transaction costs associated with the establishment of the rules. If the appropriators realize that B_{wr} is greater than B_{nr} , they will establish institutions and commit to rules (Ostrom, 2005). These influential variables are presented in Table 1 and discussed in more detail below.

2.1. Attributes of resources

Two attributes of resources have an impact on appropriators' decisions relating to common-pool resources: feasible improvement and spatial extent (Ostrom, 1990).

2.1.1. Feasible improvement

A resource should not be degraded to the extent that it is not worth any organization. The more productive the resources, the greater is the expected net benefits of organizing any rules and the higher is the probability of the establishment of rules. To represent feasible improvements in enclosures in Tigray, we used two ordinal variables: the "age group of enclosure" (a = years since establishment) and the "agroecological zone of enclosure." Three numerical scores were calculated for each variable. Enclosures are grouped into three age classes: $a \leq 10$ years (new enclosures), $10 < a \leq 15$

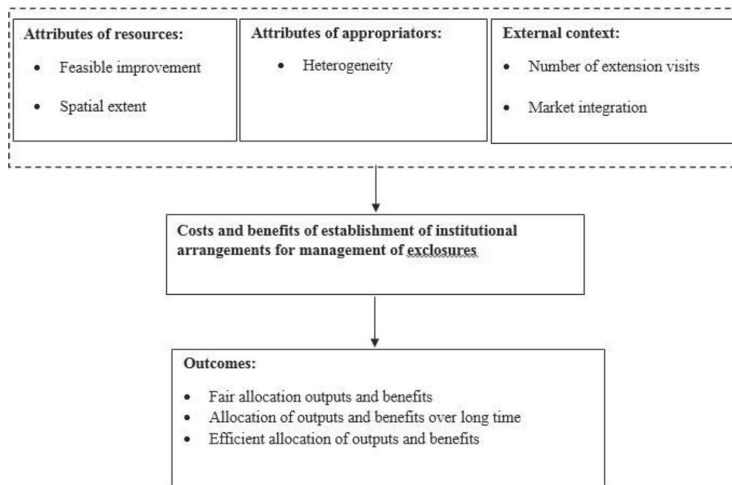


Fig. 1. Determinants of allocation of products from exclosures (authors' construction, based on Agrawal, 2001; Baland and Platteau, 1996; Ostrom, 1990; Wade, 1988).

Table 1
Definition of explanatory variables.

Variable	Definition	References
Attributes of resources (data sources: Agricultural and rural development offices in the Tigray Region; the base line survey conducted by the Department of Land Resources Management and Environmental Protection at Mekelle University (NORHED, 2014))		
Age group of exclosures	Ordinal with code 1 for new; code 2 for middle-aged, and code 3 for old exclosures	(Yayneshet et al., 2009)
Number of households per hectare of exclosure	The number of households holding access rights to exclosures divided by the area of exclosure (HH:ha ratio)	(Soltani et al., 2012)
Agroecological zone of exclosure	Ordinal with 1 = lowland, 2 = midland, and 3 = highland	(Kamanga et al., 2009)
Distance between the household's residence to the exclosure (km)	Distance from the household residence to the exclosure in kilometers	(Abebaw et al., 2012; Adhikari et al., 2004; Asfaw et al., 2013; Mamo et al., 2007; Mcelwee, 2008; Soltani et al., 2012)
Attributes of appropriators (data source: household questionnaire)		
Gender of household head	Dummy variable with code 1 for male-headed household, otherwise code 0	(Adhikari et al., 2004; Babulo et al., 2008; Fikir et al., 2016; Lepetu et al., 2010)
Age of household head	Age of the household head in years	(Appiah et al., 2009; Babulo et al., 2008; Fikir et al., 2016; Lepetu et al., 2010)
Education of household head	Number of years of schooling completed by the household head	(Appiah et al., 2009; Babulo et al., 2008; Lepetu et al., 2010; Soltani et al., 2014; Thondhlana and Muchapondwa, 2014)
Household's cropland size	Size of household's own land for agriculture in hectares	(Adhikari et al., 2004; Aung et al., 2015; Babulo et al., 2008; Mamo et al., 2007; Kamanga et al., 2009; Yemiru et al., 2010)
Household's herd size	Number of tropical livestock units (TLUs) owned by household calculated as 1 goat = 0.13 TLU; 1 sheep = 0.13 TLU; 1 chicken = 0.013 TLU; 1 cow = 1 TLU; 1 ox = 1 TLU (Storck et al., 1991)	(Adhikari et al., 2004; Aung et al., 2015; Fikir et al., 2016; Soltani et al., 2012; Yemiru et al., 2010)
Household's level of training in exclosure management	Dummy variable with code 1 if household head or any other members had participated in exclosure management programs, otherwise code 0	(Soltani et al., 2014)
Household's male labor force	Number of male household members between the age of 15 and 64 years	(Mamo et al., 2007)
Household's duty level	Dummy variables	
No duty	code 1 if household did not participate in any conservation activities otherwise code 0	
Low assigned duty	code 1 if engaged in one activity, otherwise code 0	
High assigned duty	code 1 if involved in at least two conservation activities, otherwise code 0	
External context		
Distance between household's residence and the district market (km)	Distance from household residence to the district market in kilometers	(Fikir et al., 2016; Mamo et al., 2007; Yemiru et al., 2010)
Number of extension visits	Number of extension visits made by the natural resource management development agent during 1 year (year 2014)	(Fikir et al., 2016)

years (middle-age enclosures), and a >15 years (old enclosures). Previous studies have reported positive correlations between the age of enclosures and vegetation cover and density (e.g., Descheemaeker et al., 2006; Yaynesht et al., 2009). The longer the time since the establishment of an enclosure, the less degraded the enclosure will be and, consequently, the higher is the probability that institutional arrangements will be established to avoid the problem of free riders. In Tigray, agroecological zones comprise three classes based on altitude: lowland, located less than 1500 m above sea level (m a.s.l.); midland, 1500–2300 m a.s.l.; and highland, 2300–3200 m a.s.l. (NORHED, 2014). Enclosures located in highland and midland receive higher amounts of precipitation than those located in lowlands (Mengistu, 2006) and are therefore considered relatively more productive.

2.1.2. Spatial extent

Spatial extent refers to the accessibility of a resource. The resource should be accessible for appropriators given the transportation and communication technology in use (Ostrom, 1990). The “distance between the appropriators’ residence and enclosure,” the “size of the enclosure,” and the “number of appropriators” are variables that represent the spatial extent of an enclosure. Distances between forests and local communities have been used in analyses of forest dependence (e.g., Abebaw et al., 2012; Adhikari et al., 2004; Asfaw et al., 2013; Mamo et al., 2007; Mcelwee, 2008; Soltani et al., 2012). Households living near forest resources are most likely to engage in forest harvesting activities and are more dependent on forest resources. Further, it has been documented that the greater the distance between forest resources and settlements, the better are the qualities of forest resources (Ahrends et al., 2010; Ndangalasi et al., 2007). Therefore, the distances between enclosures and villagers can have two different impacts on the management of the enclosures. First, the greater the distance between an enclosure and its adjacent villages, the lower is the expected net economic values of outputs from the enclosure (due to high transportation costs) and the lower is the probability that villagers will organize themselves to create rules. Second, the greater the distances between enclosures and appropriators, the less degraded are the enclosures and the higher is the probability that institutional arrangements will be established. Earlier research has also showed the ambiguous impacts of the size of a resource on collective resource management: Small resources are likely to be managed better (Wade, 1988). Although the size of resources affects institutional arrangements for common-pool resources, the effects of size can be modified by the state of other variables, especially the number of appropriators. Some scholars have reported that small groups of appropriators characterized communities with successful resource management (Baland and Platteau, 1996; Lam, 1998; Libecap, 1994; Pomeroy et al., 2001), while others have found contrary results (e.g., Agrawal and Goyal, 2001; Poteete and Ostrom, 2002; Vedeld, 2000). For example, Agrawal and Goyal (2001) found that moderately sized groups are more successful in the management of common-pool resources because they have more labor to undertake the level of monitoring needed to protect forest resources. Lam (1998) did not find any significant relationship between the number of users and the collective actions. In our analysis, the variable “number of households per hectare of enclosure” was used to represent a combination of the size of an enclosure and the number of appropriators. The variable was calculated by dividing the number of households with access rights by the area of an enclosure in hectares (HH: ha ratio).

2.2. Attributes of appropriators

The heterogeneity of appropriators influences their ability to

self-organize (Ostrom, 1990; Poteete and Ostrom, 2004). It is expected that the heterogeneity of appropriators will influence the level of trust and the degree of divergence in interests (Poteete and Ostrom, 2004). The self-governance will be enhanced if the appropriators have similar interests and can trust each other (Ostrom, 2005). Heterogeneity influences the outcome of collective action, as documented in previous studies (Baland and Platteau, 1996; Vedeld, 2000). Similar to the size of a resource and the number of appropriators, heterogeneity is a highly contested variable. Many scholars have concluded that homogenous communities can organize themselves effectively (e.g., Baland and Platteau, 1996). In addition, it is believed that fair allocation of benefits and outputs from enclosures can be more easily obtained in more homogenous communities. By contrast, in more heterogeneous communities, the poorest appropriators can be severely affected by any rules that limit their access rights (Reddy and Chakravarty, 1999), whereas the wealthier appropriators may receive the larger shares of outputs (Adhikari, 2005). Appropriators can vary based on their cultural backgrounds, endowments, and interests (Baland and Platteau, 1996). To consider heterogeneity, we included “gender of household head,” “age of household head,” “education of household head,” “household’s cropland area,” “household’s herd size,” “household’s level of training in enclosure management,” and “household’s male labor force” as the second set of variables. The crucial aspect of heterogeneity occurs if the rules for distributing the outputs from enclosures conflict with the rules for assigning the costs of maintenance of the resources (Ostrom, 2005). If community members spend more time and funds on sustaining the resources but receive lower shares of outputs, the institutional arrangement will risk disintegration (Ostrom, 2005). The various levels of duties represent how the required efforts to protect an enclosure are distributed among its appropriators. These duties are the construction of stone bunds, soil bunds, and terraces to reduce runoff; digging pits; and planting seedlings. For the purpose of analysis, an ordinal variable named “household’s duty level” with three numerical score was calculated. The sampled households were divided into three categories, according to the level of their duties: Group 1 (no duty), a household not assigned to any of the duties; Group 2 (low assigned duty), a household having only one duty; and Group 3 (high assigned duty), a household assigned more than one duty.

2.3. External context

In addition to the above described variables, our analysis included a third set of variable named “external context” (Fig. 1). The cost–benefit ratios of harvesting outputs and hence the sustainable use of resources can be influenced by policies and legislation (Baland and Platteau, 1996; Wade, 1988), the sudden emergence of technological innovations (Agrawal, 2001; Baland and Platteau, 1996), and the increasing integration with markets (Agrawal, 2001). For our study, the external context was described by two variables: “distance between villagers’ residence and the district market” (Soltani et al., 2012) and “number of extension visits” (Fikir et al., 2016). The distance to market described marginality and villagers’ market integration. It has been assumed that compared with other households, those in remote locations and living farther from markets are more dependent on outputs from common-pool resources for a major portion of their livelihoods, and therefore, they are more motivated to establish institutional arrangements for the management of common-pool resources (Agrawal, 2001; Ostrom, 2005). Extension services provide new information to local communities and can help them to adapt better and quicker to upcoming changes. In Tigray, these services are provided by development agents who are employed by the

district office of the Tigray Bureau of Agriculture and Rural Development, and they include information on the construction of stone bunds, soil bunds, and terraces to reduce runoff; digging pits; planting seedlings; and various plowing methods. The variable “number of extension visits” was defined as the number of extension visits made by a development agent during one year (year 2014).

3. Methodology

3.1. Study area

The Tigray Region is located in northern Ethiopia and is bordered by Eritrea to the north, the Afar Region to the east, the Amhara Region to the south, and Sudan to the west. The land uses in Tigray are cropland, grazing land, exclosures (of different ages), forests, and church forests (protected sacred forests). The grazing lands are considered degraded (Nyssen et al., 2004; Taddese, 2001; Teketay, 2001). In some cases, the overgrazing has removed most of

the vegetation, thus leading to erosion. In protected exclosures, a remarkable improvement in vegetation recovery has been observed (e.g., Descheemaeker et al., 2006; Yaynesht et al., 2009). The church forests are characterized by high vegetation density and tall trees (Aerts et al., 2006; Berhane et al., 2013).

We studied nine exclosures located in five districts (*Wereda*, in local terminology, an administrative unit comprising a number of villages) and adjacent to nine villages (*Tabia*, in local terminology, smallest administration unit, consisting of two or more sub villages) (Fig. 2). The exclosures were selected on the basis of the agroecological zones and number of years since their establishment. The main characteristics of the selected exclosures are presented in Table 2. The exclosures are characterized by their mountainous plateau location and semi-arid climate, with an average temperature of 21.6 °C and an average rainfall in the range 400–700 mm. Most of the rainfall occurs during the long rainy season, from late June to early September. The dry season lasts from October to February but sometimes lasts until May or June. With the exception of Adi Gedaw, the selected exclosures are established

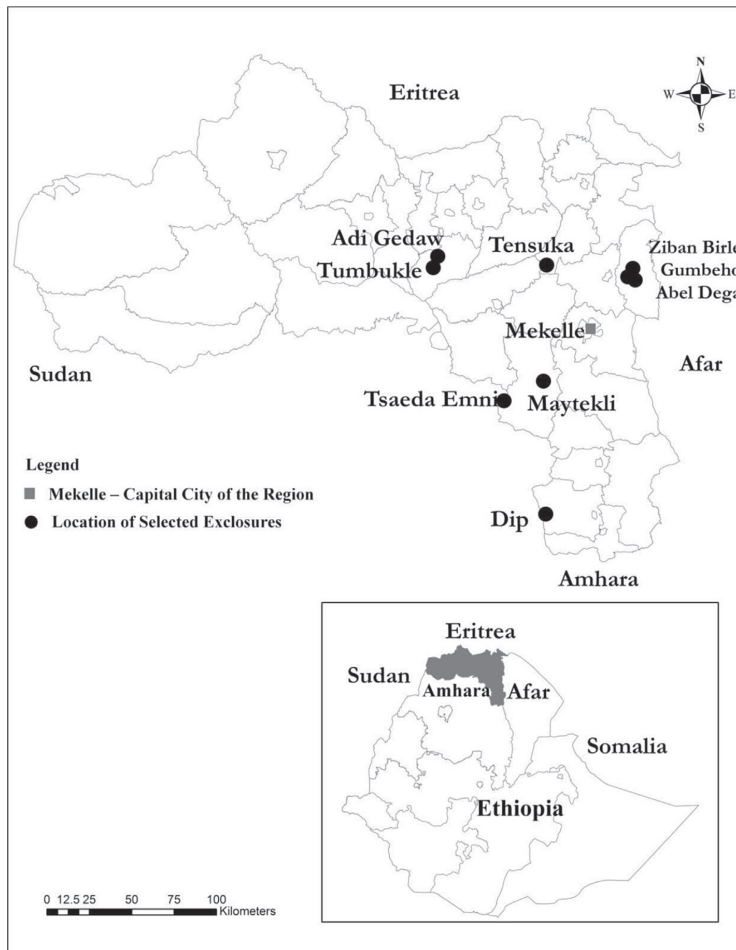


Fig. 2. Locations of the selected exclosures in Ethiopia and the Tigray Region.

Table 2
List of selected enclosures by age group, agroecological zone, and number of sample households.

No.	Name of enclosure	Age	Agro-ecological zone	Number of households		Distance to Mekelle (km)	Administrative level		Area (ha)
				Population	Sample size		Village	District	
1	Ziban Brile	8	H	55	15	75	Micheal Emba	Atsbi	220
2	Mayteki	15	H	104	27	58	Mayteki	Samre	111
3	Gumbeho	20	H	216	58	75	Kaleamin	Atsbi	350
4	Tumbukle	10	M	295	79	285	Seka-Kisadmomona	Naeder Adet	177
5	Adi Gedaw	15	M	193	52	285	Debre Genet	Naeder Adet	234
6	Abel Dega	20	M	328	88	75	Hayelom	Atsbi	80
7	Tensuka	9	L	52	14	104	Koraro	Hawzen	168
8	Tsaeda Emni	15	L	201	54	58	Nebar Hadnet	Samre	210
9	Dip	20	L	219	59	150	Zata	Ofla	1254
Sum				1663	446				2804

Notes: Age – years since establishment; Agro-ecological zones – H (highland), M (midland), L (lowland).

on degraded grazing lands, where villagers formerly collected firewood and allowed their livestock to graze; Adi Gedaw enclosure was established on a cultivated land. The vegetation type in the enclosures varies: The new and middle-aged enclosures are dominated by grass and bush species, whereas in old enclosures, the dominant plant species include *Acacia polyacantha*, *Acacia asak*, *Acacia etbaica*, and *Eucalyptus* spp. The district office of Tigray Bureau of Agriculture and Rural Development hires and pays guards to protect the enclosures in the studied sites, with the exception of Mayteki, where enclosure guards are paid by a local NGO, Relief Society of Tigray (REST). According to local bylaws at the study sites, only the collection of grass and fruits is permitted. The time for grass collection is September, when villagers are often faced with feed shortages for their livestock. The development agents employed by the district office of the Tigray Bureau of Agriculture and Rural Development announce the time and duration of grass collection. The distribution of the harvested grass among the households varies between the enclosures and is based on the traditional regulations in the bylaws.

Each enclosure belongs to only one village, but one village may have one or more enclosures. However, within a village, a household has access rights to only one enclosure, on the basis of proximity. The economic activities in the villages adjacent to the nine enclosures included crop production, rearing cattle, livestock production, various non-farm activities, and the collection of outputs such as grass for animal fodder, grass for thatching, and wild fruits. Grass for animal fodder and grass for thatching are the main products obtained from the enclosures in the study sites. Only the households from Tensuka enclosure had access to wild fruit (the fruits of *Ziziphus* trees locally known as *Gaba* fruits) in addition to grass.

3.2. Data collection

Most of the required information was collected using a questionnaire survey administered to households. The questionnaire was pre-tested and modified. Lists of households living in villages adjacent to the nine enclosures and holding access rights were obtained from the Tigray Bureau of Agricultural and Rural Development's village offices. The sample size was estimated as 425 households by using Cochran's formula for stratified sampling with optimum allocation (Cochran, 1977). To avoid problems of missing data, the sample size was increased to 450. Households were chosen by stratified random sampling (Cochran, 1977), with nine villages as strata. The sample size of each village was determined by proportional sampling. Four questionnaires with incomplete information were excluded, and questionnaires from 446 sample households were used for the analysis. The household survey was

held from October to November 2015. Household surveys provided information on key socioeconomic elements, such as household composition, education, asset ownership, market prices of different products, and participation in training programs. All outputs (e.g., grass and wild fruit) obtained from enclosures were recorded in local units of measurement and converted to kilograms. The distances from household's residence to the enclosure and the district market were measured using GPS during the household survey. Information on the enclosures, such as their area, agro-ecological zone, and age, was obtained from the results of the baseline survey conducted by the Department of Land Resources Management and Environmental Protection at Mekelle University (NORHED, 2014).

3.3. Data analysis

3.3.1. Inequality measures

Our first research problem was to assess how the values of outputs from enclosures distributed among the households. There are different inequality indices (Fields, 2001), and the most common index used in studies of forest and resource dependence is the Gini coefficient (Fisher, 2004; Jodha, 1986; Reddy and Chakravarty, 1999; Soltani et al., 2014). The Gini coefficient varies between zero and one, with higher values representing greater inequality. In our study, the value of outputs from enclosure per adult equivalent in each household was used to calculate the Gini coefficients. The conversion scales for the adult equivalent were adopted from Dercon and Krishnan (1998). For each enclosure accessed by the households, there were three components: grass for livestock, grass for thatching, and wild fruits. The quantity of each component was multiplied by its market price. Villagers in the selected study sites have access to district market, and the market prices were obtained from households involved in the sale of the outputs. These market prices were also triangulated and double-checked by market price figures obtained by interviewing knowledgeable local people purposively selected on the basis of their market experiences.

3.3.2. Probit model

The second research problem was to identify the attributes of the enclosures, the attributes of the appropriators, and the external context that influenced the probability of a household with access rights collecting any outputs from the adjacent enclosure (dependent variable). The probit regression model was applied because the dependent variable was a dummy (zero or one). The formula for binomial probit model is as follows (Greene, 2012):

$$Y_i^* = X_i' \beta_i + \varepsilon_i \quad \varepsilon_i \sim [0,1]$$

Table 3

Gini coefficients of output value distribution among households on an adult-equivalent basis for nine enclosures in the Tigray Region.

Name of enclosure	Gini coefficient	Share of output value in percent	
		Lowest income quintile	Highest income quintile
Ziban Birle	0.5776	0	64
Maytekli	0.4410	0	49
Gumbeho	0.4369	0	48
Tumbukle	0.6469	0	68
Adi Gedaw	0.6230	0	62
Abel Dega	0.3972	4	58
Tensuka	0.5610	0	58
Tsaeda Emni	0.4584	0	44
Dip	0.4120	0	41

$$y_i = \begin{cases} 1, & \text{if } y_i^* \geq 0 \\ 0, & \text{if } y_i^* < 0 \end{cases}$$

where y_i^* represents a latent variable (variable that is not directly observable, here it is the amount of outputs collected from the enclosures); y_i represents the choice that is observed by the researcher. If a household had obtained any outputs (i.e., grass or fruits) from an enclosure, it was classified as code 1, otherwise as code 0. x_i represents a vector of independent variables listed in Table 1, and β_i represents a vector of unknown parameters.

Probit and logit models are commonly used when the response variable has dummy nature. However, the probit model was used because the probability distribution of the response variable is assumed to have a standard normal cumulative distribution function (Wooldridge, 2015).

3.3.3. Multiple linear regression

Multiple linear regression was applied to assess the impact of the attributes of resources, the attributes of the appropriators, and the external context on the share of the value of outputs from enclosures. The dependent variable was defined as a household's share of economic value of outputs from enclosures and calculated as $\frac{tb_{ij}}{T_{Bj}}$, where, tb_{ij} is the total economic value of outputs from enclosure j obtained by household i , and T_{Bj} is the sum of all economic values of outputs from enclosure j captured by all the sampled households. The independent variables are listed in Table 1. R version 3.2.5 statistical software was used to analyze both the probit and multiple linear regression models (Team, 2013).

4. Results

4.1. Inequality measure

The Gini coefficients for the study sites are listed in Table 3. Four out of the nine enclosures had Gini coefficients larger than 0.5, while the remaining five enclosures had a fairly egalitarian distribution (the Gini coefficient varied between 0.39 and 0.45). The share of the value of outputs from enclosures for households in the lowest income quintile was equal to zero (except for that in the Abel Dega enclosure), while the share of value of outputs obtained by the highest income quintiles varied from 41% to 58%.

4.2. Probit model

The probability that a household with access rights obtained any output from enclosures (response variable) was significantly and positively influenced by "age group of enclosure," "number of

households per ha of enclosure," "agroecological zone of the enclosure," "household's herd size," "household's level of training in enclosure management," "number of extension visits," and "distance between household's residence and the district market." "Distance between household's residence and the enclosure" had negative impacts on the response variable (Table 4). The explanatory variable "high assigned duty" increased the probability that a household obtained any output from the enclosure.

4.3. Multiple linear regression

The model results revealed that seven variables significantly influenced the response variable. Variables "agroecological zone of enclosure," "household's herd size," "distance between household's residence and the district market," and "number of extension visits" had a positive influence, while "age group of enclosure," "number of households per ha of enclosure," and "distance between household's residence and the enclosure" had a negative influence on the share of outputs from enclosures (Table 4).

Table 4

Results of probit regression and multiple linear regression model.

Explanatory variables	Probit regression Coef. (SE)	Multiple linear regression Coef. (SE)
Intercept	-3.7881*** (0.7459)	-0.0126 (0.0129)
Resource attributes		
Age group of enclosure	0.4382*** (0.1221)	-0.0039* (0.0022)
Number of households per hectare of enclosure	0.0812** (0.0403)	-0.0032*** (0.0007)
Agroecological zone of enclosure	0.8275*** (0.2019)	0.0165*** (0.0036)
Distance between household's residence and the enclosure (km)	-0.2012* (0.1065)	-0.0040** (0.0020)
Appropriator attributes		
Gender of household head	0.0360 (0.1956)	0.0040 (0.0037)
Age of household head	-0.0075 (0.0057)	-0.0001 (0.0001)
Education of household head	-0.0194 (0.0304)	-0.0001 (0.0005)
Household's cropland area	0.1141 (0.1405)	0.0007 (0.0024)
Household's herd size	0.2032*** (0.0441)	0.0036*** (0.0006)
Household's level of training in enclosure management	0.6021*** (0.2319)	0.0030 (0.0035)
Household's male labor force	0.0952 (0.0854)	0.0011 (0.0015)
Low assigned duty	0.6882 (0.4581)	0.0044 (0.0070)
High assigned duty	0.3730* (0.2152)	-0.00004 (0.0039)
External context		
Distance between household's residence and the district market (km)	0.0638*** (0.0156)	0.0016*** (0.0003)
Number of extension visits	0.1038* (0.0549)	0.0021** (0.0009)
	N = 429	N = 429
	LR chi2(2) = 118.08	R-Sq = 0.269
	Prob > chi2 = 0.000	R-Sq(adj) = 0.243
	Log likelihood = -193.30	F = 10.19
	Pseudo R2 = 0.2339	P-value = 0.000

Note: SE = standard error; *** significant at 1%; ** significant at 5%; * significant at 10%.

5. Discussion and conclusions

With regard to the first research question, the results indicate that the distribution of value of outputs from exclosures among different households in the study sites varied from fairly equal to quite unequal, depending on the exclosures' attributes, the characteristics of adjacent households, and the external context. Regardless of the magnitude of equity measure (Gini coefficient), households in the lowest income quintile do not obtain any value from outputs from exclosures (with the exception of the Abel Dega exclosure), while the share of outputs obtained by the highest income quintile was high (Table 3). This is because grass is the major output from exclosures, and consequently, wealthier households with larger herds gained more economic advantages. However, the grass was divided equally among households with access to Abel Dega exclosure. Although the primary aim of establishing the exclosures was to improve ecological functions, our findings might raise concerns among those interested in pro-poor measures and the social aspects of sustainable resources management. Most scholars have shown that common-pool resources such as forests contribute relatively more to the income of poor households than wealthier ones (e.g. Reddy and Chakravarty, 1999; Babulo et al., 2009; Cavendish, 2000; Fu et al., 2009; Kamanga et al., 2009; Mamo et al., 2007; Quang and Anh, 2006; Shackleton and Shackleton, 2006; Shackleton et al., 2007; Vedeld et al., 2007). However, a few studies have found different results. For example, Fisher (2004) classified forest activities into high return activities (such as harvesting of timber) and low return activities (such as firewood collection). She found that poor households are more dependent on low return forest activities, while high return forest activities are more important for wealthier households. Narain et al. (2008) and Soltani et al. (2014) found a positive correlation between total income and dependence on outputs such as fodder but a negative correlation between income and dependence on outputs such as firewood.

5.1. Attributes of resources

The age group of exclosure and number of households per hectare of exclosure had similar impacts on the probability of a household collecting any outputs from exclosures (second research question, probit regression model, Table 4) and on the share of outputs (third research question, multiple linear regression model, Table 4). In exclosures protected for longer periods or that were located closer to more highly populated villages, the results showed a higher probability that households would collect some outputs from exclosures. At the same time, the outputs were more evenly distributed among households in old exclosures. In other words, in old exclosures, the values of outputs were distributed more equally than in middle-aged and newly established ones.

When exclosures are protected for longer periods, the ecosystem function will be improved. This provides incentives for local communities to follow any bylaws that may facilitate fairer allocation of products. In degraded resources (newly established exclosures), the transaction costs of establishing rules may be higher than those for economic and ecological gains. Therefore, households would be less motivated to organize themselves. In addition, in old exclosures, households have had time to acquire some skills and experience of organization, which enhances the likelihood of the establishment and implementation of rules leading to a more even allocation of values of outputs from exclosures.

Similarly, a more even distribution of values of outputs from exclosures was observed in more populated villages (more households per ha of exclosure). As can be expected from general economic theory, in sparsely populated villages, increasing the

population of appropriators leads to increasing demands for natural resources and environmental services. In turn, this might lead to environmental changes, such as resource degradation (Dirzo and Raven, 2003; Hardin, 1968). Scholars who have studied collective actions have concluded that smaller groups are more successful in organizing themselves and avoiding the problem of free riders (Cernea and Mundial, 1989; Olson, 1965). Moreover, the results of game-theoretic analysis have indicated that cooperative strategies are more likely to be chosen in smaller groups (Baland and Platteau, 1996). However, some scholars have found that small groups have difficulties in covering the cost of the establishment and implementation of rules (Agrawal, 1996). Households in sparsely populated villages may face difficulties in undertaking the required monitoring to protect the exclosures. However, the amount of duties divided among the appropriators would decrease if the number of participants increase, and this would definitely decrease the involvement cost for appropriators. In addition, outputs such as grass from exclosures adjacent to the more populated villages would become more valuable and scarce. Thus, self-organizing would be more likely to occur because the villagers would experience substantial shortages of grass. This might encourage households to collect more grass. However, the share of collected grass would decrease as the number of appropriators increases.

Long distances between exclosures and settlements increase the amount of labor needed to collect grass. Therefore, households living farther from exclosures are less likely to collect grass and their share of outputs will be smaller. This finding is also supported by economic theory: The distance from households to resource location is positively correlated with the opportunity costs of labor and the required time to collect products (e.g., Amacher et al., 1996; Köhlin et al., 2001; Robinson and Lokina, 2011). Previous studies have also considered the impact of distance on the quality of resources. Forest quality is more often lower near settlements and population centers (e.g., Ahrends et al., 2010; Ndangalasi et al., 2007). Resources located far from habitation would probably be harvested at longer intervals, when biomass density has grown higher, whereas resources close to settlements might be harvested at a lower biomass density at shorter intervals (von Gadow et al., 2002).

5.2. Attributes of households

With regard to the second research question, larger herd sizes increase the probability that a household will collect any outputs from exclosures. Additionally, the share of the value of outputs from exclosures increases as herd size increases (third research question). This finding is explained by two facts: (1) the main product gathered in the studied sites was an important input for livestock husbandry and (2) households in the study sites were not well integrated into markets. Therefore, the most collected grass from exclosures was not sold at the market but was rather used to feed livestock. In other words, the establishment of exclosures benefits wealthier households more, because they own larger herds. Similarly, other researchers have observed that the value of outputs such as fodder often contributes more to the total income of rich households (e.g., Narain et al., 2008; Soltani et al., 2014).

5.3. External context

Geographical attributes such as distance from settlements to markets and from settlements to resources influence resource accessibility and consequently resource protection. Remoteness is a very important aspect of the use of a resource and is the measured distance to markets and cities. Households living farther from markets have less access to job opportunities for income generation

and lower opportunity costs for labor. Therefore, to respond to the second research question, they are more likely to collect outputs from enclosures, as shown by the results of the probit model (Table 4) and more likely to receive a larger share of outputs, as shown by the multiple linear regression model (third research question). This finding is similar to those from Ethiopia (Mamo et al., 2007), other countries in Africa (Fisher, 2004), and Asia (Adhikari et al., 2004; Narain et al., 2008; Soltani et al., 2012). Local communities' high level of dependence on common-pool resources is an influential factor in emerging institutional arrangements for the management of common-pool resources (Baland and Platteau, 1996; Ostrom, 1990; Wade, 1988). If appropriators obtain a major part of their livelihoods from a given resource, they will be more motivated to organize a self-governing system (Ostrom, 2005). This may explain the positive impact of distance to market on the share of outputs from enclosures. The households living in remote locations relied more heavily on the outputs from the enclosures. This enhanced the probability of institutional arrangements to manage enclosures. Additionally, scholars have shown that integration into the market has an adverse effect on the management of common-pool resources (Agrawal, 2001; Chomitz and Gray, 1996). They have argued that as local communities connect to larger markets, the subsistence appropriators are likely to increase harvest levels because the market integration brings new opportunities to exploit resources for cash income (Colchester, 1994). However, in Tigray, we observed that the access to market reduced households' share of outputs. This indicates that the grass or wild fruits collected from enclosures were intended for subsistence rather than for sale in markets.

Our results did not show whether the levels of duty could influence the share of outputs (Table 4). In other words, those who contributed time and efforts did not receive any extra advantages and might have perceived the bylaws as unfair. In long term, this might lead to the disintegration of the whole distribution system and to resource degradation.

Our findings provide important insights for local policymakers when considering the expansion of existing enclosure areas. The information might lead to more sustainable management of enclosures, considering that they have not only ecological aspects but also economic aspects. It might be useful in the future to look for ways of managing enclosures that are more "pro-poor". Harvesting values that are directly useful to poor households with none or few domestic animals may be an option. Most harvested grass is used as fodder for domestic animals, and therefore, better-off households benefit the most. Alternatively, other outputs such as mushrooms, honey, or medicinal plants from enclosures may be more useful to poor households. An idea for future research could be to investigate the feasibility of trading grass in the practical management of enclosures in Tigray. In this case, equal quotas of grass to be harvested by each household could be fixed, and the quotas could be tradable; in this way, households with small herds could sell their quotas (or parts thereof) to households with larger herds.

One lesson from our study of enclosures in Tigray that may be useful to resource managers in many other places is that a measure taken to conserve or restore natural environments also has social and economic implications. It is important to reflect on such implications at the start of a project, even if the collection of outputs could not start for several years. Most local communities will be better motivated to protect the environment if they can see some valuable outputs for themselves resulting from the measures taken. However, people's motivation will probably be higher and free riders fewer if values are distributed equitably. If values are accumulated by a few persons who are already well off, projects may fail, even if their environmental impacts are positive. Ultimately, it

may be argued that too much attention to small income differences between people in rural areas is not worthwhile when wealth and income differences between rural and urban families are much more pronounced (Belachew, 2014).

The study was carried out in nine enclosures. This, however, raises questions regarding the generalization of the findings and making policy recommendations for the Tigray region as a whole. A larger number of enclosures covering more of Tigray could have resulted in more variation and also permitted better testing of resource attributes and external context variables. Although studying only nine enclosures may pose some challenges in the generalization of the results, it has certainly several advantages such as studying the selected enclosures in more detail. When designing the study, the characteristics of enclosures (e.g., agro-ecological zones, years since establishment) were considered to find enclosures that are representative of Tigray. The analysis in this study made most use of quantitative methods, while more focus on qualitative methods such as observations and group discussions could have revealed the effects of free riders and given more insight on illegal harvesting.

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References

- Abeba, D., Kassa, H., Kassie, G.T., Lemenih, M., Campbell, B., Teka, W., 2012. Dry forest based livelihoods in resettlement areas of Northwestern Ethiopia. *Forest Policy Econ.* 20, 72–77.
- Adhikari, B., 2005. Poverty, property rights and collective action: understanding the distributive aspects of common property resource management. *Environ. Dev. Econ.* 10 (01), 7–31.
- Adhikari, B., Di Falco, S., Lovett, J.C., 2004. Household characteristics and forest dependency: evidence from common property forest management in Nepal. *Ecol. Econ.* 48 (2), 245–257.
- Aerts, R., Nyssen, J., Haile, M., 2009. On the difference between "enclosures" and "enclosures" in ecology and the environment. *J. Arid Environ.* 73 (8), 762–763.
- Aerts, R., Van Overtveldt, K., Haile, M., Hermy, M., Deckers, J., Muys, B., 2006. Species composition and diversity of small Afromontane forest fragments in northern Ethiopia. *Plant. Ecol.* 187 (1), 127–142.
- Agrawal, A., 1996. Group Size and Successful Collective Action: a Case Study of Forest Management Institutions in the Indian Himalayas. *International Forestry Resources and Institutions Research Program*, Indiana University.
- Agrawal, A., 2001. Common property institutions and sustainable governance of resources. *World. Dev.* 29 (10), 1649–1672.
- Agrawal, A., Goyal, S., 2001. Group size and collective action third-party monitoring in common-pool resources. *Comp. Polit. Stud.* 34 (1), 63–93.
- Ahrends, A., Burgess, N.D., Milledge, S.A.H., Bulling, M.T., Fisher, B., Smart, J.C.R., Clarke, G.P., Mhoro, B.E., Lewis, S.L., 2010. Predictable waves of sequential forest degradation and biodiversity loss spreading from an African city. *Proc. Natl. Acad. Sci. U. S. A.* 107 (33), 14556–14561.
- Amacher, G.S., Hyde, W.F., Kanel, K.R., 1996. Household fuelwood demand and supply in Nepal's tarai and mid-hills: choice between cash outlays and labor opportunity. *World. Dev.* 24 (11), 1725–1736.
- Amede, T., Kassa, H., Zeleke, G., Shiferaw, A., Kismu, S., Teshome, M., 2007. Working with communities and building local institutions for sustainable land management in the Ethiopian highlands. *Mt. Res. Dev.* 27 (1), 15–19.
- Appiah, M., Blay, D., Damyag, L., Dwomoh, F.K., Pappinen, A., Luukkainen, O., 2009. Dependence on forest resources and tropical deforestation in Ghana. *Environ. Dev. Sustain.* 11 (3), 471–487.
- Asfaw, A., Lemenih, M., Kassa, H., Ewnetu, Z., 2013. Importance, determinants and gender dimensions of forest income in eastern highlands of Ethiopia: the case of communities around Jelo Afromontane forest. *Forest Policy Econ.* 28, 1–7.
- Aung, P.S., Adam, Y.O., Pretzsch, J., Peters, R., 2015. Distribution of forest income among rural households: a case study from Natma Taung national park, Myanmar. *For. Trees. Livelihoods* 24 (3), 190–201.
- Babulo, B., Muys, B., Nega, F., Tollens, E., Nyssen, J., Deckers, J., Mathijs, E., 2008. Household livelihood strategies and forest dependence in the highlands of

- Tigray, Northern Ethiopia. *Agr. Syst.* 98 (2), 147–155.
- Babulo, B., Muys, B., Nega, F., Tollens, E., Nyssen, J., Deckers, J., Mathijs, E., 2009. The economic contribution of forest resource use to rural livelihoods in Tigray, Northern Ethiopia. *Forest. Policy. Econ.* 11 (2), 109–117.
- Baland, J.M., Platteau, J.P., 1996. *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?* Clarendon Press, Oxford.
- Baumol, W.J., 1952. *Welfare Economics and the Theory of the State*. The London School of Economics and Political Science: Springer US, London.
- Belachew, A., 2014. Disparities in Rural and Urban Incomes in Ethiopia: 1981–2011. unpublished.
- Berhane, A., Totland, Ø., Moe, S.R., 2013. Woody plant assemblages in isolated forest patches in a semi-arid agricultural matrix. *Biodivers. Conserv.* 22 (11), 2519–2535.
- Cavendish, W., 2000. Empirical regularities in the poverty-environment relationship of rural households: evidence from Zimbabwe. *World. Dev.* 28 (11), 1979–2003.
- Cavendish, W., 2002. Quantitative methods for estimating the economic value of resource use to rural households. In: Campbell, M.B., Luckert, K.M. (Eds.), *Uncovering the Hidden Harvest: Valuation Methods for Woodland and Forest Resources*. Earthscan Publications Ltd., London.
- Cernea, M.M., Mundial, B., 1989. *User Groups as Producers in Participatory Afforestation Strategies*. World Bank, Washington DC, USA.
- Chidumayo, E.N., Marunda, C., 2010. Dry forests and woodlands in sub-Saharan Africa context and challenges. In: Chidumayo, E.N., Gumbo, D.J. (Eds.), *The Dry Forests and Woodlands of Africa*. Earthscan, London.
- Chomitz, K.M., Gray, D.A., 1996. Roads, land use, and deforestation: a spatial model applied to Belize. *World Bank Econ. Rev.* 10 (3), 487–512.
- Clark, C.M.A., 2003. Promoting economic equity: the basic income approach. In: Tool, M.R., Bush, P.D. (Eds.), *Institutional Analysis and Economic Policy*. Springer US, Boston, MA.
- Cochran, W.G., 1977. *Sampling Techniques*, third ed. Wiley, Oxford, England. 428 pp.
- Colchester, M., 1994. Sustaining the forests: the community-based approach in south and south-east Asia. *Dev. Change*. 25 (1), 69–100.
- Dercon, S., Krishnan, P., 1998. *Changes in Poverty in Rural Ethiopia 1989–1995: Measurement, Robustness Tests and Decomposition*. Centre for the Study of African Economies, Institute of Economics and Statistics, University of Oxford.
- Descheemaeker, K., Nyssen, J., Poesen, J., Haile, M., Muys, B., Raes, D., Moeyersons, J., Deckers, J., 2006. Soil and water conservation through forest restoration in enclosures of the Tigray highlands. *J. Dryl.* 1 (2), 118–133.
- Dirzo, R., Raven, P.H., 2003. Global state of biodiversity and loss. *Annu. Rev. Env. Resour.* 28 (1), 137–167.
- Fields, G.S., 2001. *Distribution and Development: a New Look at the Developing World*. Russel Sage Foundation & MIT Press, New York: Cambridge & London.
- Fikir, D., Tadesse, W., Gure, A., 2016. Economic contribution to local livelihoods and households dependency on dry land forest products in hammer district, Southeastern Ethiopia. *Int. J. For. Res.* 2016 (11).
- Fisher, M., 2004. Household welfare and forest dependence in Southern Malawi. *Environ. Dev. Econ.* 9 (2), 135–154.
- Fu, Y., Chen, J., Guo, H., Chen, A., Cui, J., Hu, H., 2009. The role of non-timber forest products during agroecosystem shift in Xishuang banna, southwestern China. *Forest. Policy. Econ.* 11 (1), 18–25.
- Gebremedhin, B., Pender, J., Tesfay, G., 2003. Community natural resource management: the case of woodlots in northern Ethiopia. *Environ. Dev. Econ.* 8 (01), 129–148.
- Greene, W.H., 2012. *Econometric Analysis*, seventh ed. Pearson Education International, New York. Prentice hall.
- Haileslassie, A., Priess, J., Veldkamp, E., Teketay, D., Lesschen, J.P., 2005. Assessment of soil nutrient depletion and its spatial variability on smallholders' mixed farming systems in Ethiopia using partial versus full nutrient balances. *Agr. Ecosyst. Environ.* 108 (1), 1–16.
- Hardin, G., 1968. The tragedy of the commons. *Science* 162, 1243–1247.
- Herweg, K., Stillhardt, B., 1999. The Variability of Soil Erosion in the Highlands of Ethiopia and Eritrea. Average and Extreme Erosion Patterns (Soil Conservation Research Programme, Research Report 42, University of Berne, Switzerland).
- Jodha, N.S., 1986. Common property resources and rural poor in dry regions of India. *Econ. Polit. Wkly.* 21 (27), 1169–1181.
- Kamanga, P., Vedeld, P., Sjaastad, E., 2009. Forest incomes and rural livelihoods in Chiradzulu District, Malawi. *Ecol. Econ.* 68 (3), 613–624.
- Konow, J., 1996. A positive theory of economic fairness. *J. Econ. Behav. Organ.* 31 (1), 13–35.
- Konow, J., 2001. Fair and square: the four sides of distributive justice. *J. Econ. Behav. Organ.* 46 (2), 137–164.
- Köhlin, C., Parks, P.J., Barbier, E.B., Burgess, J.C., 2001. Spatial variability and disincentives to harvest: deforestation and fuelwood collection in South Asia. *Land. Econ.* 77 (2), 206–218.
- Lam, W.F., 1998. *Governing Irrigation Systems in Nepal: Institutions, Infrastructure, and Collective Action*. Institute for Contemporary Studies Press, Oakland.
- Lepetu, J., Alavalapati, J., Nair, P., 2010. Forest dependency and its Implication for Protected Areas Management: a Case Study from Kasane Forest Reserve, Botswana.
- Leventhal, G.S., 1980. What should be done with equity theory? In: Gergen, K.J., Greenberg, M.S., Willis, R.H. (Eds.), *Social Exchange: Advances in Theory and Research*. Springer US, Boston, MA.
- Libecap, G.D., 1994. The conditions for successful collective action. *J. Theor. Polit.* 6 (4), 563–592.
- Mamo, G., Sjaastad, E., Vedeld, P., 2007. Economic dependence on forest resources: a case from Dendi District, Ethiopia. *Forest. Policy. Econ.* 9 (8), 916–927.
- Mcelwee, P.D., 2008. Forest environmental income in Vietnam: household socio-economic factors influencing forest use. *Environ. Conserv.* 35 (02), 147–159.
- McKean, M.A., 1992. Management of traditional common lands (Iraichi) in Japan. In: Bromley, D.W. (Ed.), *Making the Commons Work: Theory, Practice, and Policy*. San Francisco.
- Mekuria, W., Veldkamp, E., Haile, M., Nyssen, J., Muys, B., Gebrehiwot, K., 2007. Effectiveness of enclosures to restore degraded soils as a result of overgrazing in Tigray, Ethiopia. *J. Arid. Environ.* 69 (2), 270–284.
- Mekuria, W., Veldkamp, E., Tilahun, M., Olschewski, R., 2011. Economic valuation of land restoration: the case of enclosures established on communal grazing lands in Tigray, Ethiopia. *Land. Degrad. Dev.* 22 (3), 334–344.
- Mengistu, A., 2006. *Country Pasture/forage Resource Profiles*. Food and Agriculture Organization of the United Nations (FAO), Ethiopia.
- Narain, U., Gupta, S., van't Veld, K., 2008. Poverty and resource dependence in rural India. *Ecol. Econ.* 66 (1), 161–176.
- Ndangalasi, H.J., Bitariho, R., Dovie, D.B.K., 2007. Harvesting of non-timber forest products and implications for conservation in two montane forests of East Africa. *Biol. Conserv.* 134 (2), 242–250.
- Nkonya, E., Pender, J., Kato, E., 2008. Who knows, who cares? The determinants of enactment, awareness, and compliance with community Natural Resource Management regulations in Uganda. *Environ. Dev. Econ.* 13 (1), 79–101.
- NORHED, 2014. *Summary Report on Reconnaissance Survey to Select and Study the Enclosures in Tigray-prepared for Project Titled "Steps towards Sustainable Forest Management with the Local Communities in Tigray, Northern Ethiopia"*. Department of Land Resources Management and Environmental Protection, Mekelle University, Mekelle, Ethiopia (unpublished record).
- Nyssen, J., Haile, M., Naudts, J., Munro, N., Poesen, J., Moeyersons, J., Frankl, A., Deckers, J., Pankhurst, R., 2009. Desertification? Northern Ethiopia re-photographed after 140 years. *Sci. Total. Environ.* 407 (8), 2749–2755.
- Nyssen, J., Poesen, J., Moeyersons, J., Deckers, J., Haile, M., Lang, A., 2004. Human impact on the environment in the Ethiopian and Eritrean highlands—a state of the art. *Earth-Sci. Res.* 64 (3–4), 273–320.
- Olson, M., 1965. *The Logic of Collective Action: Public Goods and the Theory of Groups*. Harvard University Press, Cambridge, MA.
- Ostrom, E., 1990. *Governing the Commons: the Evolution of Institutions for Collective Action*. Cambridge University Press, New York.
- Ostrom, E., 2005. *Self-governance and Forest Resources*. Terracotta Reader: a Market Approach to the Environment. Academic Foundation, New Delhi, pp. 131–155.
- Ostrom, E., Gardner, R., Walker, J., 1994. *Rules, Games, and Common-pool Resources*. University of Michigan Press.
- Pagdee, A., Kim, Y.-s., Daugherty, P.J., 2006. What makes community forest management successful: a meta-study from community forests throughout the world. *Soc. Natur. Resour.* 19 (1), 33–52.
- Pomeroy, R.S., Katon, B.M., Harkes, I., 2001. Conditions affecting the success of fisheries co-management: lessons from Asia. *Mar. Policy*. 25 (3), 197–208.
- Poteete, A., Ostrom, E., 2002. An institutional approach to the study of forest resources. In: *Human Impacts on Tropical Forest Biodiversity and Genetic Resources*. CABI Publisher, New York.
- Poteete, A.R., Ostrom, E., 2004. Heterogeneity, group size and collective action: the role of institutions in forest management. *Dev. Change* 35 (3), 435–461.
- Quang, D.V., Anh, T.N., 2006. Commercial collection of NTFPs and households living in or near the forests: case study in Que, Con Cuong and Ma, Tuong Duong, Nghe An, Vietnam. *Ecol. Econ.* 60 (1), 65–74.
- Rawls, J., 2001. *Justice as Fairness: a Restatement*. Harvard University Press.
- Reddy, S., Chakravarty, S., 1999. Forest dependence and income distribution in a subsistence economy: evidence from India. *World. Dev.* 27 (7), 1141–1149.
- Robinson, E.J.Z., Lokina, R.B., 2011. A spatial-temporal analysis of the impact of access restrictions on forest landscapes and household welfare in Tanzania. *Forest. Policy. Econ.* 13 (1), 79–85.
- Sandler, T., 1992. *Collective Action: Theory and Applications*. University of Michigan Press.
- Sen, A., Gordon, J.A., 2015. The idea of justice. *Philos. Soc. Crit.* 41 (1), 77–88.
- Shackleton, C.M., Shackleton, S.E., 2006. Household wealth status and natural resource use in the Kat River valley, South Africa. *Ecol. Econ.* 57 (2), 306–317.
- Shackleton, C.M., Shackleton, S.E., Buiten, E., Bird, N., 2007. The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa. *Forest. Policy. Econ.* 9 (5), 558–577.
- Shiterek, T., Manaye, S., Abebe, B., 2001. *Strengthening User-rights over Local Resources in Wollo*. International Institute for Environment and Development, Ethiopia.
- Shylendra, H.S., 2002. Environmental rehabilitation and livelihood impact: emerging trends from Ethiopia and Gujarat. *Econ. Polit. Wkly* 37 (31), 3286–3292.
- Soltani, A., Angelsen, A., Eid, T., 2014. Poverty, forest dependence and forest degradation links: evidence from Zagros, Iran. *Environ. Dev. Econ.* 19 (05), 607–630.
- Soltani, A., Angelsen, A., Eid, T., Naieni, M.S.N., Shamekhi, T., 2012. Poverty, sustainability, and household livelihood strategies in Zagros, Iran. *Ecol. Econ.* 79 (0), 60–70.
- Storck, H., Bezabih, E., Berhanu, A., Borowicki, A., Hawariat, S.W., 1991. *Farming Systems and Resource Economics in the Tropics: Farming System and Farm Management Practices of Small Holders in the Hararge Highland*.

- Taddese, G., 2001. Land degradation: a challenge to Ethiopia. *Environ. Manage.* 27 (6), 815–824.
- Team, R.C., 2013. R: a Language and Environment for Statistical Computing.
- Tefera, M., Demel, T., Hultén, H., Yemshaw, Y., 2005. The role of communities in closed area management in Ethiopia. *Mt. Res. Dev.* 25 (1), 44–50.
- Teketay, D., 2001. Deforestation, wood famine, and environmental degradation in Ethiopia's highland ecosystems: urgent need for action. *Northeast Afr. Stud.* 8 (1), 53–76.
- Tesfaye, Y., Roos, A., Campbell, B.M., Bohlin, F., 2010. Forest incomes and poverty alleviation under participatory forest management in the Bale Highlands, Southern Ethiopia. *Int. Forest. Rev.* 12, 66–77.
- Thondhlana, G., Muchapondwa, E., 2014. Dependence on environmental resources and implications for household welfare: evidence from the Kalahari drylands, South Africa. *Ecol. Econ.* 108 (59–67).
- Vedeld, P., Angelsen, A., Bojö, J., Sjaastad, E., Berg, G.K., 2007. Forest environmental incomes and the rural poor. *Forest. Policy. Econ.* 9 (7), 869–879.
- Vedeld, T., 2000. Village politics: heterogeneity, leadership and collective action. *J. Dev. Stud.* 36 (5), 105–134.
- von Gadow, K., Nagel, J., Saborowski, J. (Eds.), 2002. *Continuous Cover Forestry: Assessment, Analysis, Scenarios*. Kluwer, Dordrecht.
- Wade, R., 1988. *Village Republics: Economic Conditions for Collective Action in South India*. Robert Wade Cambridge University Press. ICS Press, Oakland.
- Wisborg, P., Shylendra, H., Gebrehiwot, K., Shanker, R., Tilahun, Y., Nagothu, U.S., Tewoldeberhan, S., Bose, P., 2000. Rehabilitation of CPRS through Re-crafting of Village Institutions: a Comparative Study from Ethiopia and India. eighth biennial conference of the International Association for the Study of Common Property (IASCP), Bloomington, Indiana.
- Wooldridge, J.M., 2015. *Introductory Econometrics: a Modern Approach*. Nelson Education.
- Yami, M., Gebrehiwot, K., Moe, S., Mekuria, W., 2006. Impact of area enclosures on density, diversity, and population structure of woody species: the case of May Ba'ati-Douga Tembien, Tigray, Ethiopia. *Ethiop. J. Nat. Res.* 8 (99–121).
- Yayneshet, T., Eik, L., Moe, S., 2009. The effects of enclosures in restoring degraded semi-arid vegetation in communal grazing lands in northern Ethiopia. *J. Arid. Environ.* 73 (4), 542–549.
- Yemiru, T., Roos, A., Campbell, B., Bohlin, F., 2010. Forest incomes and poverty alleviation under participatory forest management in the Bale Highlands, Southern Ethiopia. *Int. For. Rev.* 12 (1), 66–77.

Paper II

Exclosures in people's mind: perceptions and attitudes in the Tigray Region

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Abstract

The paper examines the perceptions and attitudes of local people living next to nine exclosures in the Tigray Region in Ethiopia. Social exchange theory was used as theoretical framework and data were collected from 446 households. Factor analysis, multiple linear regression and binary logistic regression were applied to the data to identify factors that influenced local household heads' perceptions of and attitudes towards existing exclosures and further expansion of exclosures. Household heads' perceptions of exclosures can be grouped under social, economic and ecological dimensions. Some household heads expressed positive attitudes towards the existing exclosures, while some were concerned about the expansion of the exclosures in the future. The findings also revealed that household's socio-economic profile, household's knowledge about exclosures, ecological conditions of exclosures and geographical attributes played important roles in shaping local household heads' perceptions of exclosures. Moreover, their perceptions of exclosures were significantly correlated with tangible benefits and costs associated with exclosures. Thus, improvement in local communities' attitudes towards and support for exclosures would follow if exclosures contributed more directly to people's livelihoods. However, the level of support for exclosures is remarkable given the fact that those areas have been closed for grazing and other uses.

Keywords: access, exclosures, households, rehabilitation, social exchange, Tigray

1. Introduction

The establishment of protected areas is the cornerstone of land rehabilitation in different parts of the world (Allendorf, 2007; Allendorf et al., 2006; Amin et al., 2015). In the Tigray Region in Ethiopia, land degradation is addressed by closing off the most degraded grazing lands and forests from cultivation, grazing and firewood collection, to form exclosures (Aerts et al., 2009). Exclosures are protected by guards and local communities' bylaws (Mekuria et al. 2007). Thus, they can be categorized as protected areas (Aerts et al., 2009). Natural resources such as forests and grazing lands are multidimensional, and several actors with different and sometimes conflicting interests are involved in the management of such resources (Krott 2005; Nurrochmat et al., 2017). Some actors prioritize conservation and protection of natural resources through land rehabilitation projects (Nurrochmat et al., 2017), others might be interested in illegal harvesting of commercial products such as timber (Nurrochmat et al., 2017), and some actors might derive their livelihoods from these resources (Babulo et al., 2009; Mamo et al., 2007; Soltani et al., 2014). Although all the actors are affected by policy measures or management interventions restricting their access to forests and grazing lands, local communities living close to such resources are more vulnerable to these interventions. They also suffer directly as a result of land degradation. Therefore, those who are affected by a resource should be given an opportunity to have a say in its provision (Breton, 1965). Originally, the primary purpose of the establishment of exclosures was to enhance environmental regeneration in degraded areas (Gebremedhin et al., 2003). Later, it was recognized that protected areas and exclosures should contribute to sustain the livelihoods of local communities living adjacent to resources (Charnley et al., 2007; Hamilton et al., 2000) because they are the key stakeholders who actively use, manage and change their surrounding environment (Muhamad et al., 2014).

There has been consensus among academics and politicians that the long-term success of any protection program depends on the support of local people (Vodouhê et al., 2010), their perceptions of and positive attitudes towards conservation (Struhsaker et al., 2005). People's perceptions reflect their beliefs that derive from their experiences and interactions with a particular phenomenon (Htun et al., 2012). The term 'attitudes' has been used in relation to positive or negative responses towards an entity or object (Karanth et al., 2008) and is defined as a mental evaluation of a particular entity with some degree of favor or disfavor (Eagly and Chaiken, 1998). Attitudes are formed through individuals' perceptions and experiences (Infield and Namara, 2001). Studies of attitudes and perceptions have contributed to the identification of local communities' needs and aspirations, documentation of their ideas and opinions regarding conservation, and understanding of why local communities make special decisions and behave in certain ways. The results of surveys of attitudes and perceptions have indicated what means for local communities to live next to protected areas, and which factors influenced their attitudes towards protection and support for such protection. Such knowledge is important to ensure that more efficient protection policy measures are taken (Kaltenborn et al., 2006), such that both protection goals and local demands for ecosystem services are fulfilled (Hartter et al., 2012).

In recent years, the numbers of studies of perceptions and attitudes among local communities living next to protected areas in developing countries have increased. Some studies have dealt specifically with local people's perceptions of forest conditions, ecosystem services and protected areas (e.g., Amin et al., 2015; Dolisca et al., 2007; MacKenzie et al., 2017; Muhamad et al., 2014; Paudyal et al., 2018; Stickler et al., 2017; Vodouhê et al., 2010), while others have examined local communities' attitudes towards conservation and management of protected areas (e.g., Allendorf, 2007; Allendorf et al., 2006; Badola et al., 2012; Dewu and Røskaft,

2018; Infield and Namara, 2001; Kaeser and Willcox, 2017; Kideghesho et al., 2007; Rahman et al., 2017; Tomićević et al., 2010). Some have analyzed interest, influence and power of different actors involved in management of protected areas and community forestry (e.g. Nurrochmat et al. 2017; Schusser et al. 2015), and have reported that perceptions and attitudes of local communities toward conservation issues and protected areas are strongly influenced by their “intrinsic” or true interests, although they are often hidden (Nurrochmat et al. 2017). By contrast, few studies have assessed both local communities’ perceptions and attitudes towards conservation issues and protected areas (e.g., Htun et al., 2012; Hussain et al., 2016; Nurrochmat et al. 2017; Xu et al., 2006). To date, a number of studies also have been conducted specifically to examine local communities’ perceptions and attitudes towards conservation and protection issues in Ethiopia (Bessie et al., 2014; Birhane et al., 2017; Mekuria 2013; Moges and Taye 2017; Tadesse and Teketay 2017; Tesfaye et al., 2012; Tessema et al., 2010). The diversity of factors determining local communities’ perceptions of protected areas and their attitudes towards such areas has made it necessary to develop a theoretical framework. Only few of the studies on local perceptions of and attitudes towards protected areas are based or concerned with theory (Chuang and Yen, 2017; Kaeser and Willcox, 2017; Nurrochamt et al. 2017; Tesfaye et al. 2012). The use of social exchange theory (Turner and Turner, 1978) in the current study is an attempt to address this shortcoming by providing a theoretical orientation.

Homans (1958) developed social exchange theory to understand human behavior and explain human interactions. Later on, Emerson (1962) and Blau (2017) extended the theory to analyze how individuals and organizations interact to maximize their gains and minimize their costs. The theory describes how people develop attitudes towards an object (a person or thing) based on their subjective cost-benefit analysis, and comparison of alternatives. Objects that generate net benefits are more likely to be perceived positively, while those associated with net losses

will tend to be perceived negatively (Napier and Napier, 1991). The theory outlines that individuals will engage in an exchange if they believe the cost of exchange do not outweigh the resulting benefits (Skidmore 1979). The cost of exchange can appear in form of time, money or energy (Kelley and Thibaut, 1978), while benefits can be goods, information, services, money or status (Emerson 1962).

We aim to add to the vast literature on local perceptions of and attitudes towards protected areas in three ways. First, a narrative of success dominated the discourse of exclosures in Tigray (Birhane and Hadgu, 2014; WeForest, 2018; Whiting, 2017). Local communities together with district offices of Agriculture and Rural Development had established exclosures all over the region, and the results were very encouraging. The environment was improving to the benefit of people's livelihoods. This narrative seemed too good to be true. Therefore, we examined local household heads' perceptions of the various impacts of exclosures and their attitudes towards exclosures. By doing so, we could test the hypothesis that local communities supported establishment and expansion of exclosures despite their access to forests and grazing lands was limited. Second, the study presented a case from the Tigray Region, where few studies of local communities' perceptions and attitudes have been conducted to date. Third, this study provided a theoretical orientation that can integrate previous findings and lead to better understanding of how local communities perceive the various impacts of exclosures and why they develop positive or negative attitudes towards exclosures. We used social exchange theory, analyzed data from 446 households living adjacent to nine exclosures in Tigray. The objectives of the study were (1) to identify local household heads' perceptions of exclosures, (2) to identify local household heads' attitudes towards existing exclosures and further expansion of exclosures, and (3) to determine factors influencing local household heads' perceptions of exclosures, attitudes towards existing exclosures, and the expansion of exclosures. Hereafter, this article is

organized as follows. In Section 2, we present a theoretical framework based on a literature review and describe the study sites as well as the methods of data collection and data analyses. Then, we present the results of our study followed by our discussion in Section 3, and finally conclusions in Sections 4.

2. Methods

2.1. Conceptual framework

From a perspective of conservation and protection, we assume establishment of any protected area as an exchange. According to social exchange theory, there are costs and benefits associated with any exchange (Cropanzano and Mitchell, 2005). The balance between positive perceptions of benefit flows from protected areas and negative perceptions caused by the costs will determine whether people support the establishment of protected areas. Figure 1 illustrates the conceptual framework of the study. Household heads' evaluation of benefits and costs associated with exclusions is the core of the framework. Several variables affect the way household heads evaluate benefits in relation to the costs. These variables were identified through a literature review of studies examining local communities' perceptions of and attitudes towards protected areas. The variables are summarized in Table 1 and described in the following.

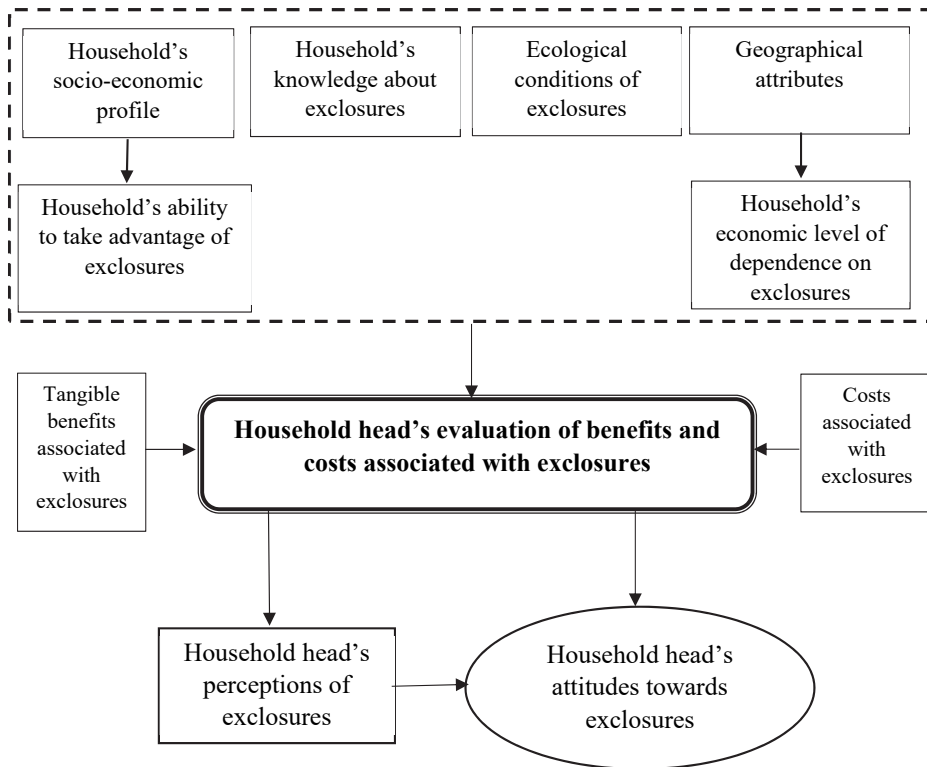


Figure 1. Determinants of local household heads' perceptions of and attitudes towards exclosures based on social exchange theory

Tangible benefits and costs associated with exclosures: Previous studies have found that local communities' perceptions and attitudes depend on the tangible benefits obtained from protected areas (Allendorf, 2007; Allendorf et al., 2006; Baral and Heinen, 2007; Dewu and Røskaft, 2018; Htun et al., 2012; Infield and Namara, 2001; Kuvan and Akan, 2005; MacKenzie et al., 2017; Tessema et al., 2010; Vodouhê et al., 2010; Walpole and Goodwin, 2001; Xu et al., 2006), compared with the cost of living adjacent to such areas (e.g., Dewu and Røskaft, 2018; MacKenzie et al., 2017; Walpole and Goodwin, 2001; Xu et al., 2006). We used a dummy variable named “household harvest status” in our analysis as a proxy for tangible

economic benefits obtained from exclosures, with code 1 if the household obtained outputs from the exclosures, and code 0 (zero) otherwise. Regarding the costs associated with the establishment of exclosures, we constructed a categorical variable termed “household’s level of duty.” People living adjacent to exclosures have to participate in a number of protection measures, and the level of duties represents the effort each household has to invest in exclosures. Some examples of these protection measures are digging pits, planting seedlings, and constructing stone bunds, soil bunds, and terraces to reduce runoff. We defined three levels for the variable: 1 = no assigned duty (households not assigned to any of the protection duties), 2 = low assigned duty (households having only one of the protection duties), and 3 = high assigned duty (households involved in more than one duty).

Household’ socio-economic profile: The literature shows an interrelationship between households’ socio-economic profile and their perceptions and attitudes. However, the impacts of these variables on local communities’ perceptions and attitudes have been found ambiguous (Allendorf et al., 2006; Baral and Heinen, 2007; Kaltenborn et al., 2006; Kideghesho et al., 2007; Shibia, 2010; Tessema et al., 2010; Tomićević et al., 2010; Vodouhê et al., 2010; Xu et al., 2006). For example, the impact of education and gender on local perceptions and attitudes seems to be site-specific and inconsistent. While some scholars have reported that education has a strong impact on local attitudes (e.g., Allendorf et al., 2006; Rahman et al., 2017; Shibia, 2010; Xu et al., 2006), others have not found a correlation between education and local perceptions and attitudes (Baral and Heinen, 2007). Some studies have revealed that gender is a predictor of attitude, as women are more likely have negative attitudes (Allendorf et al., 2006; Xu et al., 2006; Tomićević et al., 2010), whereas others have reported that women are more conservation friendly than men are (Ray et al., 2017; Kaeser and Willcox, 2017).

The social exchange theory assumes that power in social exchanges lies with those possessing greater resources. Household's socio-economic profile indicates the resources possessed by the household that indeed influence household's ability to take advantage of exclosures. The ability to take advantage of exclosures have impacts on household head's evaluation of benefits and costs associated with exclosures. For example, households with more labor force have better possibility to collect grass than those with fewer or no labor. Consequently, they are more likely to perceive exclosures as having positive economic impacts. In our analysis, the variables describing household's socio-economic profile were "gender of the household head," "log of age of the household head," "household's average years of education," "household's labor force," "household's cropland area," "household's herd size," "household harvest status" and "household's level of duty."

Household's knowledge about exclosures: Some studies have shown that knowledge affects behavior (Zelezny, 1999), and perceptions and attitudes (Aipanjiguly et al., 2003; Chuang and Yen, 2017; Htun et al., 2012; Xu et al., 2006). Also, Aipanjiguly et al. (2003) argue that households with more knowledge of protected areas will have positive attitudes, while social exclusion and lack of knowledge lead to negative attitudes towards protected areas (Paraskevopoulos et al., 2003). Based on social exchange theory, households with more and accurate knowledge about an exchange can better estimate the costs and benefits associated with it. In the Tigray Region, local communities gain knowledge about their adjacent exclosures through either participating in training activities or interacting with development agents. We therefore used two variables as proxy for household's knowledge about exclosures: "household's training in exclosure management" and "number of extension visits." Also the state of other variables, such as "gender of household's head," "household's labor force," and

geographical attributes could have an impact on results relating to household's knowledge (Gilani et al., 2017; Xu et al., 2006).

Ecological conditions of exclosures: It is assumed that if ecological conditions improve, local communities are more likely to perceive the ecological and economic impacts of exclosures as beneficial. Consequently, they might have positive attitudes towards their adjacent exclosures. In our analysis, we used two categorical variables to represent ecological conditions: "agroecological zone" and "age of exclosure." The agroecological zones in the Tigray Region consist of three classes based on altitude: lowland exclosures located less than 1500 m a.s.l.; intermediate exclosures located between 1500 m a.s.l. and 2300 m a.s.l.; and highland exclosures located above 2300 m a.s.l. (NORHED unpublished document). Since exclosures located at higher altitude receive more precipitation, they are considered more productive in terms of vegetation. Consequently, households living adjacent to exclosure located in highlands may perceive the ecological and economic improvement due to establishment of exclosures. The exclosures can be divided into three classes based on the number of years since they were established (age of exclosure = n): new exclosures ($n \leq 10$), intermediate-age exclosures ($10 < n \leq 15$ years), and old exclosures ($n > 15$ years). There is a positive correlation between the age of exclosures and the exclosures' vegetation cover and density (Yayneshet et al., 2009). However, the biomass of grass and other herbaceous species decreases as exclosures gets older, since the canopy of trees and shrubs become denser (Birhane et al. 2017).

Geographical attributes: Jurowski and Gursoy (2004) reported that geographical attributes such as distance have significant effects on how individuals evaluate the costs and benefits of an exchange. Consequently, perceptions and attitudes are likely to differ among people living in different geographical situations (Gilani et al., 2017; MacKenzie et al., 2017; Muhamad et

al., 2014). For example, local communities living closer to protected areas tend to perceive there are many ecosystem services (Sodhi et al., 2010), and consequently hold positive attitudes towards their protected surroundings (Macura et al., 2011; Rahman et al., 2017). At the same time, local communities living closer to protected areas and further from market are more dependent on natural resources for their livelihoods (e.g., Mamo et al., 2007; Soltani et al., 2012), and feel more strongly that forest is essential for their livelihood (Gilani et al., 2017). Household economic dependence has emerged as a significant factor influencing perceptions and attitudes (Kuvan and Akan, 2005). Furthermore, the size of the protected area and the number of people with access rights could influence perceptions and attitudes (Allendorf, 2007). If the area under enclosure is small and many households have access to it, the households' share of outputs from enclosures will be smaller. This might cause household heads to perceive there are fewer ecosystem services, and consequently develop negative attitudes towards enclosures. We used three variables to represent geographical attributes, namely "distance between household's residence and enclosure," "distance between household's residence and district market," and "number of households per ha of enclosures."

Household heads' perceptions of enclosures: Previous studies have indicated that people's perceptions of protected areas play an important role in shaping their attitudes (Allendorf et al., 2006; Chuang and Yen, 2017; Htun et al., 2012; Infield and Namara, 2001; McClanahan et al., 2005), and their participation in collective action and management of protected areas (e.g. Sirivongs and Tsuchiya, 2012; Sullivan et al., 2017).

Table 1. List of explanatory variables and their definitions

Variables	Definition
Tangible benefits and costs associated with exclosures	
Household's harvest status	Dummy variable with code 1 if the household collected outputs from exclosures, otherwise code 0
Household's level of duty*	Categorical variable with three levels: 1=no assigned duty (households not assigned duty), 2=low assigned duty (households involved in more than one duty), 3=high assigned duty (households involved in more than one duty).
Household's socio-economic profile	
Gender of the household head	Dummy variable with code 1 for male-headed household, otherwise code 0
Log of age of the household head	Age of the household head in years
Average education of the household	Average number of years of schooling completed by household members
Household's labor force	Number of household members in the age range 15–64 years
Household's cropland area	Size of household's own land for agriculture in ha
Household's herd size	Number of tropical livestock units (TLUs) owned by household, calculated as 1 goat = 0.13 TLU; 1 sheep = 0.13 TLU; 1 chicken = 0.013 TLU; 1 cow = 1 TLU; 1 Ox = 1 TLU (Storck et al., 1991)
Household's knowledge about exclosures	
Number of extension visits	Number of extension visits made by the natural resource management development agent in 2014
Household's training in exclosures management	Dummy variable with code 1 if household head or any other members had participated in exclosure management programs, otherwise code 0
Ecological conditions of exclosures	
Agroecological zone*	Categorical variables with three levels; 1=lowland, 2=intermediate, 3=highland
Age of exclosure*	Categorical variables with three levels; 1=new, 2=intermediate-age, 3=old
Geographical attributes	
Distance between household's residence and the exclosure	Distance between household's residence and exclosure in km
Distance between household's residence and the district market	Distance between household's residence and the district market in km
Number of households per ha of exclosures	The number of households with access rights to exclosures divided by the area of exclosure (HH: ha ratio)

*Categorical variables with k levels were transferred into k-1 variables by using dummy coding method (Stockburger, 2016).

2.2. Study sites

Nine exclosures in the Tigray Region in northern Ethiopia were selected for analysis. The region is bordered by Eritrea to the north, the Afar Region to the east, Sudan to the west, and the Amhara Region to the south (Figure 2). The exclosures selected for study are located in five districts, adjacent to nine villages, in three agroecological zones and divided into three age classes as new, intermediate-age and old exclosures. The main characteristics of the selected exclosures are presented in Table 2. New and intermediate-age exclosures are dominated by grass and bush species, while in old exclosures different tree species dominate the vegetation, such as *Acacia polyacantha*, *Acacia asak*, *Acacia etbaica*, and *Eucalyptus* spp. The selected exclosures have been established on degraded grazing lands, where livestock were taken to graze and villagers used to collect firewood. Only Adi Gedaw exclosure was established on cultivated land.

The main economic activity in the nine villages adjacent to the selected exclosures is a combination of crop cultivation and livestock husbandry. Additionally, there are a few other income sources such as remittances, handicrafts, and petty trade. Bylaws are devised to govern and manage the villages' resources. According to the bylaws, grazing, firewood collection and agriculture are forbidden in exclosures (Aerts et al., 2009; Mekuria et al., 2007), but households with access right are permitted to collect grass and fruits. The regulations defining the timing of harvesting and amount of produce gathered vary from exclosure to exclosure. Tigray Bureau of Agriculture and Rural Development hires guards to protect the exclosures. However, illegal and secret harvesting still take place (Babulo et al., 2009).

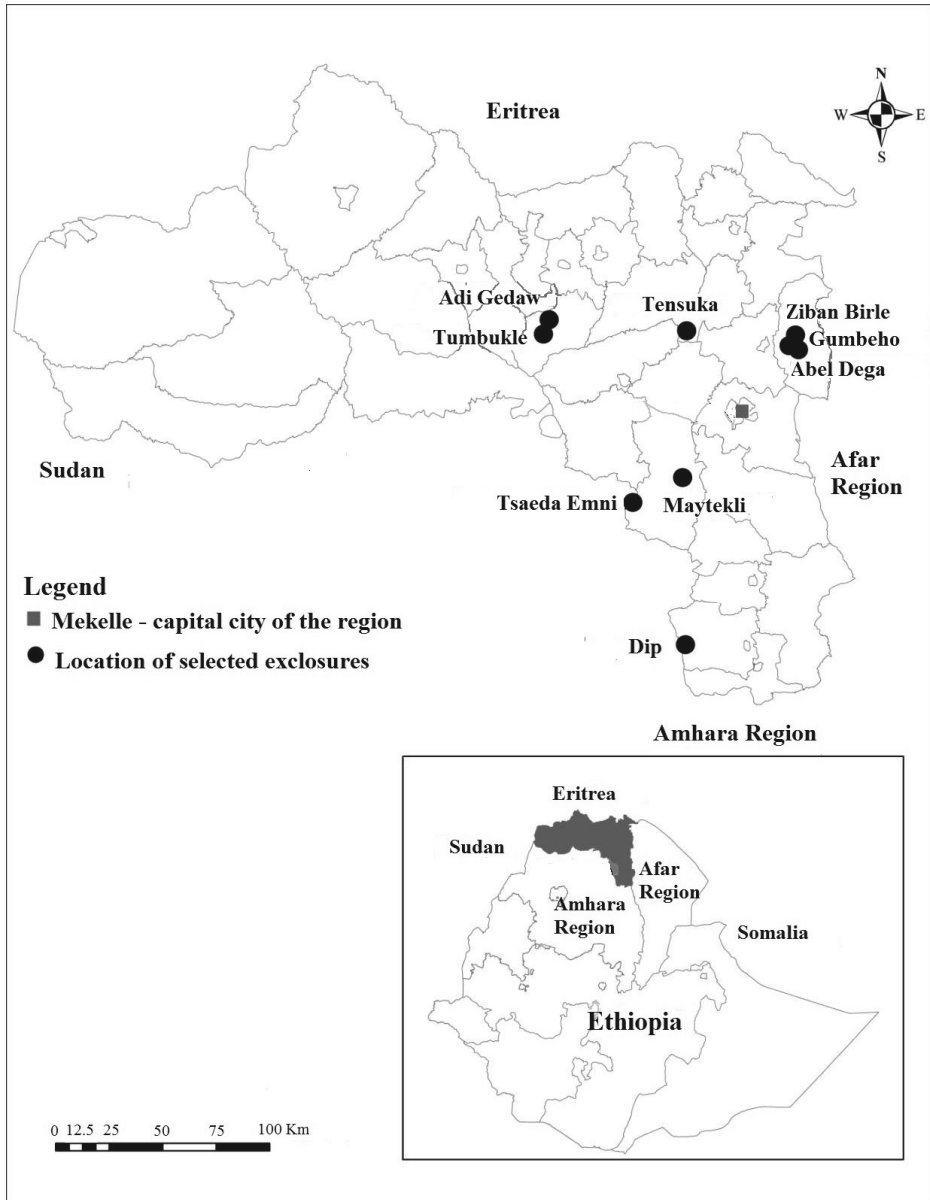


Figure 2. Location of Tigray Region in Ethiopia and the studied exclosures in the Tigray Region

Table 2. List of selected exclosures

No.	Name of exclosure	Age	Agro-ecological zone	Number of households		Distance to Mekelle (km)	Administrative level		Area (ha)
				Population	Sample size		Village	District	
1	Ziban Brile	8	H	55	15	75	Micheal Emba	Atsbi	220
2	Maytekli	15	H	104	27	58	Maytekli	Samre	111
3	Gumbeho	20	H	216	58	75	Kaleamin	Atsbi	350
4	Tumbukle	10	I	295	79	285	Seka-Kisadmomona	Naeder Adet	177
5	Adi Gedaw	15	I	193	52	285	Debre Genet	Naeder Adet	234
6	Abel Dega	20	I	328	88	75	Hayelom	Atsbi	80
7	Tensuka	9	L	52	14	104	Koraro	Hawzen	168
8	Tsaeda Emni	15	L	201	54	58	Nebar Hadnet	Samre	210
9	Dip	20	L	219	59	150	Zata	Ofla	1254
	Sum			1663	446				2804

Notes: Age = years since establishment; Agro-ecological zones: H = highland, I = intermediate zone, L = lowland

2.3. Data collection

The information required for the study was collected through a household survey, using questionnaires and structured interviews as the main tools. The questionnaires were modified following the information obtained through a pilot survey and field visits. The list of households living next to the nine exclosures with access right was obtained from the Tigray Bureau of Agricultural and Rural Development's village offices. Based on Cochran's formula, the sample size was estimated as 425 households. However, the sample size was increased to 450 in case a few of the questionnaires were incompletely filled. The households were chosen by stratified random sampling (Cochran, 1977), whereby the nine villages were the strata. The sample size in each village was calculated by proportional sampling. Four questionnaires were excluded due to incomplete information and the final sample size was 446 households. The household questionnaire consisted of two parts. The first part provided information on household composition and education, livestock and cropland ownership, knowledge regarding the exclosure, participation in training programs, amount of different outputs collected from the exclosures, household's protection duties, and interactions with development agent. The second part of questionnaire contained 17 perception statements and 3 questions to capture household heads' attitudes towards the exclosures. The statements are listed in Table 3. Each household's head was asked to rate his/her perceptions based on a five-point Likert scale, on

which 1 indicated “strongly disagree” and 5 indicated “strongly agree.” Additionally, household heads were asked whether they had agreed with the idea of exclosures prior to their establishment, whether they felt happy because of the existing exclosures, and whether they would support future expansion of exclosures. Household heads explanations for their responses were also recorded together with qualitative field observations. Information on the exclosures such as their size, age and agroecological zone was obtained from secondary data (NORHED, unpublished document). The distances between the household’s settlement and the exclosure and the district markets were recorded using GPS during the household survey.

2.4. Data analysis

We used quantitative methods namely factor analysis, multiple linear regression and binary logit regression to analyze local household head’s perceptions of and attitudes towards exclosures.

Factor analysis: Factor analysis was used to reduce 17 perception statements into four meaningful components. This was done by using the principal component extraction method and varimax rotation. Factors were structured based on proportion of variance explained, number of eigenvalues greater than one, and the number and the difference between cross-loading items. Perception statements (items) were reduced into factors according to their loading i.e. the correlation between the item and the factor. Only items with loading greater than 0.40 were selected. If the difference between loadings for cross-loading items were less than 0.2, the item was included in the factor that made most sense conceptually (Diiorio 2006; Gebreegziabher and Tadesse 2014; Rowen et al. 2011).

Multiple linear regression: After factor analysis, a multiple linear regression model using the extracted factors as dependent variables was employed to identify factors that influenced the household heads' perceptions of selected exclosures. The explanatory variables and their definitions are presented in Table 1.

Binary logit regression: To determine factors that influenced the household heads' attitudes towards exclosures, a binary measure was used in a binary logit model specification. The household heads were asked whether they felt happy with the existing exclosures (code 1 if the answer was 'Yes', otherwise code 0). In the same way, household heads were asked whether they would support the expansion of exclosures (code 1 associated with a 'Yes' response, otherwise code 0). Table 1 present the explanatory variables included in the binary logit regression.

3. Results and discussion

3.1. Local household heads' perceptions about exclosures

Table 3 shows the results of the factor analysis. The first principal component factor had high positive significant loadings on the following statements: "household income has increased," "yield of honey production has increased," "number of local breed animals has decreased," "number of exotic breed animals has increased," "crop productivity has increased," "number of conflicts over natural resource use has decreased," and "number of water springs has increased." The second factor had high positive significant loadings on "households have equal access to outputs from exclosure" and "households have equal access to information about exclosure," while the third factor had high positive significant loadings on the following statements: "bylaws are practiced to share the outputs from exclosure," "local communities are responsible for revising bylaws," "local community awareness of afforestation has increased,"

and “monitoring and evaluation of activities are undertaken.” The fourth factor had high positive significant loadings on “number of trees in the enclosure has increased,” “flooding has decreased,” and “microclimate of the area has improved.” The four factors were named according to their associated statements. Accordingly, first and second factors were respectively named “economic improvement” and “equal access,” and the third and fourth factors were named “local involvement” and “ecological improvement. Only the item “more grass is available for livestock husbandry” cross-loaded with two factors “economic improvement” and “equal access,” and the difference between the loadings (0.53-0.42) was less than 0.2. The item was linked to the quantity of grass rather than the distribution of access to collect grass, thus it was conceptually more relevant to include “more grass is available for livestock husbandry” under “economic improvement.” The mean of the Likert scale values given to perception statements ranged from 3.00 to 4.63 (Table 3). Of the 17 statements, 3 statements under “ecological improvement,” 4 statements under “local involvement,” and 2 statements under “equal access” had mean values ranging from 4.13 to 4.63, while the eight statements under “economic improvement” had mean values between 3.00 and 4.07 (Table 3).

Our results of factor analysis illustrated that local household heads’ perceptions of enclosures in the Tigray Region can be grouped under social, economic and ecological dimensions. Although factor analysis has been the most commonly used method to reduce number of perception statements and examine their structure of interrelations (e.g. Badola et al., 2012; Bessie et al., 2014; Dolisca et al., 2007; Guthiga, 2008; Hanafiah et al., 2013; Kukrety et al., 2013; Zeweld et al., 2017), other statistical methods such as multidimensional scaling (MDS) was applied to detect underlying dimensions of opinions, explain similarities and dissimilarities among perceptions, and estimate the level of sustainability of each dimension based on respondents’ opinions (Sukwika et al., 2016).

Table 3. Extracted factors and correlation with original statements used in factor analysis

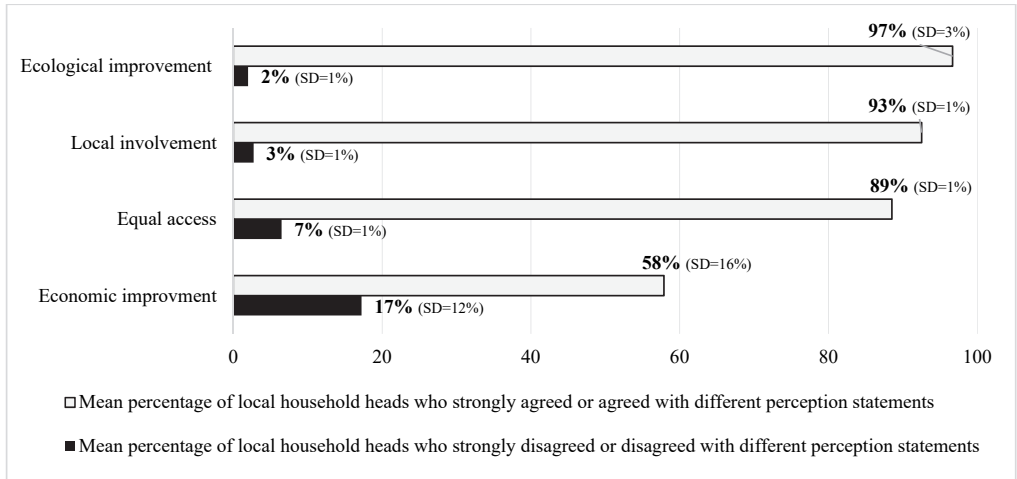
Perception statements	Factor 1	Factor 2	Factor 3	Factor 4	Mean (SD)
Household income has increased	0.74	0.28	0.11	0.24	3.0 (1.1)
More grass is available for livestock husbandry	0.42	0.53	0.21	0.19	3.8 (0.9)
Yield of honey production has increased	0.58	0.16	0.22	0.22	3.4 (0.9)
Number of local breed animals has decreased	0.66	-0.002	0.05	0.04	3.8 (0.8)
Number of exotic breed animals has increased	0.80	0.02	-0.04	-0.11	3.4 (1.1)
Crop productivity has increased	0.70	0.16	0.01	0.26	3.6 (1.0)
Bylaws are practiced to share the outputs from enclosure	-0.18	0.41	0.58	0.15	4.1 (0.8)
Households have equal access to outputs from enclosure	0.06	0.85	0.23	0.01	3.4 (1.0)
Households have equal access to information about enclosures	0.01	0.86	0.22	-0.04	4.2 (0.9)
Local communities are responsible for revising the bylaws	0.30	0.25	0.53	-0.07	4.3 (0.9)
Number of conflicts over natural resource use has decreased	0.54	-0.02	0.25	0.01	4.3 (0.7)
Local community awareness of afforestation has increased	-0.02	0.07	0.80	0.13	4.1 (0.7)
Monitoring and evaluation activities are undertaken	0.17	0.24	0.76	-0.09	4.3 (0.6)
Number of trees in the enclosure has increased	0.01	0.13	-0.13	0.82	4.2 (0.7)
Flooding has decreased	0.13	-0.15	0.25	0.70	4.5 (0.6)
Number of water springs has increased	0.79	-0.16	-0.12	-0.06	4.6 (0.6)
Microclimate of the area has improved	0.52	0.15	-0.03	0.51	4.3 (0.7)
Eigen value	4.85	2.75	1.45	1.09	
Percentage of total variance explained	28.53	16.21	8.57	6.41	
Cronbach's alpha (α)	0.84	0.85	0.711	0.57	

Meyer-Olkin Measure of Sampling Adequacy = 0.84;

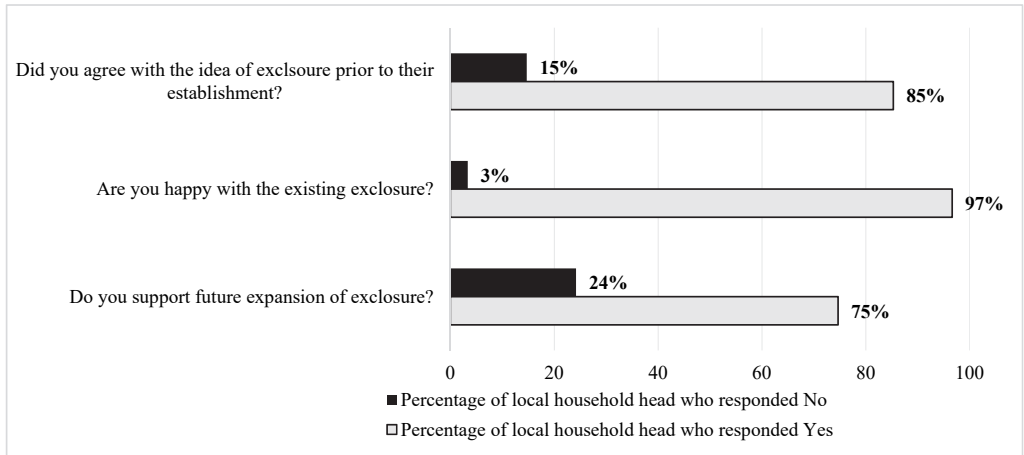
Bartlett's Test of Sphericity and approximate Chi-square = 2586.38; p-value=0.000; SD = standard deviation

Figure 3A shows the mean percentages of local household heads who strongly agreed or agreed, disagreed or strongly disagreed with each factor. The responses under “strongly disagree” and “disagree” were combined and presented together, and the responses under “agree” and “strongly agree” were treated similarly. In average 97% , 93% and 89% of the sample household heads either agreed or strongly agreed with the statements under the headings “ecological improvement,” “local involvement,” and “equal access” respectively. The fact that the respondents in our study expressed the highest level of agreement with the statements under ecological improvement can be attributable to the primary purpose of the establishment of exclosures, which was to enhance the ecological conditions in degraded lands (Balana, 2007; Gebremedhin et al., 2003), rather than to generate any economic gains. A study conducted by Schusser et al. (2015) showed that powerful actors such as forest administrations and non-governmental organizations care more for ecological outcomes of community forest management than for people who are dependent on those resources. Similarly Nurrochmat et al. (2017) found that the Meru Betiri National Park Office prioritized ecosystem preservation, while extraction and income generating activities were more important for other actors involved in management of the park. Other scholars also reported that local communities have perceived exclosures to be effective in restoring degraded soils and vegetation (Birhane et al. 2017; Mengistu et al. 2005; Mekuria 2013; Mekuria et al. 2011). However, the mean percentages of the sample household heads who strongly agreed or agreed with the statements under “economic improvement” was 58%. Similar results were reported earlier that local communities have expressed their concerns for economic impacts of exclosure (Mekuria 2013), and perceived exclosures more as an environmental rehabilitation intervention than an economic beneficial measure (Birhane et al. 2017). Sukwika et al. (2016) also found similar results in a different context, as ecological dimension of privately managed forests in Indonesia is moderately sustainable while the economic dimension is less sustainable. Scholars

previously found that the sustainable management of any protected areas should comprise both protection and income generating activities (Nurrochmat et al. 2017; Kustanti et al. 2014). It is worth mentioning that we did not analyze the achievements of exclosures in this paper, only local people's perceptions of such achievements. Therefore, our results should not be interpreted as if exclosures are not associated with positive economic outcomes, as more than half of respondents agreed that exclosures had contributed to economic improvement and there are studies showing that exclosures generate economic benefits (Balana et al., 2012; Mekuria et al., 2011).



(A)



(B)

Figure 3. Households' perceptions of (A) and attitudes towards selected exclosures (B)

SD= standard deviation

Mean percentage of local household head responded "not sure" is not illustrated in Figure A.

3.2. Local household heads' attitudes towards existing exclosures and further expansion of exclosures

As illustrated in Figure 3B, 377 of sampled household heads (85%) agreed with the idea of exclosure prior to establishment, 97% (431 households) were happy with existing exclosures, and 76% (338 households) would support the expansion of exclosures. The respondents linked their positive attitudes towards exclosures prior to the establishment to two reasons. First, those lands were marginal and degraded, to the extent that they did not contribute much to local people's livelihoods. Therefore, local communities could easily accept them becoming exclosures. Other scholars have reported that local people support conservation efforts as long as their livelihoods are met and their interests are not threatened (Akyol et al., 2018; Badola et al., 2012; Hussain et al., 2016; Kideghesho et al., 2007). Second, local communities expected to receive economic rewards such as employment, grass collection, beekeeping, and environmental rewards such as reduced erosion as consequences of establishment of exclosures. The respondent holding positive attitudes toward existing exclosure described that establishment of exclosures has reduced soil erosion, and consequently croplands located near to the exclosures are more productive. They also mentioned the access to collect grass as a reason for their positive attitudes towards existing exclosures.

However, our results showed some resistance among respondents towards expansion of exclosure as the number of household heads supporting future expansion of exclosures was lower than the number of household heads with positive attitudes towards the existing exclosures (Figure 3B). Those expressing negative attitudes towards expansion of exclosure linked their resistance to the impact of exclosures on livestock husbandry, availability of communal grazing lands and firewood. Traditional livestock husbandry in the Tigray Region is based on a continuous grazing system, managed by herders. It is not permitted to graze

livestock inside the exclosures, but animals can graze freely on grazing lands elsewhere. The main output from the selected exclosures is grass, which should be cut and transported to feed livestock (Gebregziabher et al., 2017; Tadesse and Teketay, 2017). Since cutting and transporting grass is more labor demanding than grazing animals, local farmers are concerned that the expansion of exclosures would minimize the grazing lands and make their engagement in livestock husbandry more difficult or almost impossible. In some areas, there was not enough land available for the establishment of exclosures. Moreover, local communities used firewood to meet their energy needs and the expansion of exclosures would limit available sources of firewood.

3.3. Determinants of local household heads' perceptions of exclosures, attitudes towards existing exclosures and the expansion of exclosures

The variable “household’s harvest status” had a positive and significant influence on household heads’ perception of “economic improvement,” “equal access” and “local involvement” (Table 4). The variable measures whether ecosystem services (especially direct ones) provided by exclosures (Mekuria, 2013) are recognized by local communities as benefits. Thus, it is not surprising to observe the positive association between the variable and perception of “economic improvement.” Our results are supported by other studies conducted in Ethiopia (e.g. Birhane et al., 2017, Mengistu et al., 2005). At the same time, the variable had positive and significant association with “attitude towards exclosures” (Table 5). The positive connection between obtaining benefits from protected areas and favorable attitudes towards protection is supported by the social exchange theory, and has been confirmed empirically by studies conducted in many parts of the world (Allendorf, 2007; Allendorf et al., 2006; Baral and Heinen, 2007; Dewu and Røskaft, 2018; Htun et al., 2012; Infield and Namara, 2001; Kuvan and Akan, 2005; Vodouhê et al., 2010; Walpole and Goodwin, 2001; Xu et al., 2006). In contrast with social

exchange theory, a negative association between the variable “household’s harvest status” and “attitude towards expansion of exclosures” was observed. This can be explained by the fact that the local people preferred grazing lands to exclosures. They were concerned that the expansion of exclosures would lead to the replacement of grass by trees and consequently there would be a shortage of fodder (Birhane et al., 2017). Furthermore, livestock husbandry based on cutting and transporting grass is more labor demanding than livestock husbandry based on grazing managed by herders.

Additionally, the regression results revealed that “low assigned duty,” and “high assigned duty” compared with “no assigned duty” had a positive and significant influence on household heads’ perception of “local involvement” (Table 4). By contrast, “low assigned duty” and “high assigned duty” compared with “no assigned duty” were associated with negative attitudes towards exclosures (Table 4). As suggested by social exchange theory (Ap, 1990), the relationship between benefits obtained from exclosures and the associated costs is the underlying factor that shapes local people’s attitudes. If the costs associated with the establishment of exclosures (in our case, the assigned duties and the loss of grazing land) can be offset by the expected gain, positive attitudes towards the exclosures can be maintained. The balance between costs and benefits is critical to maintain local institutions (Ostrom, 2005), and to avoid unfair distribution of outputs from exclosures (Gebregziabher et al., 2017). The authors of a number of studies have concluded that costs associated with conservation and protection have negative effects on local communities’ attitudes (e.g., Dewu and Røskaft, 2018; Walpole and Goodwin, 2001; Xu et al., 2006).

Furthermore, variable “gender of the household head” had negative and significant impact on household heads’ perception of “equal access” and a positive and significant influence on

household heads' perception of "ecological improvement" (Table 4). We do not have any quantitative data that can explain why female-headed households more often perceived an equal access to information and outputs. However, based on our observations during fieldwork we linked the association to women's previous experiences of access to information and outputs. Female-heads of households in the villages had felt that they were discriminated against in many situations. The current bylaws of exclosures provide local people with equal access to adjacent exclosures, regardless of their gender. Under such circumstances, the female respondents tended to perceive the management of exclosures as more equitable and fair than their male counterparts. At the same time, compared with women, men invest more time and effort to protect exclosures. As also found by Gebregziabher et al. (2017), the level of effort did not influence the share of outputs from exclosures. Thus, men might have perceived the distribution of outputs from exclosures as unfair. The degree of impact that gender has on perceptions varies (Allendorf and Yang, 2017; Dolisca et al., 2007; Hartter, 2010; Muhamad et al., 2014). Regarding the impacts of gender on attitudes, our results did not reveal any patterns (Table 5). The first reason for this is that the bylaws do not consider the gender of household's head. The second reason is relate to the fact that the men and women perceived exclosures differently (Table 4). Male-headed households perceived exclosures in terms of ecological improvements, while female-headed households perceived them as affording equal access. Furthermore, the cost of establishing exclosures influence both men and women. For example, men could be arrested if they were found grazing or watering their livestock inside the exclosures, while women might be fined upon entering the exclosures to collect firewood. Similar to our results, the authors of previous studies did not find any gendered impacts on attitudes (Baral and Heinen, 2007; Kideghesho et al., 2007; Shibia, 2010). However, some scholars have found that, compared with women, men are more likely to have a positive attitude (e.g., Allendorf et al., 2006; Badola et al., 2012; Xu et al., 2006), while other found that women

hold positive attitudes towards conservation issues (Ray et al., 2017; Kaeser and Willcox, 2017).

Our results revealed that, compared with households with less labor force, households with more of family members in the age range of 15-64 perceived the distribution of outputs from exclosures as more equal (positive and significant association between “household’s labor force” and household heads’ perception of “equal access”). Similarly, households with more labor force were more likely to perceive access to information about exclosures as equal (Table 4). This can be attributed to the fact that households with more family members in the age range 15–64 years tend to have better opportunities to interact with others and acquire information (Xu et al., 2006). Households with more available labor also have more opportunities to collect outputs from exclosures.

Moreover, in our study, households with more livestock perceived that the establishment of exclosures had improved their economic conditions (positive and significant association between “household’s herd size” and household’s perception of “economic improvement”). This finding should not be surprising because people with more cattle are more likely to collect grass in exclosures. This is also supported by the social exchange theory as the benefits of exclosures are mainly enjoyed by those who have more resources and are in better position to harvest from the exclosures. Muhamad et al. (2014) and Poppenborg and Koellner (2013) have reported that people with large herd sizes are more likely to have positive attitudes towards ecosystem services. However, if the establishment of protected areas limits people’s access to grazing lands and fodder, or increases the livestock losses due to increased wildlife population, it definitely creates negative attitudes among those with larger herds (Allendorf et al., 2006; Kideghesho et al., 2007; Tessema et al., 2010; Vodouhê et al., 2010).

Variable “number of extension visits” had a negative and significant impact on the household heads’ perception of “economic improvement,” while variable “household’s training in exclosure management” had a positive and significant influence on this perception. In addition, the variable “number of extension visits” had a positive and significant influence on household heads’ perceptions of “equal access” and “ecological improvement,” and associated with negative attitudes towards the expansion of exclosures. Previous studies have shown the association between knowledge of protected areas and positive attitudes towards conservation (e.g., Aipanjeguly et al. 2003; Htun et al., 2012; Moges and Taye, 2017; Tadesse and Teketay, 2017; Tesfaye et al., 2012). Our results regarding the impact of knowledge on attitudes are somewhat different (Table 5). Development agents are employed by the Tigray Bureau of Agriculture and Rural Development and provide local communities with information about protection and conservation activities. This may explain why households with more interaction with development agents expressed higher levels of agreement with statements under ecological improvement, while they did not perceive much economic improvement (Table 4). Moreover, they were less likely to have positive attitudes towards the expansion of exclosures (Table 5). This indicates that local communities will not support the expansion of exclosures if they do not perceive any economic advantages.

Furthermore, “intermediate zone,” and “highland” compared with “lowland” had a positive and significant influence on household heads’ perception of “ecological improvement” and attitude towards expansion of exclosures (Table 5). Compared with exclosures in lowland, exclosures located in highland or intermediate zones receive larger amounts of precipitation and are therefore more productive, which in turn may facilitate the rehabilitation of degraded lands. Consequently, households living adjacent to such exclosures were more likely to perceive

ecological improvements (Table 4) and expressed favorable attitudes towards the expansion of exclosures (Table 5). However, “intermediate-age exclosure” compared with “new exclosure” had a negative and significant influence on household heads’ perception of “local involvement,” while variable “old exclosure” compared with “new exclosure” had a negative and significant impact on their perception of “equal access.” The longer the time since an exclosure was established, the less degraded it will be (Yayneshet et al., 2009); hence, larger amounts of outputs from exclosures will be available. With time, the most important output also shifts from grass to firewood. The biomass of grass usually decreases over time since trees and shrubs dominate the vegetation. Consequently, local communities living adjacent to older exclosures may perceive less supply of grass from exclosures as reported by Birhane et al., (2017). Gebregziabher et al. (2017) have found that the distribution of outputs from exclosures is more equal in old exclosures compared with either intermediate-age or new exclosures. Thus, it is surprising that household heads adjacent to old exclosures perceived access to information and outputs as unequal.

The variable “distance between household’s residence and the exclosure” had a negative and significant impact on the household heads’ perception of “economic improvement.” However, variables “distance between household’s residence and the district market” and “number of household’s per ha of exclosures” were associated with the positive attitudes towards expansion of exclosures. Geographical attributes such as distance between settlements and exclosures, between settlements and district markets, and the number of households per ha of exclosures influence resource accessibility. As described by economic theory, the distance between settlements and resource location is positively correlated with opportunity cost of labor and the required time to collect outputs (e.g., Amacher et al., 1996; Robinson and Lokina, 2011). This reduces the probability of households collecting any outputs from protected areas

(Gebregziabher et al., 2017; MacKenzie et al., 2017). Therefore, households living farther away from exclosures are less likely to perceive exclosures as contributing to their economic situation (Table 4). However, distances between a household's residence and markets and cities can define remoteness. It appears that those who perceived ecological improvements tended to live in more remote villages (Table 4). It has been argued that since local communities have access to larger markets, they are likely to increase their harvest levels for cash income (Colchester, 1994). Market integration may bring new opportunities for households to sell outputs from exclosures. However, an increased harvest level may lead to resource degradation. Exclosures that are remote from markets probably are not exploited as much as the ones close to markets. This may explain why the households living in remote villages more often perceived ecological improvements. However, at the time of the study, most outputs from exclosures in the Tigray Region were used for subsistence. Generally, households living in remote villages have limited access to job opportunities for income generation and rely more heavily on products from nearby resources (Mamo et al., 2007; Soltani et al., 2012). Based on social exchange theory, economic dependence has positive impacts on attitudes (Kuvan and Akan, 2005; Rahman et al., 2017), and this may explain why we observed a positive association between "distance between household's residence and district market" and attitudes towards expansion of exclosures (Table 5). Households with user rights in exclosures under higher pressure (more households per ha of exclosures) had a more positive attitude towards the expansion of exclosures (Table 5) because the current exclosures did not meet their needs. However, if households living in more densely populated areas are faced with shortage of land for expansion of cropland or shortage of firewood, they may develop negative attitudes towards protected areas (Htun et al., 2012).

Household heads' perception of "economic improvement" had positive and significant influence on variable "attitude towards enclosure" while household heads' perception of "local involvement" was negative associated with this variable. Household heads' perceptions of "economic improvement" and "equal access" were associated with the positive attitudes towards expansion of enclosures. This indicates that perceptions of economic improvement and equal access play key roles in attitudes towards enclosures, as reported by other scholars (e.g., Allendorf et al., 2006; McClanahan et al., 2005). Local communities' perceptions of equal access strengthen their sense of ownerships and demotivate them to engage in illegal activities (Birhane et al. 2017). Furthermore, Tigray Bureau of Agriculture and Rural Development was reported to play a leading role in disseminating information about enclosures (Birhane et al. 2017). The management of enclosure was criticized for being a top down process (Lemenih and Kassa, 2014; Segers et al. 2008; Segers et al., 2009). Regardless of the amount of efforts invested by local communities, central and local authorities make most decisions regarding enclosures and local communities were only consulted with the expectation that they agree to participate. This can explain the negative association between the statements under local involvement and the attitudes towards existing enclosures. Schusser et al. (2015) also found that powerful actors had the capacity to decide on the outcomes of community forestry by influencing other actors. Overall, our results show that local perceptions have far more influence on attitudes than variables describing socio-economic context. This may indicate that a number of socio-economic variables have an indirect influence on attitudes through influencing perceptions. If so, this would support the findings made by Allendorf et al. (2006), who have argued that to improve local attitudes towards their surrounding protected areas, much effort must be invested to influence local perceptions.

Table 4. Determinants of local perceptions of exclosures

Variables	Economic improvement		Equal access		Local involvement		Ecological improvement	
	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)	Coef.	(SE)
Constant	-0.43	(0.81)	-1.13	(0.76)	0.42	(0.87)	-0.82	(0.86)
Household's harvest status	0.41	(0.11)***	1.04	(0.10)***	0.42	(0.12)***	-0.06	(0.12)
Low assigned duty	-0.25	(0.23)	0.02	(0.22)	0.54	(0.25)**	-0.35	(0.24)
High assigned duty	-0.02	(0.13)	0.02	(0.12)	0.31	(0.14)**	0.21	(0.14)
Gender of household head	0.06	(0.12)	-0.27	(0.12)**	0.00	(0.12)	0.22	(0.12)*
Log of age of household head	-0.04	(0.38)	-0.22	(0.35)	-0.19	(0.40)	-0.49	(0.40)
Household's average education	0.05	(0.03)	0.02	(0.03)	-0.01	(0.03)	0.03	(0.03)
Household's labor force	0.01	(0.05)	0.08	(0.04)*	0.01	(0.05)	-0.01	(0.05)
Household's crop land area	-0.03	(0.09)	0.09	(0.08)	-0.06	(0.09)	-0.03	(0.09)
Household's herd size	0.05	(0.02)**	-0.03	(0.02)	0.02	(0.02)	-0.02	(0.02)
Number of extension visits	-0.12	(0.03)***	0.07	(0.03)**	-0.04	(0.03)	0.07	(0.03)**
Household's training in exclosure management	0.82	(0.12)***	-0.15	(0.11)	0.16	(0.13)	0.15	(0.12)
Intermediate zone	0.20	(0.34)	0.20	(0.32)	-0.58	(0.37)	1.14	(0.37)***
Highland	0.14	(0.36)	0.32	(0.34)	-0.58	(0.39)	1.25	(0.39)***
Intermediate-age exclosure	-0.04	(0.16)	-0.12	(0.15)	-0.39	(0.17)**	-0.18	(0.17)
Old age exclosure	0.06	(0.16)	-0.36	(0.15)**	-0.08	(0.17)	0.07	(0.17)
Distance between household's residence and the exclosure	-0.18	(.07)***	0.05	(0.06)	0.11	(0.07)	0.01	(0.07)
Distance between household's residence and the district market	0.00	(0.02)	0.03	(0.02)	-0.03	(0.02)	0.04	(0.02)*
Number of households per ha of exclosures	0.05	(0.13)	0.12	(0.12)	0.07	(0.14)	0.12	(0.14)
N (observation number)	446		446		446		446	
R ²	0.257		0.340		0.121		0.159	
Adjusted R ²	0.223		0.310		0.081		0.121	
F statistic	7.648***		11.383***		3.047***		4.169***	

Notes: ***Significant at 1%, ** Significant at 5%, * Significant at 10%

Table 5. Determinants of local attitudes towards exclosures and expansion of exclosures

Variables	Attitude towards	Attitude towards
	exclosures	expansion of exclosures
	Coef. (SE)	Coef. (SE)
Constant	12.78 (14.95)	-3.05 (2.54)
Household's harvest status	5.50 (1.90) ^{***}	-0.86 (0.38) ^{**}
Low assigned duty	-7.32 (2.92) ^{**}	-0.92 (0.65)
High assigned duty	-3.12 (1.55) ^{**}	-0.21 (0.40)
Gender of household head	1.67 (1.47)	0.10 (0.34)
Log of age of household head	-8.69 (5.78)	-1.05 (1.09)
Household's average education	0.04 (0.29)	-0.03 (0.09)
Household's labor force	-0.16 (0.55)	0.18 (0.14)
Household's cropland area	-1.36 (1.15)	0.24 (0.26)
Household's herd size	-0.43 (0.29)	0.09 (0.07)
Number of extension visits	0.93 (0.63)	-0.25 (0.08) ^{***}
Household's training in exclosure management	14.25 (3082.98)	0.52 (0.42)
Intermediate zone	6.02 (9.09)	5.37 (1.46) ^{***}
Highland	1.97 (7.12)	3.64 (1.25) ^{***}
Intermediate-age exclosure	1.55 (5.23)	-0.06 (0.55)
Old exclosure	-0.15 (6.16)	-0.60 (0.60)
Economic improvement	2.88 (1.09) ^{***}	0.55 (0.16) ^{***}
Equal access	0.00 (0.51)	0.27 (0.16) [*]
Local involvement	-1.61 (0.71) ^{**}	0.07 (0.14)
Ecological improvement	0.08 (0.51)	-0.19 (0.14)
Distance between household's residence and the exclosure	0.06 (1.07)	-0.25 (0.22)
Distance between household's residence and the district market	0.40 (0.38)	0.22 (0.06) ^{***}
Number of households per ha of exclosures	2.24 (4.31)	0.94 (0.47) ^{**}
Percentage correctly predicted	98.1	77.2
-2 Log likelihood	43.675	380.588
Model Chi-square	65.132	75.508
P-value	0.000	0.000
Sample size	417	417

Notes: ^{***} Significant at 1%, ^{**} Significant at 5%, ^{*} Significant at 10%

As mentioned, we used social exchange theory to study local household heads' perceptions of and attitudes towards their adjacent exclosures. According to Schwab et al. (2017), social exchange theory provides a better orientation than other theories such as the theory of planned behavior to analyze human interactions with, perceptions of, and attitudes towards nature. By using the social exchange theory, we assumed human being in a reciprocal relationship with nature rather than being in a superior position (Schwab et al. 2017). The theory assumes that the trade-off between the benefits obtained from exclosures and the cost associated with their establishment and maintenance had impacts on both local perceptions and attitudes. This has

been supported here since our findings revealed that those harvesting outputs from exclosures, or possess larger herds and labor perceived positive impacts of exclosures, and those holding positive perceptions of economic improvement hold positive attitudes towards exclosures. Indeed our respondents justified their perceptions of and attitudes towards exclosures in terms of their expectations of benefits and costs. This points at the suitability of social exchange theory for studies of perceptions and attitudes.

However, there are a few shortcomings associated with the current study. First, our results indicated that the majority of local household heads agreed with the establishment of exclosures and hold positive attitudes. One may raise a question regarding technocratic domination in the management process. Scholars previously reported that local authorities tend to press local communities to agree with the establishment of exclosures to reach targets set by the central government (Lemenih and Kassa, 2014; Segers et al., 2008; Segers et al., 2009). The governance of exclosures, identification of powerful actors involved in the management process, and analysis of their power and influence (Krott et al. 2014; Kustanti et al. 2014; Nurrochmat et al. 2017; Schusser et al. 2015) can thus be an orientation of future studies.

Second, exclosures are multi-stakeholder resources. In this study, we examined local household heads' perceptions and attitudes regardless of their interests, power and influence. A village community is not a homogenous unit, and there are several actors within a village with different and conflicting interests. At the same time, external actors such as Tigray Bureau of Agriculture and Rural Development, non-governmental organizations, media and research organizations are involved in the management of exclosures to various extent, and their interests and powers to influence the management of exclosures are substantially different. Identification of political, social, economic and environmental actors that influence the outcomes of exclosures,

examination of their perceptions and attitudes, and analysis of their motives and interests is an idea for future research (Etongo et al., 2018; Kijazi and Kant, 2011; Nurrochmat et al., 2017; Schusser et al. 2015).

Third, one may also question whether respondents expressed their true perceptions and attitudes towards exclosures – if their statements were true expressions of their intrinsic or “real” interests (Nurrochmat et al. 2017). It is possible that local respondents told researchers that they were satisfied with establishment of exclosures because they knew (or assumed) this was what educated people from town wanted them to say. It may be necessary for researchers to observe what people do rather than asking about perceptions and attitudes (Manun’Ebo et al. 2003) to find what local people really think about exclosures. We know that illegal activities such as grazing and firewood collection take place in exclosures. It is an indication that *some* villagers are interested in short term benefits rather than long-term environmental improvements. To conclude that our findings are results of false statements and not expressions of real interests would be an exaggeration, however. There must be a limit to how free a researcher can be in the interpretation of what respondents really mean as opposed to what was actually stated (Urama and Hodge, 2006).

Fourth, power is a central element in the process of any exchange (Nunkoo 2016). Scholars have used power theories such as actor-centered power and power grid matrix to identify powerful actors involved in community forest management in different parts of the world (Krott et al. 2014; Kustanti et al. 2014; Nurrochmat et al. 2017; Schusser et al. 2015). Combination of social exchange theory with power theories can therefore be an interesting path for future research to study perceptions and attitudes (Nunkoo 2016). In this way, we might be

able to build an integrative framework that allows us to test empirically different actors' perceptions and attitudes in connection to their interests, power and influence.

Last, we studied only nine exclosures, and therefore this may raise some concerns regarding the generalization of our findings to the Tigray Region as a whole. A larger number of exclosures might have revealed more variations and provided better predictions of perceptions and attitudes. However, several factors (e.g., agroecological zones, and years since establishment) were considered when designing the study. This stratified sampling may have ensured that the selected exclosures are representative of exclosures in the Tigray Region.

5. Conclusions

Although the study was conducted in the Tigray Region in Ethiopia, our findings have relevance beyond the villages we examined. There are four main findings from our study of local perceptions and attitudes in Tigray Region. First, the majority of local household heads perceived that establishment of exclosures have positive ecological, social and economic impacts. However, the respondents gave lower score to the statements related to economic advantages of exclosures. Second, the majority of household heads had positive attitudes towards existing exclosures and little resistance towards the expansion of exclosures. Third, tangible benefits and costs associated with exclosures, household socio-economic profiles, household's knowledge about exclosures, ecological conditions of exclosures and geographical attributes influence local household heads' perceptions of exclosures. Fourth, our results confirmed that people's perceptions of economic improvement and equal access played important roles in their attitudes towards exclosures.

Our findings have three policy implications. First, to improve local people's attitudes towards their adjacent exclosures, it is important to implement measures that generate economic gains and tangible benefits for local communities. The economic gains generated from exclosures should be sufficient to offset the cost associated with their establishment and expansion. Second, the economic gains should be shared with those directly affected by the establishment of exclosures. The distribution of outputs from exclosures should be fair, such that those who invest more time and effort to maintain the exclosures should benefit more than others. If the management of exclosures is economically profitable, ecologically effective, and combined with proper benefit sharing mechanism, local communities will generally support their establishment and expansions. Third, development agents should provide local people with the information and knowledge that can be used to support their livelihoods and satisfy their basic needs. There is a need to sensitize the development agents in sustainable land use, agriculture, and animal husbandry.

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References

- Aerts, R., Nyssen, J., Haile, M., 2009. On the difference between “exclosures” and “enclosures” in ecology and the environment. *J. Arid. Environ.* 73, 762–763.
- Aipanjiguly, S., Jacobson, S. K., Flamm, R., 2003. Conserving manatees: Knowledge, attitudes, and intentions of boaters in Tampa Bay, Florida. *Conserv. Biol.* 17,1098–1105.
- Akyol, A., Türkoğlu, T., Bekiroğlu, S., Tolunay, A., 2018. Resident perceptions of livelihood impacts arising from the Kızıldağ National Park, Turkey. *Environment, Development and Sustainability*, 20, 1037-1052.
- Allendorf, T. D., 2007. Residents’ attitudes toward three protected areas in southwestern Nepal. *Biodivers. Conserv.* 16, 2087.
- Allendorf, T., Swe, K. K., Oo, T., Htut, Y., Aung, M., Allendorf, K., Hayek, L.-A., Leimgruber, P., Wemmer, C., 2006. Community attitudes toward three protected areas in Upper Myanmar (Burma). *Environ. Conserv.* 33, 344–352.
- Allendorf, T., Yang, J., 2017. The role of gender in local residents’ relationships with Gaoligongshan Nature Reserve, Yunnan, China. *Environment, Development and Sustainability*, 19, 185-198.
- Amacher, G. S., Hyde, W. F., Kanel, K. R., 1996. Household fuelwood demand and supply in Nepal’s tarai and mid-hills: Choice between cash outlays and labor opportunity. *World. Dev.* 24, 1725–1736.
- Amin, A., Zaehring, J. G., Schwilch, G., Koné, I., 2015. People, protected areas and ecosystem services: A qualitative and quantitative analysis of local people’s perception and preferences in Côte d’Ivoire. *A United Nations Sustainable Development Studies.* 39, 97–109.
- Ap, J., 1990. Residents’ perceptions research on the social impacts of tourism. *Ann. Tourism. Res.* 17, 610–616.
- Babulo, B., Muys, B., Nega, F., Tollens, E., Nyssen, J., Deckers, J., Mathijs, E., 2009. The economic contribution of forest resource use to rural livelihoods in Tigray, Northern Ethiopia. *Forest. Policy. Econ.* 11,109–117.
- Badola, R., Barthwal, S., Hussain, S. A., 2012. Attitudes of local communities towards conservation of mangrove forests: A case study from the east coast of India. *Estuar. Coast. Shelf S.* 96,188–196.
- Balana, B.B., Muys, B., Haregeweyn, N., Descheemaeker, K., Deckers, J., Poesen, J., Nyssen, J., Mathijs, E., 2012. Cost-benefit analysis of soil and water conservation measure: The case of exclosures in northern Ethiopia. *Forest. Policy. Econ.* 15, 27-36.
- Baral, N., Heinen, J. T., 2007. Resources use, conservation attitudes, management intervention and park-people relations in the Western Terai landscape of Nepal. *Environ. Conserv.* 34, 64–72.
- Bessie, S., Beyene, F., Kotu, B., Goshu, G., Mengesha, Y., 2014. Local communities’ perceptions of bamboo deforestation in Benishangul Gumuz region, Ethiopia. *Journal of Economics and Sustainable Development*, 5,148–162.
- Birhane, E., Hadgu, K.M., 2014. Community managed exclosures in Tigray, Ethiopia. In de Leeuw, J., Njenga, M., Wagner, B. and Iiyama, M. (eds.): *Treesilience, an assessment of the resilience provided by trees in the drylands of Eastern Africa.* World Agroforestry Center (ICRAF), Nairobi.
- Birhane, E., Mengistu, T., Seyoum, Y., Hagazi, N., Putzel, L., Rannestad, M., Kassa, H., 2017. Exclosures as forest and landscape restoration tools: lessons from Tigray Region, Ethiopia. *Int. Forest. Rev.* 19, 37-50.
- Blau, P., 2017. *Exchange and power in social life.* New York Routledge 372pp.

- Breton, A., 1965. A theory of government grants. *CJEPS/Revue canadienne d'Economie et de Science politique*, 31,175–187.
- Chhokar, J. S., Zhuplev, A., Fok, L. Y., Hartman, S. J., 2001. The impact of culture on equity sensitivity perceptions and organizational citizenship behavior: A five-country study. *International Journal of Value-Based Management*, 14, 79-98.
- Chuang, T.-J., Yen, T.-M., 2017. Public views on the value of forests in relation to forestation projects-A case study in central Taiwan. *Forest. Policy. Econ.* 78, 173-179.
- Charnley, S., Fischer, A. P., Jones, E. T., 2007. Integrating traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest. *Forest. Ecol. Manag.* 246, 14–28.
- Cochran, W. G., 1977. Sampling techniques. Third edition. Oxford, England: Wiley. 428 pp.
- Colchester, M., 1994. Sustaining the forests: the community-based approach in south and south-east Asia. *Dev. Change.* 25, 69–100.
- Cropanzano, R. and Mitchell, M.S. 2005. Social exchange theory: An interdisciplinary review. *Journal of Management* 31(6):874-900.
- Cruces, G., Perez-Truglia, R., Tetaz, M., 2013. Biased perceptions of income distribution and preferences for redistribution: Evidence from a survey experiment. *J. Public. Econ.* 98, 100-112.
- Dewu, S. and Røskaft, E., 2018. Community attitudes towards protected areas: insights from Ghana. *Oryx.* 52(3): 489-496.
- Diiorio, C. K., 2006. Measurement in health behavior: methods for research and evaluation, John Wiley & Sons.
- Dolisca, F., McDaniel, J. M., Teeter, L. D., 2007. Farmers' perceptions towards forests: A case study from Haiti. *Forest. Policy. Econ.* 9,704–712.
- Eagly, A. H., Chaiken, S., 1998. Attitude structure and function. In: Gilbert, D. T., Fiske, S. T., Lindzey, G. (eds.) *The Handbook of Social Psychology*. 4th ed. New York: McGraw-Hill, 269–322.
- Emerson, R.M., 1962. Power-dependence relations. *Am. Sociol. Rev.* 31-41.
- Etongo, D., Kanninen, M., Epule, T. E., Fobissie, K. 2018. Assessing the effectiveness of joint forest management in Southern Burkina Faso: A SWOT-AHP analysis. *Forest. Policy. Econ.* 90, 31-38.
- Gebreegziabher, K., Tadesse, T., 2014. Risk perception and management in smallholder dairy farming in Tigray, Northern Ethiopia. *J. Risk. Res.* 17, 367-381.
- Gebreegziabher, D., Soltani, A., Hofstad, O., 2017. Equity in the distribution of values of outputs from exclosures in Tigray, Ethiopia. *J. Arid Environ.* 146, 75–85.
- Gebremedhin, B., Pender, J., Tesfay, G., 2003. Community natural resource management: The case of woodlots in northern Ethiopia. *Environ. Dev. Econ.* 8,129–148.
- Gilani, H. R., Yoshida, T., Innes, J. L., 2017. A Collaborative Forest Management user group's perceptions and expectations on REDD+ in Nepal. *Forest. Policy. Econ.* 80, 27-33.
- Guthiga, P. M., 2008. Understanding local communities' perceptions of existing forest management regimes of a kenyan rainforest. *International Journal of Social Forestry.* 1, 145-166.
- Hamilton, A., Cunningham, A., Byarugaba, D., Kayanja, F., 2000. Conservation in a region of political instability: Bwindi Impenetrable Forest, Uganda. *Conserv. Biol.* 14,1722–1725.
- Hanafiah, M. H., Jamaluddin, M. R., Zulkifly, M. I., 2013. Local Community Attitude and Support towards Tourism Development in Tioman Island, Malaysia. *Procedia - Social and Behavioral Sciences*, 105, 792-800.
- Hartter, J., 2010. Resource use and ecosystem services in a forest park landscape. *Soc.Natur. Resour.* 23, 207–223.

- Hartter, J., Stampone, M. D., Ryan, S. J., Kirner, K., Chapman, C. A., Goldman, A., 2012. Patterns and perceptions of climate change in a biodiversity conservation hotspot. *PLoS ONE* 7(2): e32408. DOI:10.1371/journal.pone.0032408
- Homans, G.C., 1958. Social behavior as exchange. *Am.J.Sociol.* 63, 597-606.
- Htun, N. Z., Mizoue, N., Yoshida, S., 2012. Determinants of local people's perceptions and attitudes toward a protected area and its management: A case study from Popa Mountain Park, Central Myanmar. *Soc. Natur. Resour.* 25,743–758.
- Hussain, A., Dasgupta, S., Bargali, H. S., 2016. Conservation perceptions and attitudes of semi-nomadic pastoralist towards relocation and biodiversity management: A case study of Van Gujjars residing in and around Corbett Tiger Reserve, India. *Environ. Dev. Sustain.* 18, 57–72.
- Infield, M., Namara, A., 2001. Community attitudes and behaviour towards conservation: An assessment of a community conservation programme around Lake Mburo National Park, Uganda. *Oryx.* 35, 48–60.
- Jurowski, C., Gursoy, D. 2004. Distance effects on residents' attitudes toward tourism, *Ann. Tourism. Res.* 31(2), 296-304.
- Kaeser, A., Willcox, A., 2017. Identifying women's attitudes and barriers to participating in a proposed community-based conservation group in western Belize. *Ambio.*1-12.
- Kaltenborn, B. P., Bjerke, T., Nyahongo, J. W., Williams, D. R., 2006. Animal preferences and acceptability of wildlife management actions around Serengeti National Park, Tanzania. *Biodivers. Conserv.* 15, 4633–4649.
- Karanth, K. K., Kramer, R. A., Qian, S. S., Christensen, N. L., 2008. Examining conservation attitudes, perspectives, and challenges in India. *Biol. Conserv.* 141, 2357–2367.
- Kay, A. C., Jost, J. T., Mandisodza, A. N., Sherman, S. J., Petrocelli, J. V., Johnson, A. L., 2007. Panglossian ideology in the service of system justification: How complementary stereotypes help us to rationalize inequality. *Adv. Exp. Soc. Psychol.*, 39, 305-358.
- Kelley H. H., Thibaut, J. W., 1978. *Interpersonal Relations: A Theory of Interdependence.* New York: John Wiley & Sons., 341 pp.
- Kideghesho, J. R., Røskaft, E., Kaltenborn, B. P., 2007. Factors influencing conservation attitudes of local people in Western Serengeti, Tanzania. *Biodivers. Conserv.* 16, 2213–2230.
- Kijazi, M.H., Kant, S., 2011. Social acceptability of alternative forest regimes in Mount Kilimanjaro, Tanzania, using stakeholder attitudes as metrics of uncertainty. *Forest. Policy. Econ.* 13, 242-257.
- Krott, M., 2005. *Forest policy analysis,* Springer Science & Business Media.
- Krott, M., Bader, A., Schusser, C., Devkota, R., Maryudi, A., Giessen, L., Aurenhammer, H., 2014. Actor-centred power: The driving force in decentralised community based forest governance. *Forest. Policy. Econ.*49, 34-42.
- Kukrety, S., Dwivedi, P., Jose, S., Alavalapati, J. R., 2013. Stakeholders' perceptions on developing sustainable Red Sanders (*Pterocarpus santalinus* L.) wood trade in Andhra Pradesh, India. *Forest. Policy. Econ.*, 26, 43-53.
- Kustanti, A., Nugroho, B., Kusmana, C., Darusman, D., Nurrochmat, D. R., Krott, M., Schusser, C., 2014. Actor, interest and conflict in sustainable mangrove forest management—a case from Indonesia. *International Journal of Marine Science,* 4,150-159.
- Kuvan, Y., Akan, P., 2005. Residents' attitudes toward general and forest-related impacts of tourism: The case of Belek, Antalya. *Tourism Manage.* 26, 691–706.
- Lemenih, H., Kassa, H., 2014. Re-greening Ethiopia: history, challenges and lessons. *Forests.* 5, 1896-1909.

- Mackenzie, C.A., Salerno, J., Hartter, J., Chapman, C. A., Reyna, R., Tumusiime, D. M., Drake, M., 2017. Changing perceptions of protected area benefits and problems around Kibale National Park, Uganda. *J. Environ. Manage.* 200, 217-228.
- Macura, B., Zorondo-Rodríguez, F., Grau-Satorras, M., Demps, K., Laval, M., Garcia, C., Reyes-García, V., 2011. Local community attitudes toward forests outside protected areas in India: Impact of legal awareness, trust, and participation. *Ecol. Soc.* 16(3). <http://dx.doi.org/10.5751/ES-04242-160310>
- Mamo, G., Sjaastad, E., Vedeld, P. 2007. Economic dependence on forest resources: A case from Dendi District, Ethiopia. *Forest. Policy. Econ.* 9, 916–927.
- Manun'Ebo, M, S., Cousens, P., Haggerty, M., Kalengaie, A., Ashworth, Kirkwood, B.,1997. Measuring hygiene practices: a comparison of questionnaires with direct observations in rural Zaire. *Trop. Med. Int. Health.* 2,1015-1021.
- McClanahan, T., Davies, J., Maina, J., 2005. Factors influencing resource users and managers' perceptions towards marine protected area management in Kenya. *Environ. Conserv.* 32, 42–49.
- Mengistu, T., Teketay, D., Hulten, H., Yemshaw, Y., 2005. The role of enclosures in the recovery of woody vegetation in degraded dryland hillsides of central and northern Ethiopia. *J. Arid Environ.* 60, 259-281.
- Mekuria, W., 2013. Changes in regulating ecosystem services following establishing exclosures on communal grazing lands in Ethiopia: A synthesis. *Journal of Ecosystems*, 2013, 1–12.
- Mekuria, W., Veldkamp, E., Haile, M., Nyssen, J., Muys, B., Gebrehiwot, K., 2007. Effectiveness of exclosures to restore degraded soils as a result of overgrazing in Tigray, Ethiopia. *J. Arid Environ.* 69, 270–284.
- Mekuria, W., Veldkamp, E., Tilahun, M., Olschewski, R., 2011. Economic valuation of land restoration: The case of exclosures established on communal grazing lands in Tigray, Ethiopia. *Land. Degrad. Develop.* 22, 334-344.
- Moges, D. M., Taye, A. A., 2017. Determinants of farmers' perception to invest in soil and water conservation technologies in the North-Western Highlands of Ethiopia. *International Soil and Water Conservation Research*, 5, 56–61.
- Muhamad, D., Okubo, S., Harashina, K., Parikesit, Gunawan, B., Takeuchi, K., 2014. Living close to forests enhances people's perception of ecosystem services in a forest-agricultural landscape of West Java, Indonesia. *Ecosyst. Serv.* 8, 197–206.
- Napier, T. L., Napier, A. S., 1991. Perceptions of conservation compliance among farmers in a highly erodible area of Ohio. *J. Soil Water Conserv.* 46, 220–224.
- NORHED. Unpublished document titled 'Summary Report on Reconnaissance Survey to Select and Study the Exclosures in Tigray-prepared for Project Titled "Steps towards Sustainable Forest Management with the Local Communities in Tigray, Northern Ethiopia', produced in 2014 by NORHED, Department of Land Resources Management and Environmental Protection, Mekelle University, Mekelle, Ethiopia.
- Nunkoo, R., 2016. Toward a More Comprehensive Use of Social Exchange Theory to Study Residents' Attitudes to Tourism. *Proc. Econ. Financ.* 39, 588-596.
- Nurrochmat, D.R., Urrochmat, D.R., Nugroho, I. A., Hardjanto, Purwadianto, A., Maryudi, A., Erbaugh, J. T., 2017. Shifting contestation into cooperation: Strategy to incorporate different interest of actors in medicinal plants in Meru Betiri National Park, Indonesia. *Forest. Policy. Econ.* 83, 162-168.
- Olson, G. I., Schober, B. I., 1993. The satisfied poor. *Soc. Indic. Res.* 28, 173-193.
- Ostrom, E., 2005. Self-governance and forest resources. In: Parth Shah, Vidisha Maitra (eds.) *Terracotta Reader: A Market Approach to the Environment*. Academic Foundation, New Delhi, 131–155.

- Paraskevopoulos, S., Korfiatis, K. J., Pantis, J. D., 2003. Social exclusion as constraint for the development of environmentally friendly attitudes. *Soc. Natur. Resour.* 16,759–774.
- Paudyal, K., Baral, H., Keenan, R. J., 2018. Assessing social values of ecosystem services in the Phewa Lake Watershed, Nepal. *Forest. Policy. Econ.*90, 67-81.
- Poppenborg, P., Koellner, T. 2013. Do attitudes toward ecosystem services determine agricultural land use practices? An analysis of farmers' decision-making in a South Korean watershed. *Land. Use. Policy.* 31, 422-429.
- Rahman, M. M., Mahmud, M. A. A., Shahidullah, M., 2017. Socioeconomics of biodiversity conservation in the protected areas: a case study in Bangladesh. *Int. J. Sust. Dev. World.* 24, 65-72.
- Ray, B., Mukherjee, P., Bhattacharya, R.N., 2017. Attitudes and cooperation: does gender matter in community-based forest management?. *Environ. Dev. Econ.* 22,594-623.
- Robinson, E. J. Z., Lokina, R. B., 2011. A spatial–temporal analysis of the impact of access restrictions on forest landscapes and household welfare in Tanzania. *Forest. Policy. Econ.* 13, 79–85.
- Rowen, D., Brazier, J., Young, T., Gaugris, S., Craig, B. M., King, M. T., Velikova, G., 2011. Deriving a Preference-Based Measure for Cancer Using the EORTC QLQ-C30. *Value. Health.*14, 721-731.
- Schusser, C., Krott, M., Movuh, M. C. Y., Logmani, J., Devkota, R. R., Maryudi, A., Salla, M., Bach, N. D., 2015. Powerful stakeholders as drivers of community forestry—Results of an international study. *Forest. Policy. Econ.*58, 92-101.
- Schwab, K., Dustin, D., Bricker, K., 2017. Reframing humankind's relationship with nature: contributions from social exchange theory. *Journal of Sustainability Education.*12.
- Segers, K., Dessein, J., Hagberg, S., Develtere, P., Haile, M., Deckers, J., 2009. Be Like Bees: The Politics of Mobilizing Farmers for Development in Tigray, Ethiopia. *Afr Affairs.*108, 91-109.
- Segers, K., Dessein, J., Nyssen, J., Haile, M., Deckers, J., 2008. Developers and farmers intertwining interventions: the case of rainwater harvesting and food-for-work in Degua Temben, Tigray, Ethiopia. *Int J Agric Sustain.*6, 173-182.
- Shibia, M. G., 2010. Determinants of attitudes and perceptions on resource use and management of Marsabit National Reserve, Kenya. *Journal of Human Ecology*, 30, 55–62.
- Sirivongs, K., Tsuchiya, T., 2012. Relationship between local residents' perceptions, attitudes and participation towards national protected areas: A case study of Phou Khao Khouay National Protected Area, central Lao PDR. *Forest. Policy. Econ.*21, 92-100.
- Skidmore, W., 1979. *Theoretical thinking in sociology*, CUP Archive.
- Sodhi, N. S., Koh, L. P., Clements, R., Wanger, T. C., Hill, J. K., Hamer, K. C., Clough, Y., Tscharntke, T., Posa, M. R. C., Lee, T. M., 2010. Conserving Southeast Asian forest biodiversity in human-modified landscapes. *Biol. Conserv.* 143, 2375–2384.
- Soltani, A., Angelsen, A., Eid, T., Naieni, M. S. N., Shamekhi, T., 2012. Poverty, sustainability, and household livelihood strategies in Zagros, Iran. *Ecol. Econ.* 79, 60–70.
- Soltani, A., Angelsen, A., Eid, T., 2014. Poverty, forest dependence and forest degradation links: evidence from Zagros, Iran. *Environ. Dev. Econ.* 19, 607-630.
- Stickler, M.M., Huntington, H., Haflett, A., Petrova, S., Bouvier, I., 2017. Does de facto forest tenure affect forest condition? Community perceptions from Zambia. *Forest. Policy. Econ.*85, 32-45.
- Stockburger, D. W., 2016. *Multivariate statistics: Concepts, models and applications*. 3rd Web Edition. <http://psychstat3.missouristate.edu/Documents/MultiBook3/mbk.htm>
- Struhsaker, T. T., Struhsaker, P. J., Siex, K. S., 2005. Conserving Africa's rain forests: Problems in protected areas and possible solutions. *Biol. Conserv.* 123, 45–54.

- Sukwika, T., Darusman, D., Kusmana, C., Nurrochmat, D.R., 2016. Evaluating the level of sustainability of privately managed forest in Bogor, Indonesia. *Biodiversitas Journal of Biological Diversity*.17.
- Sullivan, A., York, A. M., An, L., Yabiku, S. T., Hall, S. J. 2017., How does perception at multiple levels influence collective action in the commons? The case of *Mikania micrantha* in Chitwan, Nepal. *Forest. Policy. Econ.*80, 1-10.
- Tadesse, S. A., Teketay, D., 2017. Perceptions and attitudes of local people towards participatory forest management in Tarmaber District of North Shewa Administrative Zone, Ethiopia: The case of Wof-Washa Forests. *Ecol. Process.* 6,1–17.
- Tesfaye, Y., Roos, A., Bohlin, F., 2012. Attitudes of local people towards collective action for forest management: The case of participatory forest management in Dodola area in the Bale Mountains, Southern Ethiopia. *Biodivers. Conserv.* 21, 245–265.
- Tessema, M. E., Lilieholm, R. J., Ashenafi, Z. T., Leader-Williams, N., 2010. Community attitudes toward wildlife and protected areas in Ethiopia. *Soc. Natur. Resour.* 23, 489–506.
- Tomićević, J., Shannon, M. A., Milovanovic, M., 2010. Socio-economic impacts on the attitudes towards conservation of natural resources: Case study from Serbia. *Forest. Policy. Econ.*12, 157-162.
- Turner, J. H., Turner, P. R., 1978. *The Structure of Sociological Theory*. Homewood, IL: Dorsey Press.
- Urama, Kevin C., and Ian D. Hodge., 2006. Are stated preferences convergent with revealed preferences? Empirical evidence from Nigeria. *Ecol.Econ.* 59, 24-37.
- Vodouhê, F. G., Coulibaly, O., Adégbidi, A., Sinsin, B., 2010. Community perception of biodiversity conservation within protected areas in Benin. *Forest Policy Econ.* 12, 505–512.
- Walpole, M. J., Goodwin, H. J., 2001. Local attitudes towards conservation and tourism around Komodo National Park, Indonesia. *Environ. Conserv.* 28,160–166.
- WeForest., 2018. Combatting desertification in northern Ethiopia [Online]. [Accessed <https://www.weforest.org/project/ethiopia-tigray> in June 2018].
- Wegener, B., 1990. Equity, relative deprivation, and the value consensus paradox. *Soc.Justice. Res.* 4, 65-86.
- Whiting, A., 2017. Ethiopia's Tigray Region bags gold award for greening its drylands. Reuters, August 22, 2017. <https://www.reuters.com/article/us-land-farming/ethiopias-tigray-region-bags-gold-award-for-greening-its-drylands-idUSKCN1B21CT>
- Xu, J., Chen, L., Lu, Y., Fu, B., 2006. Local people's perceptions as decision support for protected area management in Wolong Biosphere Reserve, China. *J. Environ. Manage.* 78, 362–372.
- Yayneshet, T., Eik, L., Moe, S., 2009. The effects of exclosures in restoring degraded semi-arid vegetation in communal grazing lands in northern Ethiopia. *J. Arid Environ.* 73, 542–549.
- Zelezny, L. C., 1999. Educational interventions that improve environmental behaviors: A meta-analysis. *The J. Environ. Educ.* 31, 5–14.
- Zeweld, W., Van Huylenbroeck, G., Tesfay, G., Speelman, S., 2017. Smallholder farmers' behavioural intentions towards sustainable agricultural practices. *J.Environ.Manage.*187, 71-81.

Paper III

**Learning from the local communities: Institutions for environmental rehabilitation in
Tigray Region, Ethiopia**

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Abstract:

A comparative study of two systems for management of common pool resources, namely enclosure and traditional protected grasslands, *hizaeti*, was conducted in Tigray region of Ethiopia by selecting three enclosures and one *hizaeti*. Group discussions using participatory rural appraisal were used for data collection. Significant differences were observed among the enclosures in respect of type of land assigned and distribution of outputs. While local authorities mobilized the participation of communities through various strategies, central authorities were responsible for initiating the establishment of enclosures. The *hizaeti*, based on informal rules that evolved internally to avoid degradation of grasslands and secure the livelihoods of local communities, is an efficient governance regime. The management of enclosures has remained a top-down process causing inefficiencies in the system. Therefore, giving more responsibilities to the village communities through autonomy in management of enclosures is likely to ensure more efficient governance of enclosures.

Keywords: Common pool resources, cut and carry, enclosure, *hizaeti*, informal institution, top-down management

1. Introduction

Establishment of exclosures, i.e., closing the most degraded areas to grazing, firewood collection and agricultural uses (Aerts et al., 2009, Mekuria et al., 2007), with a view to restore perennial vegetation and reduce erosion in the northern Ethiopian province of Tigray has received much acclaim (Berhane, 2017, Whiting, 2017). Although historical deforestation in Ethiopia is often exaggerated (McCann, 1997), much vegetation in arid lands in Tigray is seriously degraded (Haileslassie et al., 2005, Mekuria et al., 2009). The establishment of exclosures in such areas has led to improved growth of vegetation and reduced run-off (Hengsdijk et al., 2005, Yayneshet et al., 2009). The expectations of local farmers for economic gains have, however, not been fulfilled (Yami et al., 2013, Gebregziabher and Soltani, 2018). Even if the expectations may not have been fully realistic, these observations point to social and economic marginalization in favour of biological concerns.

The emphasis on biology and environment at the expense of livelihoods and economic benefits might be the result of governance of common pool resources in rural Tigray. According to Adams et al. (1999) most African landscapes can be divided into two broad categories: 'the holding' and 'the common pool resource' (CPR). The holding is land possessed and used relatively exclusively by individuals or households for residential, farming, or some other business activities. The common pool resource is land shared by multiple users for grazing and for gathering forest produce like firewood, building poles, medicinal plants, etc. (Thomson et al., 1992). Such CPRs have two attributes (McKean and Ostrom, 1995, Ostrom, 2000). First, it is costly and difficult to exclude those without access rights from appropriating the resources, and secondly, most of the outputs from CPRs are consumable. Therefore, one unit of output consumed by an appropriator will subtract it from the output available to others. The CPRs may further be broken down into two categories, i.e., controlled access and open access. In the

former category, a group exercises control, having the ability to exclude non-members; possibly also regulating use of the resources by members. The latter category implies the absence of control and effective governance regime (Bromley and Cernea, 1989), and thus the “tragedy of the commons” (Hardin, 1968) will be the likely outcome. According to Ostrom (2005) an effective governance regime for CPRs, defined as setting, applying, enforcing and adjudicating rules (Feeny, 1993), is characterized by certain rules. These rules clearly regulate who is allowed to appropriate outputs; the time, quantity and location of appropriation; who must contribute with labour or funds to maintain and protect the resources; how conflict over appropriation can be resolved; and finally how to respond to socio-economic changes.

Establishment of exclosures in Tigray is clearly an attempt to tighten the control of access to CPRs. In this respect, the type of land that was demarcated as exclosures, the process of introducing the idea of exclosure to local communities and formulating the rules, the type of access given to local communities, and the method of protection are some of the important aspects that need to be investigated. Based on the observation that environmental rehabilitation has taken priority over the livelihood of local people (Gebremedhin et al., 2003, Balana, 2007), we hypothesize that the Bureau of Agriculture and Rural Development (BoARD) is the most powerful actor in the governance of exclosures in Tigray and that the management of exclosures has mainly remained a top-down process.

Although there are many common features of exclosures in Tigray, only a few and limited research investigations were conducted to study the history of establishment and social arrangements governing access (Yami et al., 2006, Yami et al., 2013, Yami et al., 2009). This study represents an effort in this direction by undertaking a few case studies illustrating various paths of conflict and harmony characterizing exclosures. This was done by conducting a

qualitative analysis. Relevant data for the study were collected through participatory rural appraisal (PRA) in three villages each in the vicinity of one enclosure in Tigray. The governance of enclosures was compared with the governance of *hizaeti* – the local term for protected grasslands (Shylendra, 2002) - where access is restricted autonomously by the local communities during the wet season (Kindeya, 1997). Although the study may not be able to falsify (or even less – prove) the proposed hypothesis, yet it should be able to shed some light on the comparative governance under the two land management systems and their institutional arrangements. The study, therefore, aims at addressing the following two main questions: (1) How does the governance of the selected enclosures differ? (2) What are the differences between the governance of enclosure and *hizaeti*?

2. Methods

2.1 Conceptual framework

There has been remarkable discussion over what kind of institutions are optimal to govern CPRs (Agrawal, 2001). The conventional theory of CPRs and “The tragedy of the commons”, a famous article written by Harding (1968), influenced the discussion over the management of CPRs during 1970s (Baland and Platteau, 1996). The conventional theory described the users of CPRs as short-term, profit maximizing actors that behaved independently based on their own self-interest (Feeny et al., 1996). The theory was rather pessimistic about sustainable management of CPRs and predicted overharvesting and resource depletion as outcomes. Thus, private property (Simmons et al., 1996) or centralized state intervention (Ophuls, 1980, Ribot et al., 2008) were recommended as solutions to avoid degradation of CPRs.

The applicability of conventional theory was challenged by the explosion of empirical studies on CPRs (Berkes, 1989, Ostrom, 1990, Gibson et al., 2005, Pagdee et al., 2006, Soltani and

Eid, 2013, Soltani et al., 2014). The theory was criticized for overlooking the fact that the resource users are often able to create institutional arrangements that help them to distribute the resources equitably, and to govern and manage CPRs over long periods of time (Agrawal, 2001, McKean, 1992, Ostrom, 2005). As a consequence of such critique, the management of CPRs has been analysed by scientists from various disciplines by applying property theory, theory of collective actions, and game theory (Olson, 1965, Ostrom, 2000, Sandler, 1992). However, it is difficult to find universal solution and single widely accepted theory for sustainable management of CPRs (Agrawal, 2001). Under different circumstances, any one of private, government or community institutions can prove effective in controlling resource degradation or can simply fail (Acheson, 2006, Young, 2007).

The paradigm of “new institutionalism theory” (North, 1990) was used by several scholars to provide an alternative and rather optimistic view to understand the management of CPRs (Azuela, 2006). Institutions are defined as rules of the game of the society, humanly devised constraints to shape human interactions (North, 1990) or mechanism to restrict irrational and undesirable practices (Ostrom, 1990). Institutions are categorized as formal or informal (North, 1990) based on their emergence, change over time and enforcement of rules. According to North (1990) and Appiah-Opoku and Mulamoottil (1997), informal institutions are codes of behaviour, culture and customs that do not necessarily have a written form. On the contrary, formal institutions are provided with written rules of behaviour. North argues that while informal institutions emerge spontaneously as part of culture in which knowledge of rules is transferred over generations, through oral traditions or by the teaching of traditions (Pejovich, 1998), formal institutions are planned by political actors over a certain period of time. While formal institutions are safeguarded by court or state (Helmke and Levitsky, 2004), informal institutions are not enforced by official sanctions. Thus, the functioning of formal institutions

depends on the support of state where sanctions for breaking rules are clearly determined (Theurl and Wicher, 2012). In case of informal institutions, the sanction mechanism may include exclusion from a group and loss of reputation or alienation by friends and neighbours (Pejovich, 1998).

There exists a large body of literature on the contribution of formal and informal institutions on the management of CPRs. Informal institutions have received relatively greater attention for their role in preventing degradation of CPRs (Yami et al., 2009). For example, informal institutions based on religious beliefs and spiritual values were reported to be successful in protecting trees around religious places in different parts of Africa (Mgumia and Oba, 2003, Bryan, 2004). Informal institutions were also reported to have efficiently managed forest and livestock resources in Zagros, Iran (Soltani et al., 2014, Valipour et al., 2014, Ghazanfari et al., 2004, Soltani and Eid, 2013). Cultural beliefs and taboos were also reported to contribute to nature conservation in other parts of the world (Berkes et al., 2000, Colding and Folke, 2001, Negi, 2010, Millar, 2004). According to Yami et al. (2009), informal institutions have evolved internally to secure livelihoods of local communities and consequently created a sense of commitment and responsibility among the users. However, there are some shortcomings associated with informal institutions in so far as they are unable to offer a comprehensive solution to all problems of management of CPRs (Banana et al., 2007, Tyynelä and Niskanen, 2000, Campbell et al., 2001), and in some other cases even causing resource degradation (Masangano et al., 2003). Overall, it was argued that both formal and informal institutions are influential in achieving sustainable management of CPRs (North, 1990) by preventing outsiders and free-riders in taking advantage of the communities' collective actions (Pagdee et al., 2006). Based on literature review, Yeboah-Assiamah et al. (2017) concluded that both formal and informal institutions can strengthen natural resource governance, even though in

some cases their combination may facilitate resource exploitation, e.g., when a forest guard employed by a state organization is bribed to bend formal rules (Yeboah-Assiamah et al., 2017). In such a case, the action of forest guard is outside the official rules that can be viewed as an informal institution. A study conducted by Lambini and Nguyen (2014) revealed an urgent need to integrate formal and informal rules as a recipe to achieve sustainable forest management in developing countries. Formal institutions in the democratic and decentralized context were found important in avoiding degradation of CPRs (Ribot et al., 2008). Formal institutions were even more successful in cases where new technologies and strategies for management of CPRs were implemented for the first time (Shyamsundar et al., 2005).

In this article, we define informal institutions as rules and agreements developed by local communities living in the vicinity of CPRs having little influence of external actors. The rules are inherited from previous generations and will continue to be passed on to the future generations. An un-written sanction mechanism is in place to prevent free-riders and punish those breaking the rules agreed upon by the village community. The formal institution is defined as the one planned by actors external to the village community, such as, government agencies and officials, over a specific period and safeguarded by external aid with a written system of punishments.

2.2 Description of study sites

The Tigray Region of Northern Ethiopia is bordered by Eritrea to the north, the Amhara Region to the south, the Afar region to the east and Sudan to the west (Figure 1).

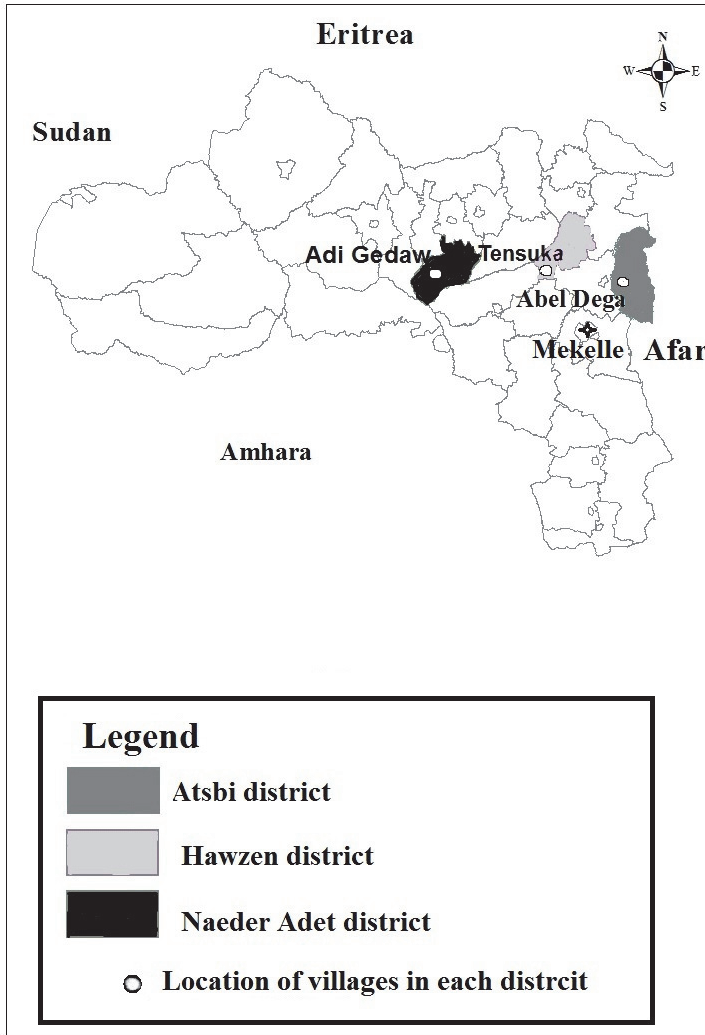


Figure 1. Location of selected enclosures in Tigray Region

The Region suffers from land degradation (Mekuria et al., 2007), and exploitation beyond the carrying capacity of nature. Growing human population pressure has led to deforestation, forest degradation, reduced biodiversity and increased erosion in this region (Girmay et al., 2009, Mekuria et al., 2009). During the 1970s, a number of soil and water conservation measures were initiated for rehabilitating the degraded land (Mekuria, 2013). The authorities soon realized that it was more economical to address land degradation in this region by establishing exclosures. For the purpose of this study, therefore, we selected three exclosures in Tigray region, namely Tensuka, Abel Dega and Adi Gedaw that are adjacent to Koraro, Hayelom and Debre Genet villages, respectively. Croplands, grazing lands, exclosures and settlement are the four main land use types in these villages with mixed crop-livestock system as the main economic activity (Araya, 2014, Bekele et al., 2012). While teff, maize, sorghum and millet are the main crops, rearing of cattle, sheep, goat, donkey, poultry and honeybees are other common economic activities. Livestock are crucially important for several reasons, i.e., draft power for ploughing, source of milk, meat, skins, etc., and stock of value that can be converted into cash during periods of hardship. Consequently, grazing lands and exclosures are important for the local communities. Croplands are grazed commonly during post-harvest period for one month. Table 1 presents some basic information about the selected exclosures.

Table 1. Salient features of the selected exclosures

	Tensuka	Abel Dega	Adi Gedaw
District	Hawzen	Atsbi	Naeder Adet
Year of establishment	2005	1994	1999
Distance to Mekelle from the village (Km)	134	55	329
Adjacent village	Koraro	Hayelom	Debre Genet
Human population with access rights in 2014	1767	585	1210
Area of the exclosures (ha)	168	80	234

2.3 Data collection and analysis

Participatory rural appraisal (PRA, Chambers (1994)) was the main approach to collect the relevant data. Two group discussions were conducted in each village. Key informants, individuals having first-hand information about exclosures and *hizaeti*, and guards of exclosures were invited to participate in these voluntary discussions. The development agents of the village office of BoARD assisted in communicating with the key informants. At the beginning of each group discussion, the first author explained the purpose of the study to participants and clarified that the information would be used purely for research purpose without mentioning any individual names. A list of relevant questions made prior to the group discussions was addressed specifically on: (i) land use type prior to the establishment of exclosures, (ii) introduction of the idea for establishment of exclosures to the local communities, (iii) formulation of by-laws for management of exclosures, (iii) distribution of outputs from the exclosures, and (iv) protection of exclosures and the punishment system for free-riders.

Information on the rules regarding *hizaeti* were collected at Hayelom village. Moreover, each of the participants of the discussion groups was given an opportunity to discuss the issues freely. After obtaining permission of the participants, a standard voice recorder was used during the group discussions to precisely capture the information. The data so recorded was then transcribed into written format and discussed with the researchers from Mekelle University and experts of the BoARD.

3. Results

3.1. Enclosures

The type of lands demarcated as enclosures: The area assigned as Tensuka enclosure was a severely degraded grazing land with deep gullies created by floods. Croplands near this grazing land were also degraded due to wind erosion and livestock grazing. It was brought out during the group discussions that wind erosion was a severe problem in Hawzen district causing loss of soil fertility. The village community perceived less crop damages after the establishment of Tensuka enclosure. The area on which Abel Dega enclosure was established also represented severely degraded grazing land with almost no vegetation. Croplands located on a steep hillside were demarcated as Adi Gedaw enclosure.

The process of establishing enclosures: The participants in the groups summarized the process of establishing enclosures as follows. First, the development agents of BoARD and the village administration presented the idea to key informants, religious leaders and elderly farmers, and suggested prioritized and suitable areas for enclosures. Secondly, the key informants and religious leaders raised awareness among the local communities on the importance of rehabilitation of degraded land areas by establishing enclosures. The participants in Koraro village narrated the contribution of community leaders in convincing the inhabitants about the urgency of establishing enclosures by putting forth the following argument:

“The grazing land is already severely degraded due to grazing pressure and floods. The lands will be further degraded unless suitable measures are undertaken in time. Consequently, we may have to migrate to other places. After we have left the area, the land will be rehabilitated gradually overtime. Grass and trees will come back and the area will be green again. That will then attract people from other areas to migrate and settle here (group discussion conducted in Koraro village, October 2015).”

The process of raising awareness was slightly different in Debre Genet village where the village administration, development agents of BoARD, experts from District office of Agriculture and Rural Development (DoARD) and experts from district administration through several meetings highlighted to the village community the negative consequences of continued cultivation on steep slopes. In addition, those owning such croplands were promised compensation in the form of suitable land areas for cultivation. Finally, agreement was reached with the villagers, and the decision on the establishment of enclosure made.

After the enclosure was demarcated, DoARD prepared a draft containing a set of written rules for management of enclosures. The draft was presented to the village administration and the development agents in each village. The rules were framed to regulate the local communities' access to the enclosures, including the magnitude of fines that must be levied for various violations. Later on, the draft was presented to each village community in a meeting to receive comments and suggestions for improvements. The draft was then modified accordingly and village bylaws for management of enclosure (locally named *serit*) were finalized. The document was signed by the development agents, village administration and local community representatives. Since the district office and village administration played a key role in formulating the bylaws, hence the documented rules incorporated strong concerns about the control of illegal activities.

Distribution of outputs from enclosures: Grass was the main output from the enclosures. It was harvested through cut and carry system. Villagers harvested grass and then carried it to homesteads where they stored it for feeding to their livestock. Participants in the group discussions mentioned that the cut and carry fodder system was more labour demanding than livestock husbandry based on grazing system. Therefore, they were sceptical about the

expansion of existing exclosures. Moreover, the harvest of grass in exclosures was allowed only for a limited duration during a specific period of the year as decided by the development agents of BoARD. The permission to harvest grass was granted mostly in the month of September when the villagers face serious shortage of fodder. The distribution of grass varies from one exclosure to another. Villagers in Hayelom and Debre Genet divided the area of exclosures into several plots of approximately equal size. The access right to harvest grass in each plot was then given to a group of ten villagers. The area of each plot was further subdivided equally among the members of the group. To account for variations in grass production over the plots, the plot distribution among various groups is changed every year. According to the participants in the group discussions division of exclosure among small groups has led to an efficient management by reducing the incident of free riders. In contrast, villagers living near Tensuka exclosure followed an entirely different system. Each of them harvested grass without dividing the area of the exclosure among themselves. Members of Koraro village community held access rights to collect as much grass from Tensuka exclosure as they could, depending on their respective family labour resources.

There has been a serious conflict among those having access rights to Adi Gedaw exclosure since 2011 as noticed during the group discussions. It was reported by some individuals that only those whose croplands had been demarcated as Adi Gedaw exclosure were given the access rights to harvest grass from it. Others, however, did not confirm the existence of such an agreement. The issue was specifically raised during the second group discussion in Debre Genet village. The participants mentioned that during the time of establishment of Adi Gedaw exclosure no proper land evaluation procedure was used that could form a basis for compensation to cropland owners whose lands were acquired to establish the exclosure. The owners of the croplands were allotted alternate lands as compensation within the village

boundary, but they claimed that the allotted areas were small and less fertile. Therefore, they abandoned the allotted lands and demanded access rights to harvest grass from Adi Gedaw exclosure. Such claims have been forwarded to the village and district administration offices. Others in the village believed that the access rights to harvest grass belonged to all those who reside adjacent to the exclosure. The conclusion drawn was that the conflict has influenced the management of the exclosure negatively, and that it needs to be resolved to the satisfaction of all stakeholders.

Several tree species, including eucalyptus, have been planted in Abel Dega exclosure since its establishment. The development agents of BoARD presented the idea of planting eucalyptus to the village community and provided them with the necessary inputs. It was, however, pointed out by the participants that the development agents did not always consult the local community in the matter of selection of tree species. Besides this, no management plan was prepared and village community was not allowed to make their own decisions about the harvest of eucalyptus. Instead, when the trees were mature, villagers had to approach the DoARD officials for permission to harvest. The money so obtained from the harvest, mainly as poles, was invested in the extension of electric grid in the village.

Local community in Koraro village was permitted to collect wild *Ziziphus* fruits from the exclosure. This fruit is edible and could be sold in the district market at a price of 3.60 Ethiopian Birr /kg (1USD = 20 Ethiopian Birr, October 2015). There was no restriction on the quantity of fruits that each family could collect. Local communities in the study villages in general and those living adjacent to Tensuka exclosure in particular have often experienced shortage of firewood. They had to travel long distances to find firewood. Thus, the establishment of exclosure added to the difficulties of inhabitants of the area and led to degradation of natural

resources in other areas. Villagers had different strategies to cope with the shortage of firewood. For example, if someone needed firewood in Debre Genet village for a ceremony, such as, wedding or other religious ceremonies, they could apply for purchasing it subject to the availability of deadwood in Adi Gedaw exclosure. A committee nominated by the villagers decided upon such an application and if accepted, the applicant could collect the permitted quantity of deadwood from the exclosure. The money so obtained from the sale of deadwood by the village community was utilized for common welfare purposes in the village.

Protection of exclosures: In all the study sites, BoARD employed guards to protect the exclosures. The guards are expected to have good physique and ability to interact and live in the villages. Average monthly salary of a guard was about 600 Ethiopian Birr. They, however, did not receive their salaries on a regular monthly basis. Respondents also mentioned the conflict between the guards and villagers during the group discussions especially in Koraro village. The conflict arose due to the fact that the guards lived in the same village against whose residents they had to report whenever the latter indulged in illegal activities. It caused discomfort or ostracism among neighbours and friends of the reported person. Village elders, however, usually helped resolving such conflicts. Participants of the group discussions in Hayelom village mentioned that the location of Abel Dega exclosure has been troublesome at least for some of the villagers. The exclosure was located very close to the settlement that rendered it difficult for the villagers to prevent their livestock from entering into it. Consequently, those living near the exclosure have often been charged for violations when their animals were found grazing in the exclosure. If someone fell trees within the exclosures, the case is tried in the village court and the offender may get imprisonment for one to five years and fine of 10000 Ethiopian Birr. According to the local authorities, the magnitude of the fine

is determined based on the timing and frequency of the illegal activity. The fine was often larger when the illegal activity was practised during night time or repeatedly.

3.2. Protected grasslands

In Hayelom village local community followed a traditional management system of *hizaeti* to protect grasslands. It was aimed at protecting the grasslands against human interference and livestock grazing by closing them during the rainy season for about three months (from first week of July to the beginning of October). In general, only oxen were allowed to graze in the *hizaeti* because of their importance to the crop-livestock system. The period of grazing was determined by a committee in the village and the same was strictly enforced. The shortage of fodder and the amount and the duration of yearly rainfall determine the duration of the closing period. The village community assumes responsibility for protecting the grassland by nominating two villagers, locally known as '*meajas*', each year. The *meajas* are responsible to assign guards to protect *hizaeti* and schedule the time of guarding. The guards are selected from amongst the villagers having grazing rights in the *hizaeti*. Whenever the guards failed in their duty in protecting *hizaeti*, they are reprimanded. The *meajas* were also responsible to punish those who grazed their livestock in *hizaeti* during the rainy season. The penalty for illegal grazing in *hizaeti* was 5 EB for a small ruminant and 10 EB for the large ruminant. If and when someone fell a tree within the *hizaetis*, the case is tried in the village court on the same pattern as for felling a tree in the exclosures. Each household in the village contributed 10 EB per month from July to October towards a fund that along with the amount of fines is utilised by *meajas* to arrange social gatherings in the village. Some villagers who kept no oxen, borrowed oxen from others during the ploughing period, as a compensation for not having accessed *hizaeti*.

Importance of *hizaeti* for livestock husbandry was highlighted during the group discussions. The village community was unwilling to convert *hizaeti* into enclosure. Inhabitants of the village did show awareness about the negative effects of grazing on the quality and quantity of grass, and also about the fact that grazing may increase the energy consumption of livestock due to need to travel long distances in search of grasslands. The following reasons were mentioned for the resistance against conversion of *hizaeti* to enclosure. First, zero grazing system or cut and carry system of grass was labour demanding. Secondly, through cut and carry grass system, villagers were allowed to harvest grass only. This was not worth the effort when the grass productivity was low. The guard of Abel Dega narrated his experience in the following words:

“Two grasslands under *hizaeti* in our neighbourhood were changed to enclosures. Our neighbours, however, regret the decision because they are now allowed to harvest only grass once a year following cut and carry system. This is very labour demanding. Also, they are not allowed to graze their animals anymore. We were also asked by DoARD to change our *hizaetis* to enclosures but learning from the experience of our neighbours we did not agree to the proposal.”

Based on the information gathered during the group discussions in Hayelom village, the differences between enclosures and *hizaeti* are summarized in Table 2. The establishment of enclosures and the formulation of relevant bylaws for their use were initiated by external actors, i.e., the DoARD, as against the establishment of *hizaeti* by the local community. The village community and both the local and district authorities were involved in the management of enclosures. This limits the local communities' power in the management of enclosures. In contrast, the village community was the only stakeholder to make the management decisions in respect of *hizaeti*. Enclosures having been invented only during the last few decades, the

village bylaws for their management were rather new. It is not clear if these bylaws will be carried to the next generation. Contrary to this, the *hizaeti* system has been practiced over several decades and the rules of their management have been passed over generations. The management of exclosures were safeguarded formally by DoARD and BoARD and the village court, but grasslands were controlled by *meajas* under an informal sanction system. In both systems, grass for fodder was the main output. While grass could be harvested only through cut and carry system (zero grazing) in exclosures, grazing was the common way of utilizing grass from *hizaeti*.

Table 2. The difference between the governance of exclosures and protected grasslands

	Exclosures	<i>Hizaeti</i>
Innovator	DoARD	Local communities
Main decision maker	DoARD and village community	Local communities
History of management system	24 years	Several decades
Protection	Guards employed by DoARD	Local communities on rotational basis
Sanction system	Village court – Formal system	Informal sanction system implemented by <i>meajas</i>
Length of management	Throughout the year	Rainy season
Harvesting system	Cut and carry system for grass	Grazing

DoARD: District Office of Agriculture and Rural Development

4. Discussion

Two different types of land rehabilitation systems practiced for management of CPRs in Tigray were investigated and compared using data collected through PRA. Regarding the first research question, significant differences were observed among the three studied exclosures in respect of the type of land assigned, the process of establishment, and the way the outputs from each were distributed. As far as the protection of exclosures was concerned, armed guards were in control in each case. Prior to establishment, two of the exclosures were used for grazing while the third one was used for cultivation. However, those lands were marginal. This suited the

local communities since the chosen land areas had low economic value. At the same time, it also met the objective of the regional and local authorities in respect of the environmental protection.

The regional and local authorities played a leading role in disseminating information about the necessity and importance of establishing the exclosures and devising village bylaws for the management of exclosures. In the study villages, the proposals for establishment of exclosures came from the BoARD. The villagers were consulted with the expectation that they would agree to such proposals. The government officials had motivated the local communities to agree for the establishment of exclosures either by creating awareness about the negative impacts of land degradation on local communities' livelihood (in the case of Koraro village) or promising them compensation (in Debre Genet village). The government officials played a key role in the process of identification and selection of areas for the establishment of exclosures. According to the government agencies, any objection to the establishment of exclosures was due to insufficient knowledge of the villagers about the positive impacts of exclosures. Thus, raising awareness among local communities about environmental rehabilitation was considered vital for the successful establishment of exclosures. Local communities in Tigray Region might have been historically accustomed to and learned to cope with the development of negative environmental pressure (Segers et al., 2008). Local government officials mobilized the participation of village communities in the rural development programmes either by highlighting the advantages of such programs or by rewarding those who agreed to participate (Segers et al., 2009). In some cases, local authorities had used their administrative power by limiting the benefits offered by the government, such as, access to credit and agricultural inputs (Gebremichael and Waters-Bayer, 2007), of those who did not agree to participate in rural development programs. Thus, the policy consisted of carrot and stick approach. This was partly

due to the fact that the local authorities tended to press village communities to participate in order to fulfil the targets set by the government as described by Lemenih and Kassa (2014).

As mentioned by Aerts et al. (2009), the term exclosures refers to areas that have been closed off to protect against interference from people and livestock. From the biological point of view, this makes a perfect sense. However, from the social and institutional point of view, however, it was difficult to use the same term for all the exclosures in Tigray as the same have been governed and managed in significantly different ways. While some exclosures were managed jointly by the community, others seemed to develop in the direction of private property. Besides others were managed by the BoARD that resemble closely to state owned property. The management of exclosures also varied according to the type of output. For example, the harvest of grass in Tensuka exclosure was commonly managed, while, the eucalyptus plantation in Abel Dega exclosure was almost state managed where the district office made decisions on the type of species to be planted and the time to harvest. The role of the village community was limited only to implementation part.

Regarding the second research question, a number of differences were found between the governance of exclosures and *hizaetis*. There is no doubt that natural resources in Tigray region are under pressure. The negative environmental trends and severity of land degradation are illustrated by the regional statistics (Mekuria et al., 2009, Hailelassie et al., 2005, Girmay et al., 2009). Our local-level analysis showed that villagers have established institutions to ensure sustainable management of *hizaeti* over time with a view to maintain the delicate balance with the natural resources on which they depend. The local institutions for management of *hizaeti* designed and enforced rules to regulate the access of local communities to land and mobilize their collective actions. The assignment of patrolling the *hizaeti* is circulated among community

members done so as to ensure that grazing does not take place during the closed period. Besides, the local institutions in their effort to manage *hizaeti* have contributed in reducing inequality among villagers by either providing them with access rights to grasslands or lending oxen-pairs to those who had no oxen of their own at the time of ploughing. On the basis of this study, and using the description of an efficient governance system given by Ostrom (1990), we conclude that the management of *hizaeti* is an efficient system. The rules of management of *hizaeti* clearly regulate as to who is allowed to graze what type of livestock, when and where the grazing is allowed, who should contribute labour to protect the grassland, how the conflict over grazing can be solved, and how the free riders and violators of rules can be punished.

All in all, it may be concluded that the management of exclosures remains to some extent a top-down and non-autonomous process. This seriously obscures the real structure of power in rural societies of Tigray. Actors in power establish exclosures, design bylaws, and administer guards. The top-down process has been observed in a context where peasant-state relations have been always hierarchic (Gebremedhin et al., 2006, Rami, 2003, Awulachew et al., 2005, Tefera et al., 2004, Bewket, 2007). Concerns that the establishment of exclosures is not fully participatory have been raised before (Segers et al., 2008, Segers et al., 2009, Lemenih and Kassa, 2014). However, the ecological and environmental advantages of establishment of exclosures found by earlier studies cannot be undermined (Hengsdijk et al., 2005, Yayneshet et al., 2009). Importance of formal institutions for implementing new strategies to manage CPRs, such as establishment of exclosures, is obvious due to their bureaucratic authority (Girmay, 2006). The bylaws for management of exclosures were described as informal institutions (Yami et al., 2013), but this seems only to be a part of a euphemist narrative that exclosures are the result of local communities' own initiative. Exclosures are established on the initiative of external agents and managed according to formal institutions. *Hizaeti* or the

traditional protected grassland, on the other hand, is governed and managed based on informal institutions.

5. Concluding remarks

There are three main findings from this study of two different types of land rehabilitation systems in Tigray Region of Ethiopia. First, local communities attempt to maintain a fragile balance between carrying capacity and utilization of natural resources by establishing informal rules. Secondly, the management of exclosures follows a top-down decision making process with limited local community participation. Thirdly, exclosures are very diverse in terms of their institutional and socio-economic background. The findings highlight three major policy implications. First, the management of exclosures is to a great extent dependent on external support from the BoARD and DoARD. This can be counterproductive as it may reduce the collective actions and local communities' efforts to initiate and organize themselves in their land rehabilitation activities. Devolving the responsibilities and activities to the village communities is recommended for more efficient management of exclosures. Secondly, the bylaws for management of exclosures need to be revised. The current bylaws focus mainly on penalizing the offenders, guarding and harvesting of grass using cut and carry system. While revising the current bylaws, reasonable balance between environmental and economic goals should be maintained. Thirdly, the knowledge base of existing traditional and informal institutions for land rehabilitation should be utilised to create and develop suitable new strategies for the rehabilitation of degraded CPRs. There is no doubt that informal institutions can greatly help initiating collective actions and excluding outsiders and free-riders at a much lower cost as compared to that by the formal institutions.

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References:

- ACHESON, J. M. 2006. Institutional failure in resource management. *Annu. Rev. Anthropol.*, 35, 117-134.
- ADAMS, M., SIBANDA, S. & TURNER, S. D. 1999. *Land tenure reform and rural livelihoods in Southern Africa*, Overseas Development Institute London.
- AERTS, R., NYSSSEN, J. & HAILE, M. 2009. On the difference between “exclosures” and “enclosures” in ecology and the environment. *Journal of Arid Environments*, 73, 762-763.
- AGRAWAL, A. 2001. Common property institutions and sustainable governance of resources. *World Development*, 29, 1649-1672.
- APPIAH-OPOKU, S. & MULAMOOTIL, G. 1997. Indigenous Institutions and Environmental Assessment: The Case of Ghana. *Environmental Management*, 21, 159-171.
- ARAYA, K. 2014. *GIS and RS Based Assessment of Area Exclosure and Vegetation Cover Change in KoraroTabia, HawzenWoreda*. Mekelle University.
- AWULACHEW, S. B., MERREY, D. J., KAMARA, A.B., VAN KOPPEN, B., PENNING DE VRIES, F., BOELEEE, E. & MAKOMBE, G. 2005. Experiences and Opportunities for Promoting Small-scale/Micro Irrigation and Rainwater Harvesting for Food Security in Ethiopia. Working paper No. 98. Colombo: International Water Management Institute (IWMI).
- AZUELA, A. 2006. Illegal logging and local democracy: between communitarianism and legal fetishism. *Ambiente & Sociedade*, 9, 9-22.
- BALANA, B. B. 2007. Economic valuation and management of common-pool resources: the case of exclosures in the highlands of Tigray, Northern Ethiopia.
- BALAND, J. M. & PLATTEAU, J. P. 1996. *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?*, Oxford: Clarendon Press.
- BANANA, A. Y., VOGT, N. D., BAHATI, J. & GOMBYA-SSEMBAJJWE, W. 2007. Decentralized governance and ecological health: why local institutions fail to moderate deforestation in Mpigi district of Uganda. *Scientific Research and Essays*, 2, 434-445.
- BEKELE, Y., TADESSE, N. & KONKA, B. 2012. Preliminary study on the impact of water quality and irrigation practices on soil salinity and crop production, Gergera Watershed, Atsbi-Wonberta, Tigray, Northern Ethiopia. *Momona Ethiopian Journal of Science*, 4, 29-46.
- BERHANE, D. 2017. *Ethiopia's Tigray region earns Gold in UN-backed award for conservation* [Online]. Tigray, Ethiopia: Horn affairs. Available: <https://hornaffairs.com/2017/08/22/ethiopia-tigray-earns-gold-award-conservation/> [Accessed 25.04.2018].
- BERKES, F. 1989. *Common property resources: ecology and community based sustainable development*, London, UK, Belhaven Press.
- BERKES, F., COLDING, J. & FOLKE, C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological applications*, 10, 1251-1262.
- BEWKET, W. 2007. Soil and water conservation intervention with conventional technologies in northwestern highlands of Ethiopia: Acceptance and adoption by farmers. *Land Use Policy*, 24, 404-416.
- BROMLEY, D. W. & CERNEA, M. M. 1989. *The management of common property natural resources: Some conceptual and operational fallacies*, World Bank Publications.
- BRYAN, T. A. 2004. Tragedy Averted: The Promise of Collaboration. *Society & Natural Resources*, 17, 881-896.

- CAMPBELL, B. M., MANDONDO, A., NEMARUNDWE, N., SITHOLE, B., DE JONG, W., LUCKERT, M. & MATOSE, F. 2001. *Challenges to proponents of common property resource system: despairing voices from the social forests of Zimbabwe*.
- CHAMBERS, R. 1994. The origins and practice of participatory rural appraisal. *World Development*, 22, 953-969.
- COLDING, J. & FOLKE, C. 2001. Social Taboos: "Invisible" Systems of Local Resource Management and Biological Conservation. *Ecological Applications*, 11, 584-600.
- FEENY, D. 1993. The Demand for and Supply of Institutional Arrangements. *Rethinking Institutional Analysis and Development*. San Francisco: ICS Press.
- FEENY, D., HANNA, S. & MCEVOY, A. F. 1996. Questioning the Assumptions of the "Tragedy of the Commons" Model of Fisheries. *Land Economics*, 72, 187-205.
- GEBREGZIABHER, D. & SOLTANI, A. 2018. Enclosures in people's mind: perceptions and attitudes in Tigray. *Unpublished*.
- GEBREMEDHIN, B., HOEKSTRA, D. & TEGEGNE, A. 2006. Commercialization of Ethiopian agriculture: extension service from input supplier to knowledge broker and facilitator. Improving Productivity and Market Success of Ethiopian Farmers Project (IPMS). IPMS Working Paper 1. Nairobi (Kenya): ILRI.
- GEBREMEDHIN, B., PENDER, J. & TESFAY, G. 2003. Community natural resource management: the case of woodlots in northern Ethiopia. *Environment and Development Economics*, 8, 129-148.
- GEBREMICHAEL, Y. & WATERS-BAYER, A. 2007. *Trees are our backbone: integrating environment and local development in Tigray Region of Ethiopia*, International Institute for Environment and Development (IIED): London, UK.
- GHAZANFARI, H., NAMIRANIAN, M., SOBHANI, H. & MARVI MOHAJER, M. R. 2004. Traditional forest management and its application to encourage public participation for sustainable forest management in the northern Zagros mountains of Kurdistan province, Iran. *Scandinavian Journal of Forest Research*, 19, 65-71.
- GIBSON, C. C., WILLIAMS, J. T. & OSTROM, E. 2005. Local enforcement and better forests. *World Development*, 33, 273-284.
- GIRMAY, G., SINGH, B., NYSSSEN, J. & BORROSEN, T. 2009. Runoff and sediment-associated nutrient losses under different land uses in Tigray, Northern Ethiopia. *Journal of Hydrology*, 376, 70-80.
- GIRMAY, T. 2006. *Agriculture, resource management and institutions: A socioeconomic analysis of households in Tigray, Ethiopia*. Ph.D. Dissertation, Wageningen University, Netherlands. .
- HAILESLASSIE, A., PRIESS, J., VELDKAMP, E., TEKETAY, D. & LESSCHEN, J. P. 2005. Assessment of soil nutrient depletion and its spatial variability on smallholders' mixed farming systems in Ethiopia using partial versus full nutrient balances. *Agriculture, Ecosystems & Environment*, 108, 1-16.
- HARDIN, G. 1968. The tragedy of the commons. *Science*, 162, 1243-1247.
- HELMKE, G. & LEVITSKY, S. 2004. Informal Institutions and Comparative Politics: A Research Agenda. *Perspectives on Politics*, 2, 725-740.
- HENGSDIJK, H., MEIJERINK, G. & MOSUGU, M. 2005. Modeling the effect of three soil and water conservation practices in Tigray, Ethiopia. *Agriculture, ecosystems & environment*, 105, 29-40.
- KINDEYA, G. 1997. Area Enclosures as an Approach in the Management of Dryland Biodiversity: A Case Study in Tigray Region. *Mekelle University, Mekelle*.
- LAMBINI, C. K. & NGUYEN, T. T. 2014. A comparative analysis of the effects of institutional property rights on forest livelihoods and forest conditions: Evidence from Ghana and Vietnam. *Forest Policy and Economics*, 38, 178-190.

- LEMENIH, H. & KASSA, H. 2014. *Re-greening Ethiopia: history, challenges and lessons*.
- MASANGANO, C. M., KAYAMBAZINTHU, D. & MWABUMBA, L. 2003. Conflicts over the miombo woodlands: The case of Blantyre, Lilongwe and Kasungu, in Malawi. *Policies and Governance Structures in Woodlands of Southern Africa*. Center for International Forestry Research.
- MCCANN, J. C. 1997. The plow and the forest: Narratives of deforestation in Ethiopia, 1840-1992. *Environmental History*, 2, 138-159.
- MCKEAN, M. & OSTROM, E. 1995. Common property regimes in the forest: just a relic from the past. *Unasylva*, 46, 3-15.
- MCKEAN, M. A. 1992. Management of Traditional Common Lands (Iriaichi) in Japan. In: BROMLEY, D. W. (ed.) *Making the Commons Work: Theory, Practice, and Policy*. San Francisco.
- MEKURIA, W. 2013. Changes in regulating ecosystem services following establishing exclosures on communal grazing lands in Ethiopia: a synthesis. *Journal of Ecosystems*, 2013.
- MEKURIA, W., VELDKAMP, E., HAILE, M., GEBREHIWOT, K., MUYS, B. & NYSSSEN, J. 2009. Effectiveness of exclosures to control soil erosion and local communities perception on soil erosion. *African Journal of Agricultural Research*, 4, 365-377.
- MEKURIA, W., VELDKAMP, E., HAILE, M., NYSSSEN, J., MUYS, B. & GEBREHIWOT, K. 2007. Effectiveness of exclosures to restore degraded soils as a result of overgrazing in Tigray, Ethiopia. *Journal of Arid Environments*, 69, 270-284.
- MGUMIA, F. & OBA, G. 2003. Potential role of sacred groves in biodiversity conservation in Tanzania. *Environmental Conservation*, 30, 259-265.
- MILLAR, D. Interfacing two knowledge systems: Local knowledge and science in Africa. Compass panel in the conference: Bridging scales and epistemologies: linking local knowledge with global science in multi-scale assessments, 2004. Citeseer.
- NEGI, C. S. 2010. Traditional Culture and Biodiversity Conservation: Examples From Uttarakhand, Central Himalaya. *Mountain Research and Development*, 30, 259-265.
- NORTH, D. C. 1990. *Institutions, institutional change and economic performance*, Cambridge, Cambridge University Press.
- OLSON, M. 1965. *The Logic Of Collective Action: Public Goods and the Theory of Groups*. Harvard University Press; Cambridge, MA.
- OPHULS, W. 1980. Leviathan or oblivion? In: DALY, H. E. (ed.) *Towards a Steady-State Economy*. Freeman, San Francisco.
- OSTROM, E. 1990. *Governing the commons: the evolution of institutions for collective action*, New York, Cambridge University Press.
- OSTROM, E. 2000. Collective action and the evolution of social norms. *Journal of economic perspectives*, 14, 137-158.
- OSTROM, E. 2005. Self-governance and forest resources. *Terracotta reader: a market approach to the environment*. Academic Foundation, New Delhi, 131-155.
- PAGDEE, A., KIM, Y.-S. & DAUGHERTY, P. J. 2006. What makes community forest management successful: a meta-study from community forests throughout the world. *Society and Natural Resources*, 19, 33-52.
- PEJOVICH, S. 1998. Toward a theory of the effects of the interaction of formal and informal institutions on social stability and economic development. *Conference Paper, University of Potsdam*.
- RAMI, H. 2003. *Ponds Filled with Challenges: Water Harvesting Experiences in Amhara and Tigray*. Addis Ababa: UN Office for the Coordination of Humanitarian Affairs (OCHA) Ethiopia.

- RIBOT, J. C., CHHATRE, A. & LANKINA, T. 2008. Introduction: Institutional choice and recognition in the formation and consolidation of local democracy. *Conservation and Society*, 6, 1.
- SANDLER, T. 1992. *Collective action: Theory and applications*, University of Michigan Press.
- SEGERS, K., DESSEIN, J., HAGBERG, S., DEVELTERE, P., HAILE, M. & DECKERS, J. 2009. Be Like Bees: The Politics of Mobilizing Farmers for Development in Tigray, Ethiopia. *African Affairs*, 108, 91-109.
- SEGERS, K., DESSEIN, J., NYSSSEN, J., HAILE, M. & DECKERS, J. 2008. Developers and farmers intertwining interventions: the case of rainwater harvesting and food-for-work in Degua Temben, Tigray, Ethiopia. *International Journal of Agricultural Sustainability*, 6, 173-182.
- SHYAMSUNDAR, P., ARARAL, E. & WEERARATNE, S. 2005. Shyamsundar, Priya; Araral, Eduardo; Weeraratne, Suranjan. 2005. Devolution of resource rights, poverty, and natural resource management: a review (English). Environmental working paper no. 104 ; environmental economics series. Washington, DC: World Bank. <http://documents.worldbank.org/curated/en/300351468321286575/Devolution-of-resource-rights-poverty-and-natural-resource-management-a-review>.
- SHYLENDRA, H. S. 2002. Environmental Rehabilitation and Livelihood Impact: Emerging Trends from Ethiopia and Gujarat. *Economic and Political Weekly*, 37, 3286-3292.
- SIMMONS, R. T., SMITH, F. L. & GEORGIA, P. 1996. The Tragedy of the Commons Revisited: Politics vs. Private Property.
- SOLTANI, A. & EID, T. 2013. Organization, practices and performance of community-based traditional forest management—empirical evidence from Zagros, Iran. *Forests, Trees and Livelihoods*, 22, 19-37.
- SOLTANI, A., SANKHAYAN, P. L. & HOFSTAD, O. 2014. A dynamic bio-economic model for community management of goat and oak forests in Zagros, Iran. *Ecological Economics*, 106, 174-185.
- TEFERA, T. L., PERRET, S. & KIRSTEN, J. F. 2004. Diversity in livelihoods and farmers' strategies in the hararghe highlands, Eastern Ethiopia. *International Journal of Agricultural Sustainability*, 2, 133-146.
- THEURL, T. & WICHER, J. 2012. Comparing Informal Institutions. *DICE Report*, 10, 52.
- THOMSON, J. T., FEENY, D. & OAKERSON, R. J. 1992. Institutional dynamics: the evolution and dissolution of common-property resource management. In: BROMLEY, D. W. (ed.) *Making the commons work: theory, practice and policy*
- TYYNELÄ, T. & NISKANEN, A. 2000. Use and sustainability of miombo woodlands under community management in Zimbabwe. *Nordic Journal of African Studies*, 9, 118-143.
- VALIPOUR, A., PLIENINGER, T., SHAKERI, Z., GHAZANFARI, H., NAMIRANIAN, M. & LEXER, M. J. 2014. Traditional silvopastoral management and its effects on forest stand structure in northern Zagros, Iran. *Forest Ecology and Management*, 327, 221-230.
- WHITING, A. 2017. *Ethiopia's Tigray Region bags gold award for greening its dryland* [Online]. REUTERS. Available: <https://www.reuters.com/article/us-land-farming/ethiopias-tigray-region-bags-gold-award-for-greening-its-drylands-idUSKCN1B21CT> [Accessed 25.04.2018].
- YAMI, M., GEBREHIWOT, K., MOE, S. & MEKURIA, W. 2006. Impact of area enclosures on density, diversity, and population structure of woody species: the case of May Ba'ati-Douga Tembien, Tigray, Ethiopia. *Ethiop. J. Nat. Res.*, 8, 99-121.

- YAMI, M., MEKURIA, W. & HAUSER, M. 2013. The effectiveness of village bylaws in sustainable management of community-managed exclosures in Northern Ethiopia. *Sustainability Science*, 8, 73-86.
- YAMI, M., VOGL, C. & HAUSER, M. 2009. Comparing the effectiveness of informal and formal institutions in sustainable common pool resources management in Sub-Saharan Africa. *Conservation and Society*, 7, 153-164.
- YAYNESHET, T., EIK, L. & MOE, S. 2009. The effects of exclosures in restoring degraded semi-arid vegetation in communal grazing lands in northern Ethiopia. *Journal of Arid Environments*, 73, 542-549.
- YEBOAH-ASSIAMAH, E., MULLER, K. & DOMFEH, K. A. 2017. Institutional assessment in natural resource governance: A conceptual overview. *Forest Policy and Economics*, 74, 1-12.
- YOUNG, O. R. 2007. Rights, Rules, and Common Pools: Solving Problems Arising in Human/Environment Relations. *Natural Resources Journal*, 47, 1-16.

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