Carbon Finance in Ethiopian Rangelands:

Opportunities for Save the Children/US Leadership

Final Report

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Tropical Forest Group

Doyo Hargessa (SC/US) and two pastoralists near Nagelle Borana estimating percent cover of bare soil, grass, shrubs. Each of ten pebbles represented 10% of the plot's area.

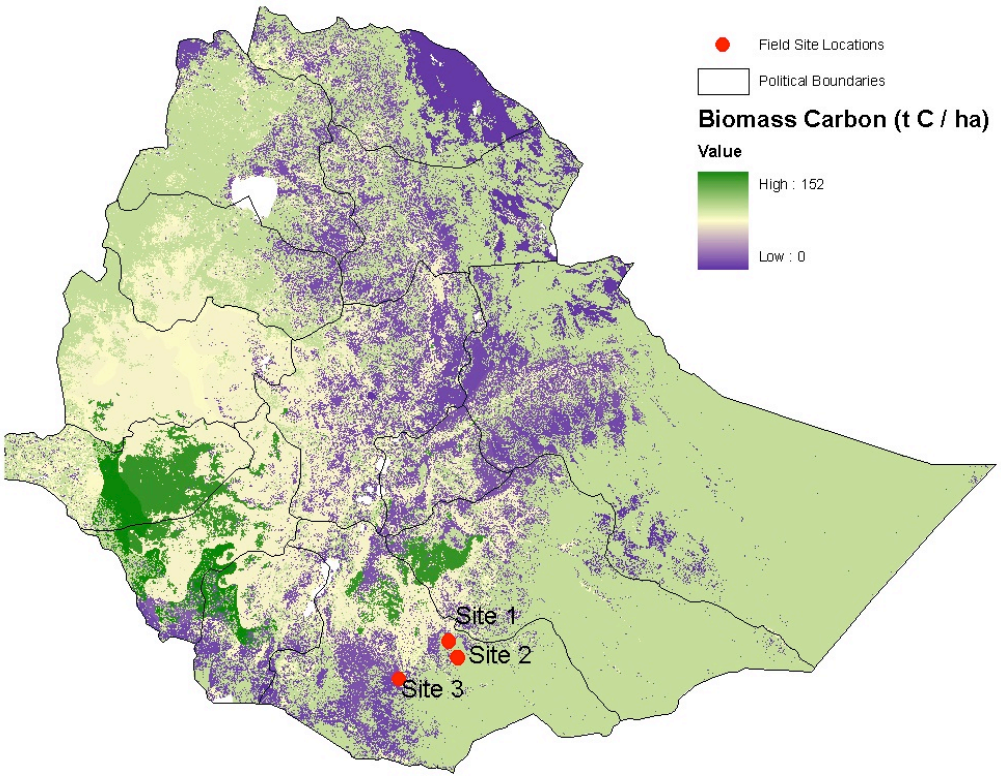
Photo: Tropical Forest Group, July 2009.

Acronyms and Glossary of Technical Terms

Biomass	The total weight or volume of organisms in a given area or volume
C	Carbon
Carbon Credits	Financing offered by donors for climate change mitigation activities in a given area based on the amount of carbon stored and prevented from entering the atmosphere
Carbon Sequestration	Long-term storage of carbon in the soil to prevent its release into the atmosphere
COP-15	15th Conference of the Parties of the United Nations Framework Convention on Climate Change (see UNFCCC below)
EPA	Environmental Protection Agency
FCPF	Forest and Carbon Partnership Facility—a World Bank facility established to support developing countries in their efforts to reduce emissions from deforestation and forest degradation by providing financial incentives (see REDD below)
IPCC	Intergovernmental Panel on Climate Change—the leading scientific body for the assessment of climate change and its potential environmental and socio-economic consequences (established by the United Nations Environment Program (UNEP) and the World Meteorological Organization)
KP	Kyoto Protocol
NGO	Non-Governmental Organization
NRM	Natural Resources Management
PLI	Pastoralist Livelihoods Initiative
REDD	Reducing Emissions from Deforestation and Forest Degradation—financing for carbon sequestration through forest preservation
Save the Children	Save the Children/US—an international NGO working to create lasting change in the lives of children and their families and communities around the world. In Ethiopia, Save the Children works with pastoralist communities to improve their livelihoods and mitigate risk.
Terrestrial Carbon	Carbon found in soil and vegetation
Top-Down Modeling	Use of macroeconomic and econometric models to calculate the impact of a particular energy technology. In this report, "top-down modeling" is mainly used to refer to the "look-up"

	reference tables for carbon values in particular geographical areas (according to IPCC land classification maps).
TFG	Tropical Forest Group—a non-profit organization working to catalyze policy, science and advocacy to conserve and restore the planet's forests
TWG	Technical Working Group
USAID	United States Agency for International Development
UNFCCC	United Nations Framework Convention on Climate Change—a Convention signed in 1992 which aims to reduce greenhouse gas emissions

Map 1. Estimated Above and Belowground Biomass in Ethiopia



This map shows the locations of the three field sites visited by TFG and Save the Children during the course of this study. The map is based on 2000 Global Land Cover 2000 Project and Intergovernmental Panel on Climate Change (IPCC) Tier 1 Default Values.[1]

[1] Unpublished Map, Dr. Holly Gibbs. Ruesch and Gibbs 2008.

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Executive Summary

This report, funded by USAID under the Pastoralist Livelihoods Initiative (PLI) and Enhanced Livelihoods in Mandera Triangle/ Enhanced Livelihoods in Southern Ethiopia (ELMT/ELSE), describes a preliminary effort by Save the Children/US (Save the Children) and the Tropical Forest Group (TFG) to explore opportunities for carbon finance in the rangelands of Ethiopia. International donors provide financial incentives for reducing carbon emissions through increased storage of carbon in the soil—a process known as *carbon sequestration*—, although this funding is currently limited to forest protection. Save the Children and TFG conducted this study to test the potential for increased carbon sequestration through improved rangeland management and grazing practices. It is hoped that the findings of this study can provide Ethiopia with a starting point for discussions with donors regarding the potential for carbon finance in the rangelands.

The TFG team conducted analyses of terrestrial carbon, trained Save the Children staff in soil analysis and performed fieldwork with pastoralists at three sites in Oromia Region. Substantial progress was made in understanding the vegetation (above ground) carbon in various land uses, particularly in identifying significantly higher carbon levels in enclosed areas than in grazed areas. Because of technical fieldwork challenges, however, less was achieved in understanding soil (below ground) carbon.

Field analyses enabled the team to compare "top-down" global carbon models with "bottom-up" field measurements in various environments. This comparison had mixed results, with very strong agreement in the woodlands of Liben Woreda but significant differences in grazed and ungrazed areas near Nagelle as well as forests near Arero. There are various explanations for these discrepancies, with the most likely dominant explanation being that global carbon models simply are not that good at predicting Ethiopian values for carbon in broad land use classes. The results also suggest there may have been substantial loss of carbon near Nagelle in the past decade and that efforts for sustainable forestry near Arero would be eligible for substantial funding.

Following the fieldwork and analysis, TFG and Save the Children convened various Government and NGO stakeholders to present their findings and discuss challenges and opportunities in carbon finance for the rangelands.

TFG's analysis demonstrated that pastoral responses to drought (and, by extension, to climate change) can be locally-appropriate synergies of adaption and mitigation. The work also showed that pastoral livelihoods and traditions, such as fire, enclosures and community-based forestry, are vulnerable institutions trying to succeed under extremely challenging circumstances. These are precisely the types of organic, appropriate, and scalable responses to climate change that the international community is seeking to support with carbon finance. Finally, the fieldwork rigorously used pastoral participation to estimate percent cover in plots of shrub, grasses, and bare ground, thereby confirming that participatory research can inform responses to climate change, and vice versa.

Background

A five-year drought is afflicting more than 20 million people in seven east African nations. It is highly likely this drought, which has hit Ethiopia particularly hard, has been exacerbated by human-induced climate change. Such developments accentuate the urgent need for interventions to reduce greenhouse gas emissions.

Diplomatic efforts to avert the most damaging scenarios of climate change are intensifying. Instruments such as Reducing Emissions from Deforestation and Forest Degradation (REDD) have been set up in recognition that climate change has been caused largely by industrialized nations and that its consequences have been disproportionately borne by developing nations. REDD provides financial incentives for reducing greenhouse gas emissions by protecting forests.

Funding for developing countries was a key agenda item at the 15th Conference of the Parties (COP) 15 of the United Nations Framework Convention on Climate Change (UNFCCC) in December 2009, where Ethiopian Prime Minister Meles Zenawi served as the lead Africa negotiator. The Copenhagen Accord calls for:

> Scaled up, new and additional, predictable and adequate funding as well as improved access shall be provided to developing countries […] to enable and support enhanced action on mitigation, including substantial finance to reduce emissions from deforestation and forest degradation (REDD-plus), adaptation, technology development and transfer and capacity-building, for enhanced implementation of the Convention.

The Accord calls for the allocation of US $30 billion for the period 2010-2012 and aims for US $100 billion a year by 2020 to address the needs of developing countries. Such funding is currently earmarked for forest protection activities; however, in Ethiopia, rangelands represent an equally interesting opportunity for potential carbon finance.

The Ethiopia Government appears keen to work with international climate change initiatives to support adaptation and mitigation programs on forests and rangelands in the country. The Environmental Protection Agency (EPA) has been appointed as the focal point for the Kyoto Protocol (KP) and for the World Bank Forest and Carbon Partnership Facility (FCPF). The REDD program is coordinated by the Ministry of Agriculture and Rural Development in close cooperation with other sectoral agencies (federal and regional), local communities and civil society[2].

[2] Ethiopian Readiness Idea Plan Note (R-PIN) submitted to the World Bank Forest Carbon Partnership Facility, March 8, 2008.

Key Participants

The Tropical Forest Group (TFG) was asked by Save the Children/US (Save the Children) to conduct preliminary field work in Oromia Region and to provide technical training and policy advice on terrestrial carbon mitigation, adaptation and carbon finance in Ethiopia. This study was funded by USAID under the Pastoralist Livelihoods Initiative (PLI) and Enhanced Livelihoods in Mandera Triangle/Enhanced Livelihoods in Southern Ethiopia (ELMT/ELSE).

The Tropical Forest Group's mission as a non-profit organization is to support forest and land conservation efforts and sustainable livelihoods throughout the tropics. TFG has particular expertise in providing scientific and technical support on carbon measurements and technical methodologies. TFG focuses the majority of its work in conflict and post-conflict areas of the world.

Three TFG staff visited Ethiopia from July 22 to August 1, 2009. The TFG staff and their core responsibilities were:

- **John O. Niles** (*TFG Director*): project inception, field design, contract facilitation, data analysis, writing.
- **Dr. Holly Gibbs** (*TFG Affiliate*, *Stanford University Post Doctoral fellow*), field methods, allometry and carbon modeling
- **Benji Orcutt** (*TFG Volunteer*, *graduate student at San Diego State University*), field work (both "muscle and brains"), GIS, equipment and logistics.
- **Dr. Elsa Cleland** (*TFG Affiliate*, *University of California San Diego Assistant Professor*) provided statistical support and advice on laboratory methods.

San Diego State University's Ecological Analysis Laboratory completed the soil carbon (C) analysis under contract to the Tropical Forest Group.

Save the Children contracted TFG for this study and the two organizations worked hand-in-hand to complete this study. Save the Children works to improve the lives of pastoralist children and communities by supporting customary institutions that improve health, livelihoods, and opportunities while decreasing vulnerabilities to emergencies. Save the Children has incredibly competent field staff who are trusted in their areas of expertise and in their regional offices. Save the Children also has strong capacity and relationships at the national and regional levels, including with pastoral associations and other members of civil society. Save the Children has been instrumental in collaboration in natural resource management (NRM) through its various field programs and through leadership in the NRM Technical Working Group (TWG). The entire Save the Children team was extremely involved in field work and sampling design, local arrangements, meetings with stakeholders, logistics, safety, and the actual completion and processing of field work. They included:

- **Biruk Asfaw**, Save the Children natural resource specialist was the person who pulled everything together. He was absolutely essential to the overall safety and success of the project. He initiated and organized high-level meetings with Ethiopian agencies and civil society. He handled all logistics. He was adept at

technically and physically demanding field work. Biruk made this entire project succeed. He was incredibly smart, kind, competent and fun to work with.

- **Doyo Hargessa** provided incredible all-around support. Doyo's reputation throughout Oromia Region is beyond words. His ability to recruit local participants, provide regional overviews and advice and scramble at the last minute for scientific gear, and his intimate knowledge of the land and people, also allowed this work to proceed. Doyo ultimately helped TFG select, locate and involve local people in field work at the ground level. His advice, guidance and participation in the work was essential and of the highest quality.
- **Adrian Cullis** was critical in overall project inception, orientation and oversight.
- **Fiona Flinton** provided invaluable background documents, information and facilitation with government agencies and the NRM TWG.
- **Jason Forauer** oversaw in-county support and facilitated TFG's logistics and interactions with wider Save the Children staff.
- **Cherinut Beyene** is probably the safest, kindest professional driver in the world. He was competent, safe, knowledgeable, helpful (above and beyond his duties) and kind. Cherinut involved himself in rigorous field work when and where appropriate.

Stakeholder Meetings

At the start of the study, TFG and Save the Children staff held two days of meetings and private discussions with a variety of local and national stakeholders, including government officials, NGOs and academics. These meetings provided general introductions, an exchange of ideas and information, and networking opportunities. The following individuals participated:

- Ben Irwin, Project Manager for **Farm Africa/SOS Sahel**. Ben has an exceptional project in the Bale Forests.
- Ato Tegeny Gudeta, Head of Extension Processes Wwner, **Oromiya Pastoral Area Development Commission** (OPADC). The OPADC noted a keen interest in employing local people in measuring and monitoring, and provided TFG with information on natural resource mapping work being carried out.
- **Environmental Protection Authority**'s Deputy Director General Ato Desalegn Mesfin, and Kyoto Protocol focal person Ababu Anage, Head of Ecosystem Department and REDD Coordinator (EPA). The EPA was extremely eager to coordinate and potentially cooperate on technical work to support Ethiopia's participation in the World Bank Forest Carbon Partnership Facility
- **Oxfam America**, Dr Senit Regassa, Secretariat for the NCC Forum. This meeting was a general introduction to the role of civil society engagement on climate change in Ethiopia.
- **World Vision**, Ato Hailu Tefera, Environmental Program. World Vision has a forest carbon in a semi-advanced state that has completed excellent standard and methodological work.
- Ato Gebru Jeber from **Federal Mapping Authority**.
- Ato Araya Asfaw, Dean of Sciences, **Addis Ababa University**.

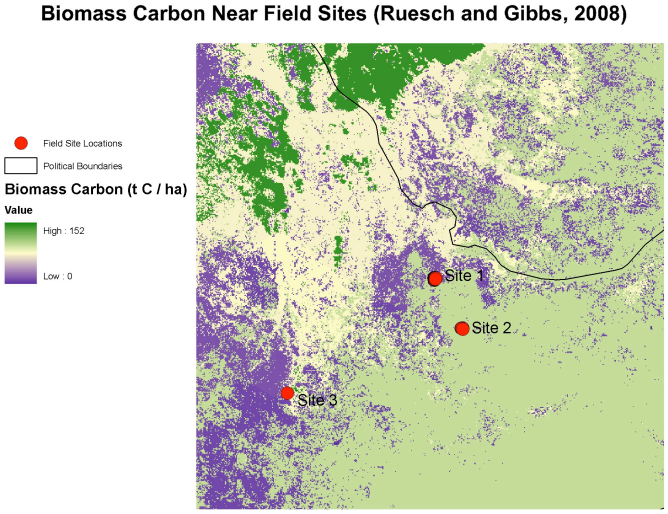
What emerged from these meetings was a clear interest in having more Ethiopian fieldwork and training on terrestrial carbon stocks, flows and dynamics. Most participants felt there was a looming opportunity to use technical information to access the fast-growing donor and private sector interest in carbon finance but that what was lacking was an understanding of the technical concepts. All meetings suggested sharing the experience of the study to wider circles beyond Save the Children. The World Vision and Farm Africa/SOS Sahel projects are already operating examples of strong Ethiopian terrestrial carbon projects that involve local communities and have the strong support of appropriate levels of government.

Fieldwork

The objective of the fieldwork was to analyze the effects of different land uses on carbon emissions by grazed vs. ungrazed land, burned vs. unburned land, disturbed forests vs. intact forests . TFG worked with Save the Children staff to collect preliminary data from the following three field sites in Oromia Region, as shown in Map 2 below:

Site 1: Grasslands. Kara Kuto enclosure[3] of the Koba Adi Pastoralist Association (PA), outside of Nagelle Borena in Liben Woreda, Gujji Zone;
Site 2: Woodlands. Enclosure in Siminto PA, Liben Woreda, Gujji Zone; and
Site 3: Forest. Disturbed forest just outside of Arero, in Borena Zone.

Map 2. Location of terrestrial carbon test sites, Oromia, Ethiopia



Fieldwork was coordinated by Save the Children locally with the deliberate participation of local communities. At each site, the team delineated 25x25m plots at regular intervals within different land use zones—for example, at Site 1 (grasslands), they delineated plots within the enclosure and in the grazing lands outside the enclosure. Similarly, at Site 2 (woodlands), they delineated plots within areas that followed a traditional burning pattern and areas that were not burned. For each plot, they then collected vegetation and soil samples. These samples enabled them to measure the means and variance of carbon stocks in land use types (enclosed, grazed, burned, unburned and disturbed forest).

At each plot, the following information was recorded.

1. GPS readings
2. General characteristics/land use (e.g., grazed or not grazed, burned or not burned)
3. Percent cover (% bare, % grass, % shrub) using participatory assessment. The local communities were asked to use rocks to estimate what percentage of a plot

[3] This enclosure was an area of grazing land fenced in by the community to keep animals out during certain periods so that the grass has time to regenerate and can serve as a reserve grazing land during the dry season. In some cultures, such fenced-in areas may be called "exclosures".

was bare, how much was covered by shrubs, and how much was covered by grasses.[4]

4. Total **wet grass weight** in two 1x1m plots (one representative shrub plot, and one representative grass plot)
5. Total **wet shrub weight** in two 1x1m plots (one representative shrub plot, and one representative grass plot)
6. Diameter of all trees at breast height

Table 1 below shows the main findings, which will be further explained in the following sections.

Table 1. Land Use and Estimated Carbon in Oromia Region Plots

Plot Type		Plot #	Shrub C in plot (g)	Grass C in plot (g)	Tree C in plot (g)	Total C (g) for plot	tC/ha equivalent
Site 1: Pasturelands	**Enclosure**	1	144,661	13,183	0	157,844	**2.53**
		2	104,904	10,655	0	115,560	**1.85**
		3	5,580	101,516	0	107,097	**1.71**
		4	73,999	195,901	72,533	342,433	**5.48**
		5	151,183	211,306	0	362,489	**5.80**
		6	332,817	28,619	0	361,436	**5.78**
	Grazed	7	58,073	3,143	0	61,216	**0.98**
		8	1,700	15,929	0	17,629	**0.28**
		9	10,827	625	0	11,452	**0.18**
Site 2: Woodlands	**Burned**	10	11,016	9,549	57,231	77,796	**1.24**
		11	98,960	38,533	6,481	143,974	**2.30**
		12	257,111	86,423	53,733	397,267	**6.36**
		13	28,970	5,795	1,022,698	1,057,463	**16.92**
	Unburned	14	94,109	45,612	626,727	766,447	**12.26**
		15	94,517	16,059	234,189	344,764	**5.52**
Site 3: Forest	**Disturbed**	16*	n/a	n/a	41,171,877	41,171,877	**164.69**

* Note: In Site 3 (outside of Arero) the team began surveying one forest plot (number 16 in the table above) before the effort was canceled for security reasons. Plot 16 was 50 x 50m (= 2,500 m^2), significantly larger than plots 1-15 which were all 25 x 25m (= 625 m^2). In this plot, the diameter at breast height was recorded for 106 trees that were greater than 10cm at breast height, but shrubs and grasses were not measured. TFG had planned to survey more than one forest plot; however, local conflict prevented additional surveys.

[4] The percent cover is the most important variable for calculating plot-level carbon stocks.

Findings, Site 1 (Nagelle)

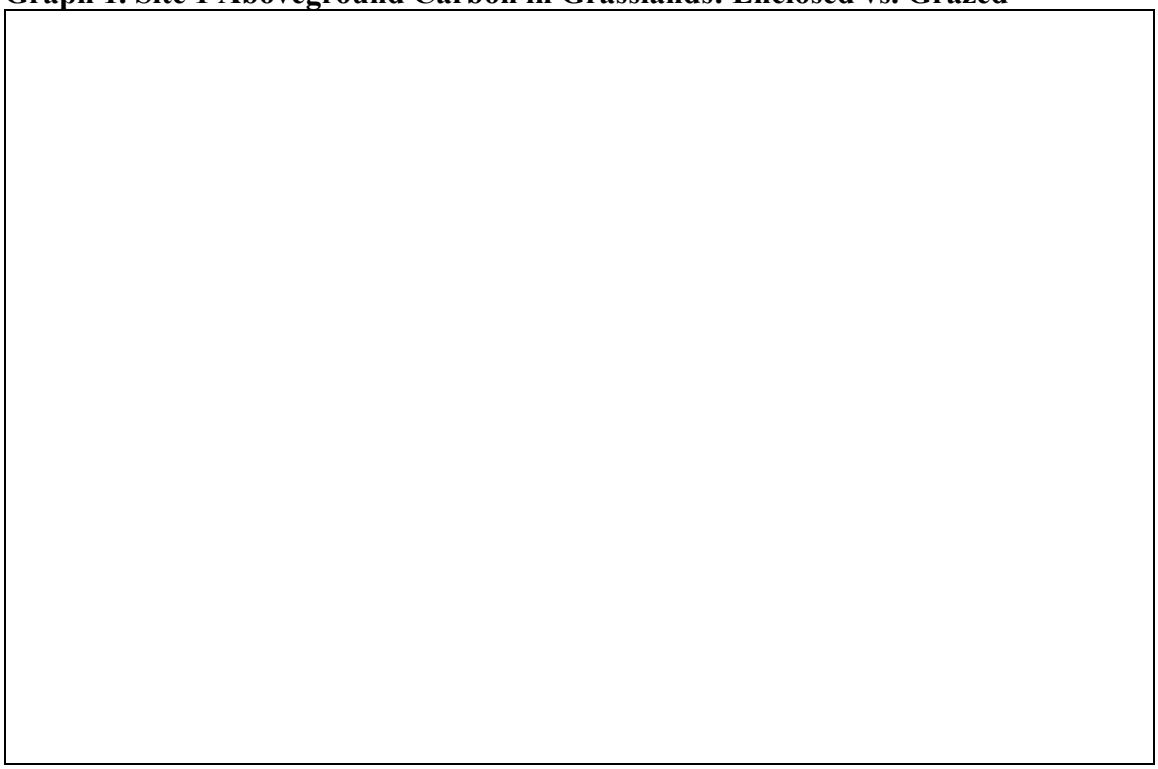
Location: Kara Kuto enclosure, in Koba Adi PA, outside Nagelle Borana, Ethiopia (5.36 degrees N X 39.60 E)

Description: Site 1 is a pastoral enclosure just outside of the town of Nagelle Borana. An area of grass and shrubs bordering a seasonal riverbed was fenced by a community. This enclosure keeps animals from grazing on the land during "normal" times in order to ensure the availability of pasture during times of drought or stress. The community did, however, remove substantial quantities of forage from the enclosure during "normal" times to feed their cattle.

Research Goal: The purpose of research at Site 1 was to determine whether the enclosure increased carbon storage, as reducing grazing generally leads to immediate aboveground biomass gains. A secondary goal was to establish the variance between plots in the same area, in order to determine the number of samples that would be needed for subsequent research.

Results: Plots inside the enclosure stored statistically significant more carbon than grazed plots outside the enclosure (**Graph 1**).

Graph 1. Site 1 Aboveground Carbon in Grasslands: Enclosed vs. Grazed



On average, plots within the enclosure (1-6) stored 241 kg of carbon per plot, which equates to 3.86 tons of carbon per ha. This is compared to just 30 kg of carbon per plot in normally grazed lands (7-9), which equates to 0.48 tons/ha.

Notes:

- This does not take into account the amount of grass that is cut by pastoralists from the enclosure, dried on site, and used for forage (this amount in plots 3 and 4 could have been several tons of grass per year).
- Plot 4 was the only plot that had a single tree
- The enclosure was in a slight gully, suggesting the area could have been moister and have stored more carbon naturally—a factor which may potentially diminish the significance of the research results in Site 1.

Discussion: The six plots inside the traditionally-managed enclosure store more carbon than those plots outside the enclosure. This suggests that there is climate change mitigation potential to this communal activity. Although the differences per unit basis are not great, the practice of protecting certain areas during times of low stress could contribute to climate change mitigation as well as a variety of other important benefits. These include:

- Preventing absolute denudation of grazing lands during time of drought
- Conserving seed banks and variable grazing intensity, which will add resilience to the overall environment and the community
- Conserving (very) intermittent riverbeds and the ecological services they provide

This indigenous practice shows how traditional users of the land mitigate risk in an unpredictable and changing environment. Given the likely relationship between increased droughts and climate change, it can be considered a local adaptation to climate change.

During the dry season or droughts, the enclosures would presumably be opened for grazing, which would deplete vegetation and soil carbon. However, the community agreement to restrict grazing in certain areas does increase the *average* carbon stored on these lands, which is significant as it is this average that the atmosphere "experiences". A rough estimate is that enclosures would lead to a doubling of carbon storage per unit area if community grazing practices are used and enforced.

Comparison of Site 1 Measurements Vs. Top Down Carbon Modeling: Top-down models are essentially reference tables for carbon combined with appropriate land classification maps. For a particular area, maps generated by satellites are assigned a particular amount of carbon based on collections of field data and other inferences. For Site 1, these models show a carbon density of 26 tons/ha, which is significantly higher than the team's survey findings of 3.86 tons/ha .

This difference may be due to the fact that the reference tables are based on vegetation data from the year 2000. It is possible that in 2009, the enclosure had significantly fewer trees than in 2000 as a result of land degradation. It is also possible that Ethiopian ecosystems simply stored relatively less carbon for different types of ground cover when compared to other similarly-classed ecosystems in other parts of the world.

Findings, Site 2 (Liben)

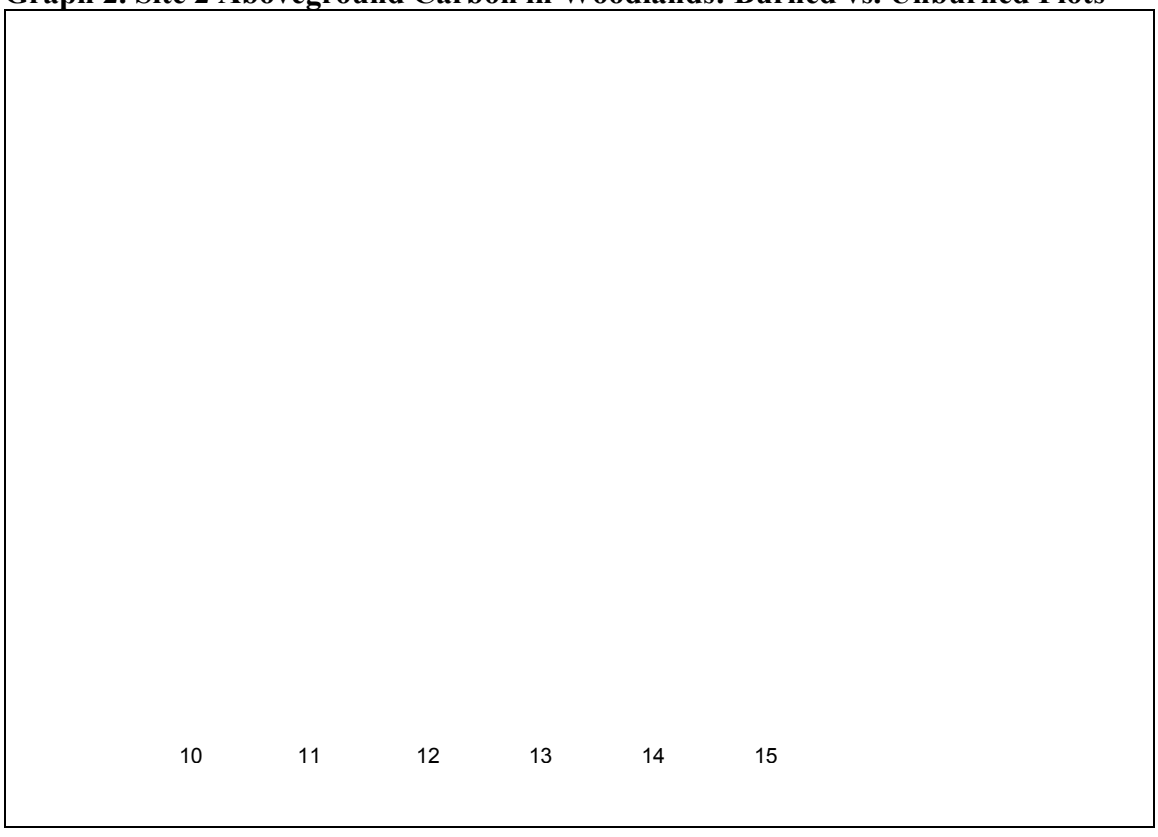
Location: Enclosure and Test Burn, Siminto Pastoral Association, Liben Woreda

Description: Site 2 is a combination of woodlands, shrubs and grasses. The main trees in the region are *Acacia busei*, *Acacia droponium* and *Combiretum* species. The area was patchily burned in a moderate intensity planned fire in 2006. Parts of this area were also initially part of an enclosure (similar to Site 1), although the enclosure was removed and the area was grazed for the three months preceding the field visit.

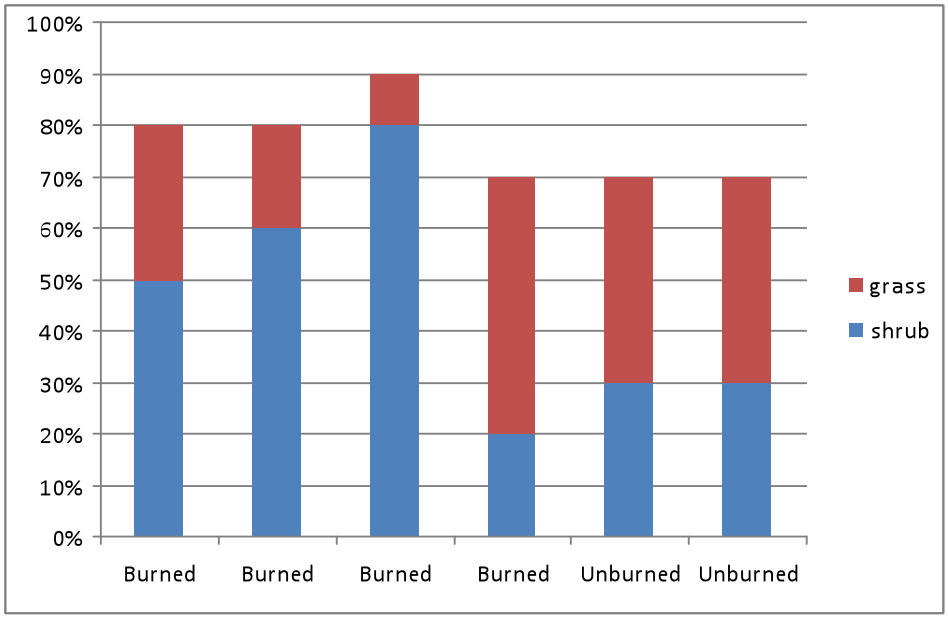
Research Goals: The purpose of analysis in Site 2 was to ascertain the differences in carbon between enclosed and non-enclosed land (which we were not able to evaluate, due to the recent grazing). A secondary goal was to determine if burning of a few years ago made any difference in carbon storage or vegetation composition of the lands—with the hypothesis being that the lack of burning would have contributed to the spread of invasive shrubs and non-grass species.

Results: The field tests did not reveal any significant differences in carbon levels, although the sample sizes were quite small (four burned and two unburned plots). In an ideal situation, the team would sampled around 6 burned and 6 unburned plots.

Graph 2. Site 2 Aboveground Carbon in Woodlands: Burned vs. Unburned Plots



Graph 3. Percent Cover (Shrubs and Grasses) for Site 2



Discussion: In this site, there are no obvious differences in soil or vegetation carbon between burned and unburned areas. The likely reasons are as follows:

1) The number of plots measured was too small to give an accurate picture of the differences caused by burning

2) The recent removal of the enclosure inevitably led to grazing, which made it impossible to determine the differences in forage between the burned and unburned plots. Local pastoralists suggested that the quality and quantity of forage in recently-burned areas was superior.

3) The intensity of the fire may have been too weak to penetrate the dense shrubs. Looking at Graph 3 above, we see that in burned areas there is relatively little grass compared to unburned areas. This is counter to what we would expect (fire knocks back grass). It may be that the fire simply did not penetrate the dense shrub. Considering the long time that fire was prohibited, this is quite reasonable. This should be explored further as it could inform future fire initiatives and policy.

Comparison of Site 2 Measurements Vs. Top Down Carbon Modeling: For this site, IPCC tables estimate a carbon density of 6 ton of carbon per hectare, which is close to the actual value measured in the field. This similarity is welcome, as it suggests that the area has not undergone substantial change in the past ten years and has an appropriate "look-up" value.

Findings, Site 3 (Arero)

Location: Forest near Arero.

Description: This is a moderately high-elevation forest lying outside the village of Arero. There has been a project promoting community conservation and sustainable forestry activities in the area, though it is no longer funded and operating. The forests have some large cedar and a wide range of other native species.

Research Goals: The goals of the research at Site 3 were to see: a) how much carbon a young/secondary forest could store, and b) how much carbon potential there would be for land use practices that allowed degraded forests to recover. The team hoped to measure the difference between degraded and intact forests to determine the potential carbon credits that could be realized by allowing disturbed forests to recover. Hence the team had planned to take multiple plot measurements for intact and for disturbed forests. However, after completing the first 50 x 50m plot and measuring 106 trees, local conflict between clans prevented additional research.

Results: Based on their findings, TFG estimated that there were 41 tons of carbon in the 2,500 m^2 plot. This equates to a value of 167 tons of carbon per hectare.

Comparison of Site 3 Measurements Vs. Top Down Carbon Modeling:
The team's findings at Site 3 are almost five times higher than the IPCC tables, which show a value of 34.5 tons of carbon per hectare for most of the Arero area forests. There are two possible explanations for this discrepancy. First, it is possible that since 2000 when the maps were generated, the forest has regrown (in terms of density) as a result of the community forestry project. Second, it is likely that top-down models underestimate the size of the forests near Arero, and therefore underestimate their potential for carbon storage.

Discussion: Although the research was limited to one plot, the findings are significant, as they suggest that the IPCC tables may be underestimating carbon in forests near Arero. Hence there is more potential for mitigation through reforestation or forest conservation in this area than previously thought. If donors are made aware that Arero forests can store up to (or more than) 167 tons of carbon per hectare, they may be more interested in funding forestry projects.

REDD carbon credits are calculated as the difference in carbon storage between the existing land use (forest) and any land use that replaces the forests—in this case, grazing or agriculture. A conservative estimate of the potential for carbon credits—the amount of carbon that could be saved by preserving these forests rather than cutting down some of them for agriculture—would be around 100 tons of carbon per hectare. Since one ton of carbon equals 3.67 tons of carbon dioxide (CO_2), this would translate to 367 tons of CO_2 per hectare. Given a very rough and conservative value of \$5/ton of CO_2, this would translate into approximately \$1,800 in potential mitigation value per hectare. This is a substantial sum and value for land, relative to other prices.

Findings on Soil Carbon

Research Goal. A secondary goal of this research to understand the dynamics of soil carbon in different land uses (grazed, ungrazed, burned, unburned, degraded and intact forests). The team collected soil samples from each plot and bulk density measurements from several representative plots. Bulk density is important as it allows the conversion from percentage carbon in soil samples to total carbon in a unit area.

Results: It was impossible to measure soil depth as Site 1 had extremely rocky, variable and thin soils, ranging from bare ground to approximately 15 cm. Without being able to estimate volume, it is difficult to infer substantial carbon potential values per unit area.

When one looks at available organic carbon (carbon in living or recently living matter), the grazed soils show slightly less organic carbon than ungrazed soils. Soils from the woodland Liben district plots (Site 2) show higher carbon levels than soils from Site 1.

Discussion: It is difficult to draw strong conclusions from the soil results. The values are not that different in different land use classes (especially from a statistical point of view). If the field team had been more diligent (and prepared) for the thin and rocky soils experienced in Site 1, bulk density and volume measurements could have been taken, which would have increased the validity of the findings.

The challenges of bulk density in the field and the lack of a uniform soil depth limit the team's ability to draw significant conclusions about total soil carbon (tons of soil carbon per unit area). The basic challenge is with so much bare ground and rock, and with extremely variable soil types and depths, techniques other than "normal soil cores" will need to be used to estimate soil carbon per unit area. This is a lesson learned and something that TFG and SC/US can seek to resolve in future grant applications.

Workshop

Following the fiedwork, TFG and Save the Children organized a workshop on "*Carbon Finance in Rangelands: Realities, Opportunities and Challenges*" in Addis Ababa on 1st August, 2009.

This workshop brought together a broad range of stakeholders from various NGOs and Government agencies. The attendees were:

1. Dereje Agonafir, Environmental Protection Authority
2. Mateos Mexiso, Federal Environmental Protection Authority
3. Representative, Federal Ministry of Agricultural and Rural Development
4. Gebru Jeber, Ethiopian Meteorological Agency
5. Abdirahman Ahmed, Somali Region Livestock, Crop and Natural Resource Bureau
6. Haileyesus Brook, United Nations Environmental Program
7. Mahelet, United Nations Environmental Program
8. Getachew Gebru, GL-CRSP/PARIMA
9. Nikocal Thtalnson, PACT Ethiopia
10. John O. Niles, TFG
11. Holly Gibbs, TFG and Stanford University
12. Benji Orcutt, TFG
13. Elias Getachew, SC/US, Addis Ababa
14. Ferhan Abdulkadir, Save the Children, Jijiga
15. Jason Forauer, Save the Children, Addis Ababa
16. Biruk Asfaw, Save the Children, Addis Ababa

The workshop enabled TFG to explain the work it did in the field, including the hypotheses, techniques and preliminary results. TFG explained that there were tremendous opportunities to use technical terrestrial carbon information to engage the growing sphere of carbon finance, particularly with government and philanthropic support. TFG informed participants that this support is growing rapidly and that future policy decisions are likely to lead to more requirements from donors for projects to have a strong carbon vocabulary. This might require using more climate change arguments for both traditional and new support, as noted in the Conclusions and Recommendations sections below.

Conclusions

1. Various Ethiopian Government agencies and groups expressed a strong desire to expand existing climate change mitigation and adaptation plans and to collaborate on further work. The Ethiopian EPA has since requested follow-up from TFG as part of Ethiopia's participation in the World Bank's FCPF.

2. Save the Children and its pastoral and community partners can be powerful forces for climate change mitigation and adaptation. Indigenous practices such as enclosures and the use of fire to control invasive species and increase forage quality can be considered both as adaptations to climate change and as mitigation measures.

3. Although these goals have not been explicit in prior work, much of Save the Children's support for indigenous community practices is already contributing to climate change mitigation and adaptation. Save the Children programs have potential to use more carbon arguments and vocabulary in their efforts to secure funding.

4. The combination of climate change mitigation and adaptation with improved livelihoods and resilience to natural disasters—such as community-developed grazing enclosures that both enhance food security and increase the amount of carbon stored in the land—is likely to be highly attractive to public and philanthropic support.

5. The nature of pastoral livelihoods in southern Ethiopia makes climate change work—which by its nature requires long-term results—challenging. The tenuous livelihoods of many pastoralists and the fragility of enforcing community practices such as enclosures will make it difficult to reassure investors that long-term change is possible and that fungible carbon credits can be invested in with a decent shot at a profitable rate of return. Our fieldwork, which met with difficulties of data collection due to unenforced enclosures and clan violence, clearly demonstrated this challenge. This is likely to prevent massive private investment in carbon credits, as private capital is likely to seek safer environments and more stable communities. However, other funds are widely available and are detailed in the Recommendations section below.

6. Carbon finance from both mitigation and adaptation sources could be a powerful new tool to support customary institutions and communities, by providing:
    - **General resources** to strengthen the carbon and ecological competence and vocabulary of key constituents;
    - **Technical capacity** to understand soil and vegetation processes and characteristics, responses to climate change, responses to interventions, and the impacts of various land use practices on carbon in different land use systems; and
    - **Long-term financial incentives** to support climate change mitigation and adaptation activities for highly vulnerable people.

Recommendations

Given the momentum toward agreements on climate change, it is inevitable that donors will increasingly support livelihood projects with a strong carbon vocabulary. The Government of Ethiopia and Save the Children have opportunities to recruit new carbon finance from three new areas of funding:

1. **Climate change mitigation**. The level of funding for terrestrial mitigation is unknown, given that US and UN policy deliberations are unsettled. However, projections show that combined US and UNFCCC resources for mitigation could translate into approximately **US $5 and $10 billion per year** respectively.
2. **Climate change adaptation,** including decreasing vulnerabilities and food insecurity. The potential funding level also is unknown, but the European Union recently estimated it would take US $150 billion per year to help developing countries adapt. Public European finance is projected to increase to **US $3-22 billion per year** to help countries adapt to climate change.
3. Efforts to support general **capacity** of developing countries in reducing carbon emissions. Funding in the early years to help countries ramp up capacity on climate change programs is likely to be **US $1-5 billion** per year.

Save the Children has the following immediate opportunities for follow up:

1. Promote its current work with pastoralists and participatory land use as a culturally intelligent approach to executing carbon finance projects. Save the Children's approach will resonate loudly with carbon donors. Although there have been many meetings and reports about bringing carbon finance to the world's most vulnerable communities, very few organizations and groups in the carbon circles have experience working with pastoralists in such a participatory manner.
2. Use the carbon data in this report to seek additional funds to complete the basic analysis of terrestrial carbon stocks and fluxes. New grants that explore carbon dimensions of existing Save the Children work should highlight the average tons of carbon per hectare (means) we identified and the variance (standard error, standard deviation) of different land use classes to propose intelligent future assessments. Other work can explore the use of novel techniques to overcome the challenge of bulk density measurements for soils that are not amenable to soil cores. This critical variable allows the conversion of soil analyses to the landscape level.
3. Allow key staff to specialize in carbon science and carbon finance. Capitalize on vast Ethiopian expertise, building key relationships with local and national partners. This should include assisting the Federal Government with World Bank applications, submitting information to the UN-REDD project and helping facilitate other grants.
4. Provide new angles of leadership on Ethiopian carbon through the informal Natural Resource Management Working Group. One option would be to approach the Federal Government with a request that Save the Children or the Working

Group provide specialized services and assistance to Federal Government on carbon.

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Appendix A. Data and Calculations Spreadsheet