Sustainability **2014**, *6*, 4308-4325; doi:10.3390/su6074308

OPEN ACCESS

sustainability

ISSN 2071-1050

www.mdpi.com/journal/sustainability

Article

The Sustainability of Community-Based Adaptation Projects in the Blue Nile Highlands of Ethiopia

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Received: 27 February 2014; in revised form: 1 June 2014 / Accepted: 30 June 2014 / Published: 14 July 2014

Abstract: Climate resilience in subsistence agricultural communities depends strongly on the robustness and effective management of the agricultural natural resource base. For this reason, adaptation planning efforts frequently focus on natural resource conservation as the primary motivation for and primary outcome of adaptation activities. Here, we present an analysis of the sustainability of community based adaptation (CBA) activities in 20 community based organizations (CBO) that were established in the Blue Nile Highlands of Ethiopia in order to promote resilience to climate change. CBA sustainability was assessed through multi-criteria analysis using the Analytic Hierarchy Process (AHP). Sustainability was considered for social, institutional, technical, financial, and environmental dimensions, with second-order indicators or factors defined for each dimension. According to this analysis, CBA efforts of two thirds of the COBs studied were found to be unsustainable in all dimensions and CBA efforts of the remaining CBOs were found to be at risk of unsustainability. A number of barriers to CBA sustainability were identified, including inadequacies in community participation, training of local community members, local government commitment, farmer capacity, and bureaucratic efficiency. Participatory evaluation of CBA, however, revealed that many of these barriers can be attributed to the decision to use conservation of natural resources as the primary framework for CBA activities. Based on this evaluation, new efforts have been developed that use markets as the entry and exit points for sustainability activities. Lessons learned in this project are relevant for CBA efforts in other agricultural regions of the developing world.

Keywords: adaptation; analytic hierarchy process; community based adaptation; community based organizations; multi-criteria analysis; sustainability

1. Introduction

Climate change (CC) has occurred across much of Ethiopia, particularly since the 1970s, at a rate that is variable but broadly consistent with wider African and global trends. Mean annual temperature increased by 1.3 °C between 1960 and 2006, an average rate of 0.28 °C per decade [1,2]. Climate models suggest that Ethiopia will see further warming in all seasons of between 0.7 °C and 2.3 °C by the 2020s and of between 1.4 °C and 2.9 °C by the 2050s and that the timing, intensity, and volume of rainfall will change over much of the country [3,4]. Climate change is predicted to affect the GDP growth of the country by between 0.5 and 2.5 percent each year unless effective steps are taken to build resilience [5]. Climate change, therefore, has the potential to hold back economic progress or to reverse the gains made in Ethiopia's development and could exacerbate social and economic problems [6]. Dedicated adaptation is required to reduce vulnerability and strengthen resilience to unavoidable climate change.

In recent years, the international community has increasingly emphasized the need for adaptation, and more funding has been made available, but most efforts to help countries adapt have centered on top-down approaches and policy solutions [7]. However, given that climate change impacts, appropriate responses, and, to some extent, adaptive capacity, are location-specific, community level design is critical to the adaptation process [8]. Community organizing for adaptation to climate change in itself also increases resilience to climate risks by strengthening and expanding social networks and links with donors and supporting institutions [9] and by having communities take responsibility for environmental and social problems rather than creating a reliance on external actors to assume these responsibilities on behalf of the communities. Here, we use the term "Community-Based Adaptation" (CBA) to refer to adaptation activities based on the principles of participatory, community-driven planning and community responsibility for project implementation. As such, the CBA process is based on communities' identified priority needs, knowledge, and capabilities. It empowers community members to plan and adapt to the impacts of climate change that are most relevant to their well-being [10]. Implicit in CBA is the principle that meaningful measures to reduce vulnerability and minimize socioeconomic consequences of climate change can be achieved through an understanding of how people cope with and adapt to climate variability consistent with predicted CC effects. The ultimate goal of CBA projects is to increase the resilience of communities by enhancing their capacity to cope with CC impacts [11].

This kind of CBA depends on the ability of a community to work collectively through social networks to manage the risks of climate change. Collective work, in turn, frequently requires the presence of a sustainable community based organization (CBO) that can coordinate community efforts. The sustainability of a CBO is in large part a function of the empowerment of organizations, such that members are capable of planning and implementing their development initiatives independently [12]. Community driven developments are part of a broader paradigm shift responding to critiques of top-down approaches that have dominated development over the years [13]. The local institutions do not replace national and international development actors, but they serve as an essential complement that ensures a bottom-up component emerges from participating communities. Building sustainable communities requires a proactive, localized, and highly participatory approach that depends upon the unique role and capabilities of local government and the engagement of a wide range of stakeholders [14]. It also requires the establishment and maintenance of considerable community autonomy and participatory management within the community [15,16].

The establishment of CBOs does, however, require technical and financial capacity that is often beyond the reach of climate vulnerable communities. In the case study presented here, the impetus for CBA and the need for CBOs emerged from a natural resource management workshop held for farmers and other stakeholders in the Choke Mountain region of the Blue Nile Headwaters in 2008. At this workshop, development experts from international organizations and local government agencies emphasized the importance of community organizations for implementing effective and supportable CBA. Following the workshop, individuals from a number of subsistence farming communities approached local officials to engage on the topic of implementing CBA and requested technical and financial support from local government to self-organize themselves as CBO. This led to the establishment of CBOs in 21 communities within the Choke Mountain Watersheds over the period 2008–2012.

Further, through discussion with local officials the CBO organizers decided to invite technical experts to participate in CBA planning sessions in order to match community adaptation priorities with established principles and technologies. In this sense, the CBOs represent a hybrid of bottom-up and top-down adaptation planning, in which projects are formulated and executed by local CBO members but informed by the experience of invited experts. This also presented an opportunity to study the organization of CBOs and to examine the effectiveness and sustainability of CBA strategies selected by the community but informed by principles used more broadly in the climate adaptation world.

2. Methodology

2.1. Institutional Arrangement

CBA planning meetings were held independently at each of the 21 CBOs. The initial planning session included local development experts and volunteer farmers who were highly motivated to engage in CBA. At this planning session, development experts presented a range of potential adaptation options and discussed appropriate alternatives with participating farmers, following participatory watershed management planning methods [17]. The presented CBA options were derived from prior experience both within the region and in other parts of Ethiopia. They focused on vulnerability reduction and adaptation by establishing community-based projects and took as a foundational principle that success in community based adaptation and sustainable development is a function of stakeholder capacity to plan and implement projects relevant to their needs. Existing field-based extension and watershed planning were leveraged for this initiative, with the active participation of the local administration. After the initial planning session, the list of viable adaptation options was presented to a broader audience of local farmer groups, who selected suitable adaptation options for their localities following a five-step environmental management planning process [18].

Project implementation was the responsibility of the CBOs with support of different partners. At local level, the major partners involved are community members, local administration, and sector experts, such as Woreda (the smallest legal administrative unit which is equivalent to district) and zone agriculture and rural development experts. The Woreda agriculture and rural development offices have played a vital role in mobilizing the community, conducting trainings, monitoring project activities while the zone agriculture, and rural development office has been responsible for technical and administrative backstopping. The Woreda Cooperatives Promotion Office was responsible for improving governance and administrative aspects ofthe cooperatives.

2.2. Strategic Aims of Adaptation

Interventions pursued for community based adaptation at a watershed level adopted a strategy of integrated land management to address food security and watershed management and rehabilitate degraded ecosystems. All interventions emphasized conservation of natural resources, livelihood improvement of the community, community participation and gender equity. The empowerment of the community through training, awareness raising and on-farm practices were central components of the adaptation process in order to achieve improvements in key areas of environmental problems that have been affecting the communities' livelihoods.

- Building and strengthening the capacity of the CBOs*:* In order to build and strengthen the overall capacity of the CBO, major activities include training of CBO members and leaders, the community planning team, and development agents (DAs), developing local level environmental action plans and holding educational visits and workshops. Projects with capacity building components are preferred because trained participants can continue to provide benefits, train others, and form a constituency in support of the program after the conclusion of the project [19].
- Conserving biodiversity: Activities that contribute to the conservation of biodiversity at the farm level include conserving the locally important farmers' varieties (FVs) through *in situ* conservation; beekeeping, and establishing protected areas by developing a protected area management plan that incorporates both the required activities to conserve the biodiversity resources and provisions for benefit sharing with the local communities.
- Reducing deforestation: Forest preservation activities include efforts to reduce demand for wood, such as training in production of efficient stoves (Gonzie). In one example, landless females were trained in stove production and provided with workshop sheds, improved stove casting molds, and required hand tools and materials. Direct actions to counter deforestation are also pursued by CBOs, such as establishing protected forests and community woodlots.
- Improving crop productivity: As the demand for land increases with growing population, and as soil nutrients are depleted through intensified agriculture, there is continuing expansion to new slopes and unsustainable use of old ones. Sloping land agriculture is susceptible to high rates of soil erosion, loss of soil fertility, and poor retention of water. In order to improve crop

productivity, CBOs have engaged in focused work on nutrient enhancement (e.g., composting), conserving landrace varieties, local seed multiplication and agroforestry with highland fruit trees.

- Improving soil and water conservation practices: To reduce the extent of soil erosion at the watershed level, major CBO activities include soil and water conservation practices such as bund construction, hillside terracing, and conservation tillage. Capacity for these activities has been provided through the procurement and delivery of equipment and tools, trainings, and establishment of school environment clubs that raise awareness, prepare tree nurseries, and plant nursery seedlings on school grounds.
- Improving livestock production: improvement in livestock production has focused on communal pasture management, including practicing rotational grazing and cut-and carry systems, enriching pastures, producing hay, and practicing tethering or stall-feeding.

2.3. Sustainability Analysis

The sustainability of CBA was assessed using the Analytic Hierarchy Process (AHP) for multi-criteria decision making. [20,21]. The hierarchy is as follows: (1) the overall goal of CBA (implementing integrated land management to address food security and maintaining the ecosystems goods and services) lies at the top; (2) dimensions of sustainability—social, institutional, technical, financial and environmental—are the second level; (3) specific CBA activities (e.g., composting, training in project administration, *etc*.) form the foundation of analysis (Table 1).

Table 1. The hierarchal structure used to evaluate the sustainability of Community-Based Adaptation (CBA) activities. Weighting of each dimension are indicated in brackets in the first column.

Dimensions [weighting]	Indicators/factors
Social sustainability [0.1]	Training of local communities and administrator Information and knowledge management Establishing school environmental club Developing local level environmental action plans
Institutional sustainability [0.2]	Training for the planning team and agriculture experts Supervision Annual Workshop
Technical sustainability [0.5]	Improved SWC practices Conservation of locally important farmers' varieties Composting Conservation tillage Production of improved stoves Communal pasture management Bee keeping Establishment and preservation of forest
Financial sustainability [0.1]	Auditing mechanism Improved household income Diversified Income sources Contributions from members

Table 1. *Cont.*

Dimensions [weighting]	Indicators/factors
Environmental sustainability [0.1]	Formulation of bylaws Establishing closed area Establishment of management plan Introduction of MPT to enrich biodiversity Spring water development Construction of water troughs

The sustainability of each activity was evaluated on the basis of percentage participation and effectiveness—either measured, where possible, or reported by farmers. For each activity, sustainability was quantified by experts from the local development and agriculture authorities. The assigned sustainability score was determined subjectively by these experts, taking into account both participation rates and effectiveness of implementation relative to expectation. These scores were then averaged with equal weights within each dimension. To evaluate the aggregate sustainability of CBA at each CBO a weighted average was calculated across all five dimensions. Weights were established based on review of relevant literature and on the relative contribution of each factor to the overall goal (implementing integrated land management to address food security and maintaining the ecosystems goods and services), as assessed in consultation with local agricultural experts, development agents and some farmers.

Quantitative and qualitative data sets collected from both primary and secondary sources were used when quantifying the sustainability of each factor. Primary data were collected using a multitude of data collection techniques, which included structured questionnaires, key informant interviews, and focus group discussions. Participation of the members was conducted on a sample of 124 households randomly selected from four micro-watersheds, which in this case are the major units of analysis. Key informant interviews were held with 17 knowledgeable informants comprising local communities, experts, and focal persons of external support providers. Focus group discussions were also held with men's groups, women's groups, and watershed team leaders group.

Results of sustainability analysis are summarized in several ways. These include an analysis of acceptance rates for each activity on a five point scale of very low (<30%), low (30%–50%), moderate (50%–70%), high (70%–90%), and very high (>90%), average sustainability score within each dimension, and an overall AHP sustainability classification calculated on the basis of dimension sustainability scores as follows [21]:

- Sustained CBA: The CBO obtains a 70% score (or more) in aggregate across all five dimensions *and* a 70% score (or more) in each dimension;
- Sustained but at risk CBA: The CBO obtains a 50% score (or more) in aggregate across all dimensions (individual dimensions can be below 50%); and
- Unsustained CBA**:** The CBO fails to obtain a 50% score in aggregated form.

3. Results and Discussion

3.1. CBO Profiles

The 21 CBOs were organized and established during 2007 and 2008 as natural resource conservation and tourism cooperatives (CNRCTC) and received legal entity from the respective Woreda cooperatives offices (Table 2). This was a requirement to open a bank account and receive financial support from the GEF Small-Grants Program. The stated objective of the CBOs upon establishment was to conserve and rehabilitate the natural resource base following a watershed management approach.

Table 2. Community Based Organizations (CBOs) profile.

Woreda	CBO	Financial support		Beneficiaries (No of households)			Watershed (ha)
		Birr	USD	Male	Female	Total	
Sinan	Ababule	223,000	19,983	1228	182	1410	500
	Abajime	287,710	30,303	267	49	316	467
	Abo	250,875	22,559	2286	442	2728	1068
	Chemoga	268,416	25,172	280	50	330	620
	Godeb	250,875	24,221	319	67	386	620
	Temcha	261,530	25,063	320	50	370	934
	Work Awtuley	251,946	20,156	270	50	320	525
	Zumander	268,412	21,473	316	49	365	745
	Sub Total	2,062,764	188,930	5286	939	6225	5479
Dibay Tilatgin	Boreborit	202,561	18,167	224	28	252	237
	Tsion	244,835	21,958	220	7	227	385
	Washa	257,630	26,142	297	21	218	467
	Woifen Adkim	243,280	26,695	401	46	447	500
	Yegomera	256,229	22,980	146	9	155	625
	Jibara Meda	238,030	26,168	298	17	315	467
	Ambaber	257,756	20,620	500	90	590	900
	Dedek	251,371	20,109	148	25	173	245
	Sub Total	1,951,692	182,839	2234	243	2377	3826
Bibugn	Adagn MA	273,381	27,721	320	50	370	650
	Bahiru Arusi	216,461	19,414	67	29	196	292
	Gedeb Giorgis	348,243	31,233	373	45	418	971
	Meleya	245,612	22,028	259	13	272	330
	Adisalem	252,846	20,228	368	41	409	612
	Sub Total	1,336,543	120,624	1387	178	1665	2855
	Total	5,350,999	492,393	8907	1360	10,267	12,160

These CBOs were envisaged as agents of empowering the local people to create lasting community-wide progress in livelihoods, bio-diversity protection, soil conservation, and related social services. They developed their own bylaw/constitution stipulating their vision, mission and objectives, membership criteria, terms of office of executive committee members, arbitration procedures, financial management standards, organizational structure and staffing, duties and responsibilities of the different organs of the CBO, penalty for illegal acts of members and leaders and procedures in the case of liquidation.

The CBOs received financial support primarily from the GEF Small Grants Program (SGP). This support was supplemented by member contributions in the form of registration fees, purchase of shares and in-kind contributions, including labor and materials. A total of 10,267 households (8907 male-headed and 1360 female-headed) have become beneficiaries of the CBOs established in the area.

The total external financial support from the GEF SGP to the CBOs was Birr 5.4 million (USD 492,393). Membership in these CBOs has grown steadily since their establishment as people come to realize the advantage of organizing in associations/cooperatives to achieve collective benefits. The Woreda administrations have also provided considerable in-kind support in the form of technical assistance, knowledge transfer, and agricultural inputs like seeds and fertilizer.

3.2. Sustainability of Community Based Adaptation Activities

Community participation was low at the beginning of the initiative but increased in most cases as activities gained momentum. As indicated in the focus group discussion, the reasons for initial delays in participation were attributed to limited awareness, suspicion of development plans, and inadequate planning and organizational structure of the CBOs. The performance of the different CBOs in implementing different factors of sustainability dimensions ranged widely (Table 3). For some activities, all CBOs reported attaining at least a “low” level of participation (>30%), including training, knowledge management, introduction of biodiversity, and introduction of soil and water management techniques. For others, including the development of local environmental action plans, acceptance ranged from very low to high. Composting stands out as a single activity that achieved high or very high participation and effectiveness in all CBOs.

Table 3. Values of indicators that determined sustainability of CBA efforts.

Dimensions	**Indicators/factors**	**Values**			
		Minimum	**Maximum**	**Mean**	**SD**
Social sustainability	Training of local communities and administrators	0.35	0.95	0.65	0.18
	Information and knowledge management	0.30	0.70	0.43	0.14
	Establishment of school environmental club	0.10	0.70	0.56	0.17
	Development of Local Level Environmental Action Plans	0.15	0.85	0.41	0.22
Institutional sustainability	Training for the planning team	0.35	0.95	0.64	0.14
	Supervision	0.25	0.65	0.33	0.12
	Annual Workshop	0.35	0.62	0.45	0.13

Table 3. *Cont.*

Dimensions	Indicators/factors	Values			
		Minimum	Maximum	Mean	SD
Technical sustainability	Improved SWC practices	0.30	0.86	0.62	0.20
	Conservation of farmers' varieties	0.35	1.00	0.72	0.17
	Composting	0.80	1.00	0.93	0.09
	Conservation tillage	0.10	0.40	0.20	0.13
	Production of improved Stove (Gonzie)	0.25	0.90	0.53	0.18
	Communal pasture management	0.20	0.61	0.34	0.11
	Bee keeping	0.10	0.70	0.39	0.18
	Forest establishment	0.35	1.00	0.62	0.15
Financial sustainability	Audit management	0.10	1.00	0.54	0.34
Environmental sustainability	Formulation of bylaws	0.20	0.95	0.48	0.23
	Delineation of area closure	0.35	1.00	0.68	0.14
	Establishment of management plan	0.15	0.63	0.37	0.15
	Introduction of biodiversity	0.35	0.75	0.62	0.14
	Spring development	0.10	1.00	0.36	0.37
	Construction of water trough	0.10	0.95	0.32	0.33

The overall sustainability of CBA efforts at each CBO was calculated by averaging acceptance rates for all indicators within each of the five sustainability dimensions—social, institutional, technical, financial, and environmental—and then summing up the factors proportional to the relative weights of the dimensions. These weights approximate the relative importance of each dimension to achieving the aims of the CBOs.

Weighted social sustainability scores ranged from 0.04 (Meleya, Addis, Worke and Zumander) to 0.07 (Gedebgiorgis) with a median of 0.05 out of a weighted maximum of 0.1 (Table 4). Institutional sustainability indicators ranged from 0.03–0.06 with a median of 0.046 out of a possible weighted maximum of 0.2, which is much lower than the expected average value. Technical sustainability indicators contribute half of the overall sustainability (50%) and the dimension average score ranged from 0.21–0.37 with a median of 0.27 out of a weight of 0.5, which is far better than all the other indicators. While financial sustainability ranged from 0.01–0.1, the environmental sustainability indicator ranged from 0.03–0.07 with median values of 0.054 and 0.046, respectively, out of a possible weighted maximum of 0.1 each.

Table 4. Weighted scores for all five sustainability dimensions of the CBOs.

CBOs	Dimensions of Sustainability					Sustainability of CBOs
	Social	Institutional	Technical	Financial	Environmental	
Weight	0.1	0.2	0.5	0.1	0.1	1.0
Minimum	0.04	0.03	0.21	0.01	0.03	0.32
Maximum	0.07	0.06	0.37	0.10	0.07	0.66
Mean	0.051	0.046	0.27	0.054	0.046	0.47
Standard Deviation	0.0095	0.0082	0.042	0.034	0.016	0.068

The aggregate value of sustainability ranged from 0.32–0.66 with a mean of 0.47. CBA activities at seven CBOs (33%) are categorized as sustained but at risk CBAs at the other 14 CBOs (67%) fail to achieve an aggregate score of 50% or in any of the factors and are not sustainable in all the dimensions (Table 5).

Table 5. Percentage of CBOs categorized as sustained, sustained but at risk, or not sustained for CBA activities in each sustainability dimension and in the aggregate.

Dimension of sustainability	**CBOs (n = 21)**		
	% Sustained	**% Sustained-risk**	**% Not sustained**
Social	9.5	66.7	23.8
Institutional	0.0	47.6	52.4
Technical	9.5	76.2	14.3
Financial	61.9	4.8	33.3
Environmental	14.3	28.6	57.1
Aggregate value	0.0	33.3	66.7

3.3. Dimensions of CBA Sustainability

3.3.1. Social Sustainability

Critical barriers that repeatedly affect social sustainability across all the CBOs are community participation, training of local community members and administrators, and information management by both administrators and the community. A participation index analysis of farmers' participation in all watershed management activities indicated that 96.4% of farmers have participated in only 60% of activities. Over half of the farmers participated in 40% of activities. It was found that 51%, 43%, and 1% of respondents participated in planning, implementation, and monitoring and evaluation phases of the interventions, respectively.

Trained individuals are more likely to bring about sustainability than those that are not. Those trained can continue to generate benefits, train others, and form a constituency in support of the program [19]. At the beginning of the project implementation period, community members were suspicious of the development work; some members had fear of losing their land to investors. The support of local authorities and sector offices with training was essential when carrying out analysis and devising solutions with some community members who misunderstood the objective of the initiative. In the process of establishing sustainable CBA activities at the community level, roles, concerns, and views of participants should not be overlooked, regardless of any preconceptions regarding the position they adopt.

3.3.2. Institutional Sustainability

Even though the CBOs are established as autonomous and self-supporting entities, some external support, particularly from the zonal agricultural office, is critical to sustain success of their development initiatives. Thus, the zonal agricultural office provides communities with technical and monitoring capacities.

Although the presence of locally evolved and well-articulated by-laws for natural resource management is desirable for success, applying it was quite a challenge due to various socio-economic factors. Inability to apply and to properly implement these by-laws by CBOs was a major problem for the institutional sustainability of CBA. There are no tangible disincentive mechanisms in place for negative activities on the natural resources. The presence of a well-articulated sanctioning mechanism in the by-laws and its effective implementation are the facilitating conditions for proper governance in natural resource management [22]. While 88% of community members have confirmed the existence of locally developed and agreed by-laws, 40% of them claimed the by-laws were not binding and are not functional and 11% of the respondents claimed they were not familiar with the by-laws. Only 15% regarded the by-laws as binding and functional. This diverse understanding within communities contradicts with the principles of CBA. Due to this, even though all members of the CBO are supposed to participate and contribute equally in watershed development activities, the majority (60%) of respondents reported the dominance of free riders in all activities, *i.e.*, only a few were actively engaged in the process. In addition, since natural resource management activities are typically coordinated at Woreda level by the Woreda administration, CBOs received some technical and institutional support from Woreda offices.

3.3.3. Technical Sustainability

The project area is dominated by hilly and mountainous highlands on the back-slope of Choke Mountains. The type is predominantly shallow with rapid drainage characteristics (Liptosols) and altitude varies between 2800 and 3800 m. To reduce the extent of soil erosion at the watershed level, construction of bunds and hillside terraces were planned following a participatory watershed-planning exercise as a major component of CBA. Development Agents (DAs) were engaged to advise farmers on design and implementation of bunds and hillside terraces. Their primary target was covering as large an area as possible in a short time. However, it was found that farmers met this objective by convincing DAs to accept widely spaced, small bunds as sufficient. This implementation is faster, takes up less farmland, and is more convenient for the traditional plowing system, but it does not meet the soil conservation objectives of a robust bund and terracing system for adaptation to climate change.

Soil and water conservation (SWC) activities such as hillside terracing have been largely weak due to limited experience of farmers and the terrain of the area. Planned live fencing of individual plots, establishing hedgerows along the contours of sloping farmlands and cultivation of various crops in the alleys as part of the integrated agricultural land management has not proved to be successful.

A new type of conservation tillage (CT) involving contour plowing and the construction of invisible subsoil barriers using a modified Maresha winged 'subsoiler' has been suggested as a means of tackling these problems as an integral part of the soil conservation structures [23] for CBA. The conservation tillage technology was found convenient to apply between soil conservation structures. With the application of this technology, surface runoff was reduced by 48% for wheat and 15% for tef, reducing sediment load by 51% and 9.5%, for wheat and tef, respectively [23]. Reduced waterlogging was observed behind soil conservation structures in conservation tillage compared to traditional tillage. The grain yields of wheat and tef increased by 35% and 10%, respectively, as compared with the traditional tillage [23]. However, it has not been possible to extend the conservation tillage technology widely, due largely to the absence of enterprises that can reproduce the winged subsoiler. One recommendation from this experience is that community-based programs should attempt to support and enable micro-enterprises and start to produce the tool. Each CBO in the Woreda that is funded by SGP scheme has demarcated and enclosed previously degraded areas for area closure, particularly in the sensitive afro-alpine ecosystem that is found on the mountain summit. As a result, on the back-shoulder of the mountain (lower altitude) long disappearing tree species have been remerging, including *Hygienia abyssinica*, *Juniperus procera*, *Erica spp and Hypericum revolutum*. However, this action has not met stated community goals due to free communal grazing and use of the areas for firewood collection, as well as the presence of a huge number of landless individuals in the area.

3.3.4. Financial Sustainability

CBO leaders and Woreda agriculture office jointly manage financial resources for the project. The majority of study participants indicted that this arrangement has created a sense of responsibility and accountability for both parties and a sense of trust for the community.

Pertinent issues for the financial sustainability component include the following:

- Limited capacity and experience of local experts and community leaders: Budget transfers were effectively facilitated by the zonal coordinator with the help of the Woreda cooperatives promotion office;
- Effective project budget utilization by the CBOs has been a challenge, including timely use of funds and timely implementation of planned activities;
- The extended bureaucratic procedures and the time it takes to purchase goods is too long in view of the critical timing of natural resource management and other farming activities; and
- Budgetary constraints of government offices limited the level of complementary support from local government offices given to CBOs.

3.3.5. Environmental Sustainability

According to FAO best practice guidelines, an environmentally sustainable system must maintain a stable resource base that considers land use and management, water availability, population density, judicial exploitation of renewable resources, and preservation of biodiversity [24]. This requires ample time and realizing interests of community members and other stakeholders. Despite the presence of a local-level environmental management action plan development (LEAD) manual, a guideline with detailed steps on how to plan CBA activities [14], implementation was rushed to meet the donor's deadline without genuine, community-wide participation. As a result, not all community members accept and own the outcomes of the project, undermining CBA sustainability.

Nevertheless, CBO participants have responded positively to activities that approach climate change adaptation by applying current knowledge on climate risks. Adaptation practices involving community actions such as modern bee keeping, highland fruit tree planting, and fuel-saving technologies have been highly preferred by participants, as they can generate considerable income throughout the year. Activities that do not offer near-term net financial benefits for farmers, in contrast, have not been received with enthusiasm. The dysfunctional implementation of soil bunds is an example of this:

properly implemented bunds created difficulties for oxen-drawn plowing without providing any near-term economic advantage.

3.4. Barriers to the Implementation of the Community-Based Adaptation Strategy

A major outcome of the study was a multiple criteria participatory framework for sustainability monitoring including identification of the strong/weak areas that maintain/lower sustainability status. A stakeholders' workshop identified the criteria-wise contribution to the sustainability of CBA by key dimensions, which are considered to be vital information for recommendations to increase the likelihood of sustainability of the existing CBA activities [25]. The critical barriers across the performance of CBA at the 21 CBOs studied and the areas for future improvement are presented in Table 6 in a top-down order according to stakeholder-identified priority.

Table 6. Key dimensions affecting sustainability, as identified by CBO participants.

Dimension of sustainability	Critical barriers of sustainability (in top down order)		
	1st	2nd	3rd
Social	Community participation of members	Training of local communities and administrator	CBO organization procedures
Institutional	Local government dedication, support and leadership	Leadership, coordination and supervision	Enforcement of local by-laws
Technical	Soil and water conservation	Conservation tillage	Communal Pasture management
Financial	Financial management	Diversified income sources	Marketing

Some barriers are technical, such as the lack of understanding of adaptation process, information, and impact assessments. Others are political, including inter-departmental conflicts, issues of 'territoriality', lack of guiding principles and limited understanding at Woreda and kebele levels. Cultural barriers include reluctance to overstep existing activities and traditions and a tendency not to view landscape level issues as community problems.

The perceived effectiveness of CBA must also be understood in terms of the political ecology of the initiative. Stakeholders of the CBA effort include agricultural experts, environmentalists, the donor community, development sociologists, and local leaders, in addition to participating farmers themselves. Agriculture experts see CBAs as a means to scale up technologies such as soil and water conservation. For the donor community and experts in the environment sector, they are seen as a means for enhancing society-wide environmental services and public goods that are provided by well-managed headwaters regions. Among local leaders and social scientists, CBA activities undertaking watershed management are seen as a framework for enhancing collective action and equity in natural resource access and governance or for addressing livelihood problems that cannot be solved at farm or household levels [26]. However, the main objective of CBAs for subsistence smallholder farmer members is improving their livelihoods by improving productivity and enhancing engagement with a functioning market system. As such, interventions that fail to deliver a market return are unlikely to be sustained beyond the timeline of a supported development project. A key step in any adaptive management application is to engage appropriate stakeholders and ensure their involvement in the process [27]; in the case of CBAs, this includes a wide range of potential stakeholders, but farmer involvement in the design and implementation of activities is absolutely critical to sustainability.

Adaptive management recognizes that natural resource management policies and actions should not be static, but that they should adjust based on a combination of scientific and socio-economic information to improve management by learning from the ecosystems being affected [28]. In agricultural adaptation to CC, where the focus is natural resources management, adaptive management simply refers to a structured process of learning by doing, and adapting based on what is learned [29]. It is based on recognition that resources are partially understood and that there is value in tracking resources to inform management. Learning in adaptive management occurs through informative practice of management, with the management strategy adjusted as understanding improves [30]. It is a structured decision-making process, with special emphasis on iterative decision making in the face of uncertainty [28]. During the interim monitoring process, applying and properly implementing the agreed upon by-laws for natural resource management was found to be a significant challenge due to the absence of tangible disincentive mechanisms in place for negative activities on the natural resources. Following the adaptive management principle, a well-articulated sanctioning mechanism in the by-laws and its effective implementation were added for proper governance in natural resource management. Another good example of adaptive management was the construction of bunds and hillside terraces to reduce the extent of soil erosion at the watershed level, which were effectively implemented in CBOs located in hilly and mountainous terrain.

4. Conclusions

Climate change is already affecting Ethiopia's economy and social wellbeing, and continued climate change is predicted to seriously affect the country's GDP growth unless effective steps to build resilience are taken. The natural resources base in the Blue Nile Highlands of Ethiopia is under intense pressure from population growth and erosion-inducing traditional farming and management practices. The livelihoods of farming communities face severe constraints related to intensive cultivation, overgrazing and deforestation, soil erosion and soil fertility decline, water scarcity, livestock feed, and fuel wood demand. Climate change is already contributing to these challenges. Notwithstanding the uncertainty associated with climate models and emissions projections, adaptation actions are urgently needed to eliminate or reduce the vulnerability of systems to the impacts of climate variability and change. Community-based Adaptation (CBA) provides numerous opportunities to manage the impacts of climate change in the Ethiopian context. A community based approach ensures that local stakeholders engage in alleviating and preventing environmental and social problems, rather than depending on external actors to assume these responsibilities on behalf of the communities. It is a way of working in partnership with all stakeholders of concern during all stages of the project cycle, with a focus on community stakeholders.

Here, the sustainability of CBA in a highland region of Ethiopia was assessed for 21 community-based organizations (CBO) on the aggregate rating of the social, institutional, technical, financial, and environmental dimensions. This analysis indicated that the sustainability of CBA in these CBO was questionable: for two thirds of the communities CBA efforts were failing in all sustainability dimensions, and in the remaining communities aggregate sustainability was deemed to be at risk. It is clear from this analysis that many interventions that are effective during an active project period, when external investments in adaptation capacity are available, are unlikely to be sustained at the completion of the project. The exceptions are project activities that focus on establishing market links, thus providing income to farmers and incentivizing continued participation after the project ends. This emphasizes the need to focus on markets as an entry and exit point for sustainable adaptation activities.

Furthermore, sustainability of CBA activities was hampered when the activities were designed and implemented primarily by participants external to the community without genuine involvement of community members. A true participatory planning process is required to avoid this pitfall. At the same time, participant reports on CBA activities in this project indicated that local government dedication, support, and leadership are critical for the sustainability of CBAs. This was true because of the institutional, financial, and technical expertise that established government offices can bring to CBO administration and implementation of activities. In this sense, a balance of external support and internally-driven decision making is required to achieve CBA sustainability in developing countries like Ethiopia.

Finally, project results also highlighted the fact that CBA sustainability depends on adaptive and learning-based management rather than top down and prescriptive management. Adaptive management, a process where decision-makers take action in the face of uncertainty by promoting flexible decision-making that can be adjusted as events develop, was core to effective CBA activity. A more systematic and consistent application of proven agricultural and environmental development technologies may serve as a suitable entry point to adapt to and mitigate the impacts of climate change and environmental conditions. Technologies that are proven elsewhere should be customized and adopted for smallholder's farmers in a participatory way for successful adoption.

The sustainability of CBA projects that take the natural resource base as an entry point has come into question. Interventions that are effective during the active project period, when external investments in adaptation capacity are made available, often fail to establish the link to markets that is required to sustain efforts after the project comes to a close [18]. Based on this experience, this research has concluded that markets are a more appropriate entry and exit point for future resilience building efforts.

The CBA initiative described in this paper was customized to the Ethiopian Highlands in its specifics, but the concept of community-driven adaptation is currently being implemented in many countries around the world using similar frameworks. For future work in this region of Ethiopia and, as appropriate, for community-based adaptation initiatives elsewhere, the findings of this study lead to the following recommendations:

- Impacts and vulnerability will vary by region, as will the resources available to respond to climate change, necessitating local-level solutions to adaptation rather than the one-size-fits-all approach. CBA is a good approach for location-specific adaptation activities that is based on the communities' priority needs, knowledge, and capacities, and that empowers people to plan and adapt to the impacts of climate change.
- The sustainability of community-based adaptation projects that take the natural resource base as an entry point has come into question. Based on this experience, markets are a more

appropriate entry and exit point considering natural resource management, technologies and enabling environments as additional pillars for future resilience building efforts at community level.

- Recognize and leverage the diverse interests of different stakeholders in the adaptation process.
- Involve community group members in CBA project design, implementation, resource contribution, monitoring and evaluation, to ensure ownership and hence sustainability.
- As establishing enabling environment requires time, provide adequate time for social mobilization.
- Customize and adopt the technologies that are proven elsewhere to match local smallholder farmers' capacity and biophysical conditions of the area, through a participatory process; and
- Apply adaptive, learning-based management to ensure stakeholder involvement and post-project CBA sustainability.

Acknowledgments

Work on this paper was supported in part by Addis Ababa University Thematic Research programme, Small Grants Programme-UNDP, and by NSF-CNH GEO-1211235. The Zonal Agricultural Office, Environmental Protection Authority and the Ethiopian Society for Appropriate Technology (ESAT) have provided technical assistance throughout the implementation period.

Author Contributions

This research has been undertaken under the leadership of the first author with technical support in analyzing and writing the paper from the second author.

Conflicts of Interest

The authors declare no conflict of interest.

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