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Community forest management (CFM) in south-west Ethiopia: Maintaining forests, biodiversity and carbon stocks to support wild coffee conservation

Adrian Wood[a,*], Motuma Tolera[b], Matthew Snell[c], Peter O'Hara[d], Afework Hailu[e]

[a] Huddersfield Business School, Huddersfield University, Queensgate, Huddersfield HD1 3DH, UK
[b] Wondo Genet College of Forestry and Natural Resources, Hawassa University, Ethiopia
[c] Huddersfield Business School, UK
[d] Huddersfield University, UK
[e] Ethio-Wetlands and Natural Resources Association, Ethiopia

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ABSTRACT

Community forest management (CFM) is increasingly recognised as a potentially effective way of maintaining forests, especially in the Global South. Despite the growing adoption of this approach, the results have been mixed and there is a need to explore both the ways in which a wider range of benefits can be obtained and how CFM can be implemented more effectively. New forest legislation on community forest management in the Southern Region of Ethiopia in 2012, alongside the development of a highly devolved method of CFM, provided a natural experiment for testing the effectiveness of this method as a way of maintaining forest and also supporting biodiversity conservation and carbon storage. The specific circumstances and details of the methods applied also provided an opportunity to compare this approach against other experiences of CFM to assess factors seen to be influencing success. This study was undertaken in an area of montane forest in south-west Ethiopia, which includes some of the remaining stands of wild *Coffea arabica,* and so it also sought to create supportive conditions for the *in situ* conservation of the wild coffee. Analyses of this approach to CFM over the six years show that the loss of forest was reduced to 0.18% per annum in the CFM managed areas compared to 2.6% per annum in the non-CFM forest, while biodiversity, in terms of species diversity, richness and evenness of distribution, was maintained in the natural forest managed under CFM. Carbon storage also increased in the natural forest managed under CFM. While the long-term results will only be seen after several decades, the findings show that the use of a highly devolved form of CFM, responding to felt needs and building up a community of practice were some of the positive influences which helped in achieving multiple impacts towards sustainable forest management and wild coffee conservation.

1. Introduction

Protecting tropical forest has become increasingly important given recognition that loss of these forests accounts for between 6% and 17% of global carbon dioxide emissions (Baccini et al., 2012). Challenges to the REDD+[1] approach to carbon storage have suggested further attention is needed on ways to reduce forest loss and maintain carbon stocks (Brown, 2013; Sills, et al., 2014; Lee et al., 2018). Tropical forests should also be maintained because they house many of the world's poorest and most marginalised communities whose forest-based livelihoods need improving and whose rights should be respected (White and Martin, 2002; Odera, 2004; Sunderlin et al., 2005; RECOFTC, 2013). A further important consideration is that tropical forests contain valuable biodiversity, many of their plants and wildlife having useful properties, both known and still to be discovered, which are of economic value (Gibson et al., 2011).

The challenge of how to maintain tropical forests in situations of poverty has been explored over many decades (Roe and Elliot, 2010; Oldekop et al., 2019). This has included debates about causes of forest loss and the need to address the drivers of change, whether they be proximate ones, such as the need for farmland, or structural such as tenure insecurity and criminalisation of customary forest use (Geist and Lambin, 2002; Rudel et al., 2009). More recently this debate has focused on the different ways forests can be managed and the role of community participation. In

* Corresponding author.
E-mail address: a.p.wood@hud.ac.uk (A. Wood).

[1] REDD+ is a programme under the UN's Framework Convention on Climate Change to Reduce Emissions from Deforestation and Degradation.

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particular, there have been discussions about the need to give communities stronger rights over forests and increase the revenue from them to motivate maintenance and develop an approach which is sustainable (FAO, 2016). This has led to considerable financial and political support for community forest management (CFM). These initiatives provide important lessons but also raise a number of questions (Arts and Koning, 2017; Baynes et al., 2015; Bowler et al., 2012; Coleman and Fleischman, 2011; Minang et al., 2019; Porter-Bolland et al., 2012; FAO 2016). A key area of concern is whether CFM can be undertaken in ways which make it more effective and increase the number of community benefits. This would increase its value to communities while ensuring the social and economic sustainability of the process.

2. The community forest management (CFM) approach

CFM has evolved from different approaches to forest management over the last 60 years, especially in the Global South (Fig. 1). It has progressed from an exclusionary approach that sought to separate local communities from their forests, with the state taking ownership of them (Odera, 2004; Couillard et al., 2009), to ones where people are given increasing responsibility, even to the extent of individual ownership (Sonko and Camara, 2000). This evolution of approaches has recognised the inability of governments to protect extensive forests and the need for communities to be involved (Springate-Baginski and Balikie, 2007). Linked to this has been a growing understanding of the need for adequate recompense to motivate communities to take on these responsibilities. Progression along this route is on-going and cases of participatory conservation and joint forest management, with different degrees of community engagement, still exist, although increasing devolution is occurring and CFM is becoming more widespread (FAO, 2016).

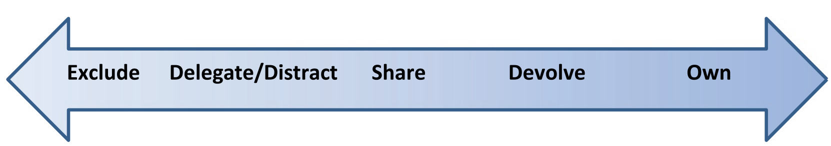
CFM involves the devolution of some degree of control and autonomy in forest decision making, including tenure and user rights, to communities who, in return, collectively manage and maintain the forest. In a day-to-day management sense, the forest under CFM "belongs" to the communities who have usufruct rights, and undertake forest management, although the state may remain legally the owner of the forest, as is often the case for all land in a country (FAO, 2016). CFM should lead to actively managed forests with communities practising silvi-culture to regenerate degraded forest, protecting forest from degradation and sustainably harvesting products to generate income that compensates for management activities.

Almost one third of the world's forests are now under CFM, with 35 African countries having such approaches in place, although few are fully operational (FAO, 2016). CFM has attracted major funding from international agencies and national governments because it is considered capable of turning degrading forest into a managed and productive resource, while reducing the burden on the state and rural poverty (Bowler et al., 2010 and 2012). Forests can thus become a competitive land use (Sutcliffe et al., 2012).

However, CFM experience varies considerably in terms of the aspects of forests addressed and the approaches adopted. Most CFM projects focus on forest extent, with fewer giving attention to forest condition, biodiversity, livelihoods, carbon storage, governance arrangements and sustainability (FAO 2016). In a meta study by Bowler (Bowler et al., 2012) only seven of 51 outcomes considered data on plant species richness and only five on plant species diversity. The 2016 FAO global study points to a similar neglect in most cases (RECOTFC, 2013; Gobeze et al., 2009; Monela et al., 2005). Consideration of livelihood impacts has also been given limited attention (FAO, 2016).

So far, the results from CFM have been variable. While some cases show success in forest maintenance and livelihood improvement, and suggest the approach is sustainable (Singh, 2008; Blomley et al., 2008; FAO, 2016), two meta studies - of more than 30 cases each, have shown mixed outcomes (Bowler et al., 2012; Porter-Bolland et al., 2012). For forest maintenance results vary from a gain of just under 1% per annum to continued forest loss of 2% per annum. These figures are further questioned due to limited monitoring, confounding variables and an absence of control situations. These make it difficult to compare CFM situations (Ameha et al., 2016; Arts and Koning 2017; Bowler et al., 2010 and2012; Brown and Lassoie, 2010).

In terms of the approach adopted, CFM interventions differ from case to case although there is increasing recognition of several key success factors (Baynes et al., 2015; FAO, 2016). Prime amongst these is the devolution of rights and authority over forest management decisions from



Exclusive reserves	Participatory conservation	Joint forest management	Community forest management	Private forest ownership
Delinking: Enforced separation of local people from state reserved forests, sometimes with alternative livelihood strategies.	**Reducing pressure & some delegation:** Attempts to take pressure off government owned forest through restricting use to non-wood forest products combined with alternative livelihood strategies, and delegation of forest protection functions to local people.	**Benefit sharing:** Share forest produce from government owned forests to entice local people to jointly manage the forests.	**Increasing value, devolving power:** Devolve legal forest control/tenure, use rights and decision making to communities to engender collective maintenance and management responsibility for the forest.	**Hand over completely:** Full ownership, use rights and trust in communities or smallholders to maintain and manage forests.

Fig. 1. Spectrum of devolved forest management approaches (O'Hara, 2016).

the state to the community. An important consideration is the groups to whom power is devolved and how much they identify with the forests (Baynes et al., 2015). A second factor relates to the revenue which communities can obtain and the longer-term benefits from access which compensate for the extra responsibilities they have maintaining the forest. This is important given the poverty of forest-fringe communities (Haile et al., 2009; Macqueen, et al., 2015; Macqueen et al., 2018). A third consideration is a supportive policy environment, both in legal terms and in practice with effective prosecution for illegal deforestation. Linked to this is trust between government and communities. Government is often concerned that there will be complete deforestation once rights to timber are given to communities (de Jong et al., 2010). On the other hand, communities may fear that government will take back control of the forest and officials will return to past rent-seeking behaviours, or else the benefits of CFM will be captured by local elites and further marginalise the poor (Gilmour and Fisher, 1991; Kamoto et al., 2013; FAO 2016).

Institutional arrangements have been identified as a critical influence on CFM. Building on neoinstitutionalism considerations for common property resource management (Ostrom, 2009; Agrawal, 2001), it is recognised that successful CFM needs the democratic operation of forest management institutions to build coherence in the community, ensuring that the benefits of CFM reward people according to their involvement (Hobley, 2006; Sunderlin et al., 2008; Hagen, 2014). More recently, critical institutionalism has identified the need for flexibility and adaptation, *bricolage*, in institutional arrangements (Arts and Koning, 2017). This is one of a number of practice-based observations reflecting the need to understand the way forest-community interactions evolve. Other observations include new institutions needing to build on socially embedded logics to be most successful (Arts and Koning, 2017) and the need for more socially grounded and anthropological approaches in CFM where new directions evolve from practice (Charnley and Poe, 2007; Minang et al., 2019).

One further factor, recently stressed, is the need to build support for community-wide groups, whether through strong and active government or through institutional structures at the local or national level to develop a "community of practice" (Ojha, 2014; Arts and Koning, 2017). This links to earlier considerations of intra-community forest governance (Baynes et al., 2015). The argument here suggests that successful PFM needs the development of a "high degree of networking, amongst internal and external stakeholders based on common concerns" to ensure social learning, mutual respect and understanding, in other words a community with similar understanding (Arts and Koning, 2017, p.323).

In this paper we seek to add to this understanding of the practice of CFM. First, we focus on the ability of a particular CFM approach to address three impacts- forest extent, biodiversity, and carbon storage. These are all concerns of the sustainable development goals (SDGs) (https://sustainabledevelopment.un.org/sdgs). Second, we seek to identify key variables which may be important in making this CFM case successful. The specific case study used is the application of a locally developed form of CFM in the south-west highlands of Ethiopia and its application shortly after a major revision of regional forest legislation which supported CFM. In addition to the topics outlined above, this project sought to test if CFM, by protecting forest biodiversity, could help maintain the globally important wild coffee (*Coffea arabica)* gene pool in these forests.

3. Community forest management (CFM) in Ethiopia

Over the last two millennia, population growth, expansion of trade and development of an integrated political entity has seen a repeated process of settlement and deforestation in the highlands of southern and western Ethiopia (Abir, 1968; Pankhurst and Piguet, 2009). Resource assessments show that less than 4% of the country was forested at the end of the twentieth century (Eshetu and Högberg, 2000; WBISPP, 2000). According to FAO (2010, 2015) the current rate of net forest loss is estimated to be 1.1% per annum.

The country's forests were brought under government control in the late 19th century as the south and west were incorporated into Menelik II's empire. Forests, like low altitude grasslands, were seen as unused and having no owners. Consequently, the feudal state used them in a reward system for those supporting the monarch, or to generate income (Perham, 1948; Clapham, 1969; Gilkes, 1975). However, the Ethiopian state never had resources to effectively manage those forests it retained and local communities had no interest in maintaining their forests once they were alienated by the state. As a result forests became *de facto* open access areas for people to use with little government supervision or monitoring. Where they were not cleared for farming, forests suffered serious degradation (Bekele, 2003).

Concern about forest loss goes back to the 1960s when, under Haile Selassie, several policy discussions and aid projects raised this as a serious problem (Huffnagel, 1961). The military government (1975–1991) developed initiatives to improve forest management (E.G., 1994), while also clearing high forest for agricultural estates and regarding forests as a frontier for development (Wood, 1983). However, it was not until the mid-1990s, and the arrival of a different government, that opportunities appeared for a new approach to manage the country's forests.

Community forest management (CFM) was introduced in the mid-1990s under various donor-supported initiatives (Ameha et al., 2014). It started with a pilot project in Adaba Dodola, in Oromia Region. After early successes and more pilots in other parts of the country, forest legislation was revised in the two regional states with the largest areas of forest, Oromia and Southern Nations, Nationalities and Peoples' Regional State (SNNPRS) (Oromia, 2003; SNNPRS 2012). These changes provided a policy environment which devolved a degree of forest control, management responsibilities and user rights to communities. Both regional proclamations stipulate a category of 'community ownership', but subject to the over-arching national constitution which states that all land is vested in the government and people of Ethiopia. In reality, in SNNPRS this translated into a transfer of day to day forest management planning and usufruct to communities, but with the state requiring forests to be maintained intact. CFM has been scaled up rapidly in these two regions, particularly in the last 15 years. As of 2015 there were reported to be 1.3 million hectares of forest under CFM in Ethiopia, some 30% of the country's high forest (A. Said and T. Tadesse, pers. communication, 2015, cited in FAO, 2016), with the largest contiguous forest block under CFM being in the south-west highlands.

The practice of CFM has varied across the country, depending on the region, project funding and implementing partners. The predominant approach has focused on *kebele* level cooperatives to jointly address forest management and forest-based enterprises, while a number of other arrangements build on local institutions at the sub-*kebele* or *got* level and separate forest management and forest enterprises (see Table 1 below) (Takahashi and Todo, 2012; Ameha et al., 2014; Ayana et al., 2017).

Analysis of these various CFM approaches has identified common issues. These include institutional weaknesses – often linked to top-down implementation and conflicts with cultural rules about forest use (Ayana et al., 2017). CFM has generally failed to pay sufficient attention to income generation from forest-based enterprises, and its impact on motivation to undertake forest management activities (Gobeze et al., 2009). Lack of clarity about forest ownership and rights under CFM and uneven power relations amongst actors have added to economic weaknesses, reducing community motivation and engagement (Ayana et al., 2017). Finally there is concern about the lack of government support and commitment to CFM (Kassa et al., 2017; Ayana, et al., 2017).

CFM has also faced challenges from investment policies which encouraged investors to develop "under-utilised" forests and grassland with minimal rental charges (Rahmato, 2011). However, in 2016 this policy was amended, in part because of REDD+ opportunities, and the state no longer allows high forest to be allocated to investors. Forest policy has also evolved since 2015 when the Ministry of Environment and Forests, later renamed the Ministry of Environment, Forests and

Table 1
Administrative hierarchy in Ethiopia.

Generic name for administrative level	Area or number	Comment
Federal	1.1 m sq km	State level
SNNPRS	105,887 sq km	One of nine regions
Zone in SNNPRS	13 zones and 8 special *weredas* (zonal status)	Sub regional level with all government offices
Weredas in SNNPRS	77 *weredas*	District; each *wereda* has most government agencies and a court
Kebeles in Sheko *Wereda*	25 *kebeles*	Parish equivalent; with one government administrative staff
Gots per *kebele*	3–6 *gots* per *kebele*	No government staff

Climate Change (MEFCC), was established. This ministry, now a Commission, has sought to explore how forests can be sustainably managed (E.G., 2018a), and has introduced a new national Forest Development, Conservation and Utilization proclamation (E.G., 2018b), which recognises community tenure. It is in this evolving situation that this paper reports the first evidence of the effectiveness of CFM in Ethiopia as a means of halting forest loss, maintaining biodiversity and carbon stocks, and protecting the wild coffee gene pool, while reviewing lessons for improving the effectiveness of CFM.

4. Community forest management and the *in situ* conservation of wild coffee in south-west Ethiopia

The forests in south-west Ethiopia are one of the two major remaining blocks of high forest in the country. They are globally important as the genetic hearth of *Coffea arabica*; it is where this plant is thought to have evolved and was domesticated (Senbeta, 2006). At altitudes of 900–1900 m amsl and with rainfall above 1500 mm a year, coffee grows wild as an understorey shrub. It evolves here and new varieties are still being found, such as those low in caffeine or resistant to coffee berry disease (Dubalef and Tektay, 2000). After several unsuccessful attempts at exclusionary conservation of the forests with wild coffee, CFM was identified as a potential approach and an action research project with a natural experiment framework was developed to explore this. The project[2] involved the Huddersfield University in UK and a local NGO, Ethio-Wetlands and Natural Resources Association, working with the Agriculture Department of the SNNPRS government.

This research project applied CFM in four districts in Sheka and Bench Maji zones, in SNNPRS (Table 1) .[3] The focus was in Sheko *wereda* of Bench Maji Zone where the moist montane forest covers 71% of the area (Sutcliffe, 2013) (Fig. 2). Kontir–Berhan and Amora Gedel forests, covering 10,000 ha and 3500 ha respectively, account for most of the forest and within these is wild coffee with a high degree of genetic uniqueness (Tesfaye, 2006). While these forests are a globally important gene bank for one of the world's most valuable commodities, they also provide many benefits for local communities including honey, spices, medicinal plants and wood products. The population is ethnically diverse, comprising indigenous inhabitants, who have a forest-based culture, and in-migrants or settlers (Dessalegn, 2013). The latter, who moved from other parts of Ethiopia, especially during the northern famines in 1984 or to work on state farms established in the 1970s and 1980s (Wood, 1983 and1993), are generally less familiar with forest management (Dessalegn, 2013).

In Sheko *wereda*, there had been limited conversion of the natural forests, with indigenous people having a very positive view of the forest from which they derived much income (Stauder, 1971; Dessalegn, 2013). However, with the rise in coffee prices during the 1990s accessible fringes of the natural forest were transformed for coffee

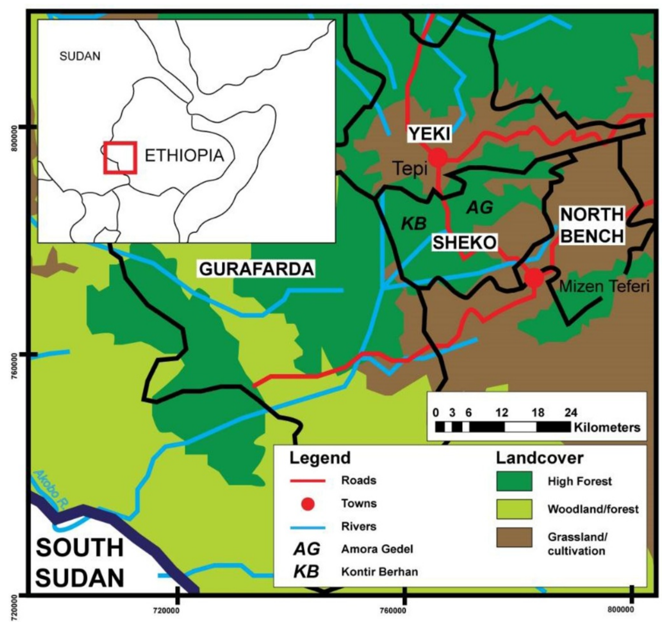


Fig. 2. Sheko *wereda* and neighbouring project *weredas*.

production. These “coffee forest” areas are created in return for tax payments to local government. Creating coffee forest involves removal of ground cover vegetation, as well as the lower storey shrub layer, and planting the cleared land with coffee seedlings. The density of coffee bushes can be several hundred per hectare compared to less than ten in the natural forest. The tree canopy is thinned with only large trees retained to provide 60% shade which is optimum for coffee. The high price of coffee has led to continued pressure for this practice.

This CFM project built on eight years of work in south-west Ethiopia which sought to introduce this approach into SNNPRS. The project involved participatory learning to understand the economies and cultures of the different ethnic groups and their interactions with the forest. Project staff sought to understand the body of local knowledge and the traditional institutional arrangements for forest management. This was followed by a review of CFM approaches in the country and opportunities for legally-compliant community institutions – notably cooperatives and associations. This was shared with communities and they chose the association format with a highly devolved form of CFM focused at the *got* / village level, one step below the *kebele* which is the lowest level where government staff are found (Table 1).

This CFM process involves *got*-level communities collectively applying for permission from local government to undertake CFM. Once approval is obtained, communities participate in forest boundary negotiation and demarcation, forest management planning and Forest Management Group (FMG) formation (Said and O'Hara, 2013). Once completed, a devolution agreement is signed between the government and community.

[2] The project was called Wild Coffee Conservation by Participatory Forest Management – WCC-PFM.

[3] The data reported here refers to the first phase of that work up to 2016, although follow on activities are continuing up to 2021.

The FMGs have a legal identity being branches of a *wereda* level Forest Management Association (FMA) which they develop and register. Registration allows the FMA and its branches to be represented in court. The FMA provides a forum for coordination, management and negotiation of forest issues with government. The FMAs and FMGs finance their operating costs using member contributions and a share of the profits made by multi-community cooperatives established to market the coffee, honey, spices and other forest products (Fig. 3).

CFM implementation has been an iterative process with some re-ordering to reflect community priorities, and adjustment of demarcation and institution formation due to practicalities. A secret ballot system is used for CFM committee member elections, with candidates having the opportunity to make a presentation to community members. This system was appreciated by communities who felt it was respectful and democratic. Furthermore, village-level groups were supported to develop income-generation and marketing opportunities through private or cooperative organisational forms.

The CFM process was helped by the development of a regional forest policy that recognised community ownership and user rights. This was promulgated in 2012, the result of a five year process of consultation by government across forested areas in SNNPRS (Said and Lemenih, 2013). Since 2012 there has been a rolling process of helping communities obtain communal land certificates which require financial compensation for communities in the event of CFM forest land being alienated by the state (Lemineh and Wood, 2013).

In 2016, at the end of the first six years of this CFM project, approximately 76,500 ha of forest were managed by 55 *got* communities representing around 48,000 people. This forest included (i) 60,000 ha of natural forest under CFM and (ii) 16,500 ha of coffee forest. The coffee forest was included in CFM management plans but the individual owners of that forest are able to act independently, with the exception of any felling of canopy trees. As a result there is restricted CFM in these areas. In the non-CFM areas in Sheko *wereda* there were 5000 ha of forest not under CFM, of which (iii) half was natural forest and (iv) half coffee forest. These four forest categories provided the basis for comparison to address our first question about the three areas of impact of different forest management arrangements (Table 2).

5. Methodology

The project partners have used a range of methods since 2003 when they began introducing CFM into SNNPRS. Underpinning the approach has been the belief that the project team should share information with the communities and facilitate local discussion and decision making, mostly in villages but also with government, about how management of the forests could develop. The work has been undertaken by a team of Ethiopian professionals employed by Ethio–Wetlands and Natural Resources Association, supported by Ethiopian and international consultants, with staff from the University of Huddersfield leading the work through a joint management committee with its Ethiopian NGO partner and with regular government and external reviews.

Table 2
Experimental design – (a) ideal and (b) actual.

(a) IDEAL	Forest type	Forest cover	Biodiversity	Carbon
With CFM	(i) Natural forest	✓	✓	✓
	(ii) Coffee forest	✓	✓	✓
Without CFM	(iii) Natural forest	✓	✓	✓
	(iv) Coffee forest	✓	✓	✓
(b) ACTUAL	Forest type	Forest cover	Biodiversity	Carbon
With CFM	(i) Natural forest	✓	✓	✓
	(ii) Coffee forest		✓	✓
Without CFM	(iii) Natural forest	✓	✗	✗
	(iv) Coffee forest		✗	✗

The overall research method was a form of Participatory Action Research with different actions discussed and then implemented, monitored, reviewed and revised, before further implementation (Jum et al., 2003). It involved an iterative process of testing and learning, revealing the realities in life in the *gots*, as well as about government operations and market place dynamics.

The highly devolved CFM approach, which came from the consultative and facilitatory process, was used in this particular project from 2010 to address the key questions of whether CFM could both reduce the rate of forest loss and maintain biodiversity in the forests. By maintaining biodiversity in the natural forest the project sought to retain the conditions for *in situ* conservation of wild coffee. The project also sought to identify whether in seeking to maintain biodiversity other benefits could be obtained, notably carbon storage and payments through REDD+ arrangements.

To test the three questions (forest extent, biodiversity and carbon) in the four different forest types and different management situations- (i) CFM in natural forest, (ii) reduced CFM in coffee forest, (iii) non-CFM in natural forest and (iv) non-CFM in coffee forest, a four by three matrix was envisaged (see Table 2a). While this was the ideal for experimental design, political and technical realities limited what was possible. By not working with the communities in the non-CFM natural and coffee forests, ground assessments of biodiversity and carbon were not possible. In addition, only remote sensing could be applied in these non-CFM areas to assess change in forest extent. Further, with the use of remote sensing it was not possible to distinguish between the natural forest and the coffee forest. Hence these two types of forest were grouped together for comparing rates of forest loss in areas under CFM

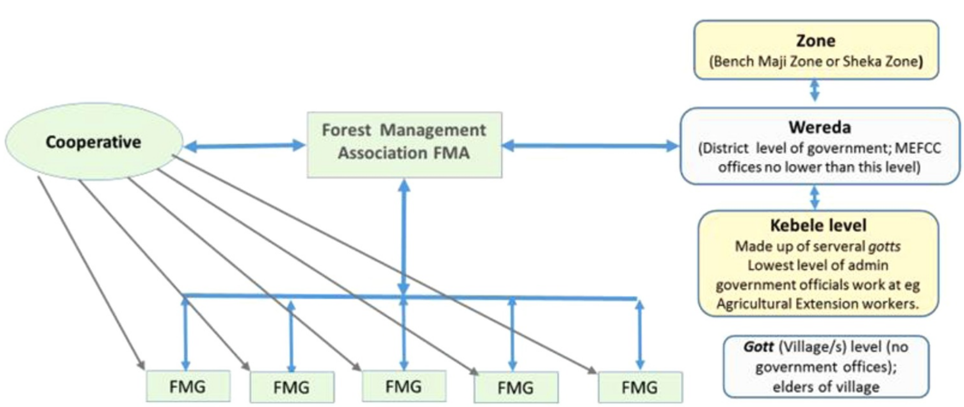


Fig. 3. Forest management institutional arrangements in Sheko *wereda*.

Table 3
Land cover and land cover change in Sheko *wereda*, 2009 and 2015.

Class name	2009 Area (ha)	% of total area	2015 Area (ha)	% of total area	Change over 6 years	Annual rate of change
Forest land	33,927.5	68	32,744.0	65.6	−2.4	−0.4
Agro-forestry and shrub	4579.3	9.2	9189.7	18.4	9.2	1.5
Grass land	6630.4	13.3	2286.5	4.6	−8.7	−1.5
Agriculture and settlement	4692.4	9.4	5605.5	11.3	1.9	0.3
Total	**49,829.6**	**100**	**49,825.7**	**100**		

Table 4
Forest cover change in Sheko *wereda* – a comparison of CFM and non-CFM *kebeles*.

Project & non-project *kebeles*	Area (ha) 2009	Area (ha) 2015	Forest change over 6 years	Change (ha/yr)	% Change of 2009 forest	Annual rate change
Project *kebeles*	28,281	27,977	304	50.7	1.1%	0.18%
Non-project kebeles	5646	4767	879	146.5	15.6%	2.60%

and those without CFM (Table 2b).

The first study – mapping and analysis of changes in land cover – was undertaken for the whole of Sheko *wereda* (Table 3). This compared the 13 *kebeles* where the project was working and CFM had been applied with the 12 where CFM was not used. The 13 *kebeles* within the project included over 80% of the *wereda's* forest. The impact of CFM on forest loss was measured by assessing land cover change using Landsat images (http://www.usgs.gov). These were selected from the driest part of the year to reduce cloud cover - February 2009 and February 2015. Four land cover classes were identified. These were (i) forest, (ii) agro-forestry/shrub, (iii) grassland, and (iv) agriculture/settlements (Table 4) (Guchie, 2015).

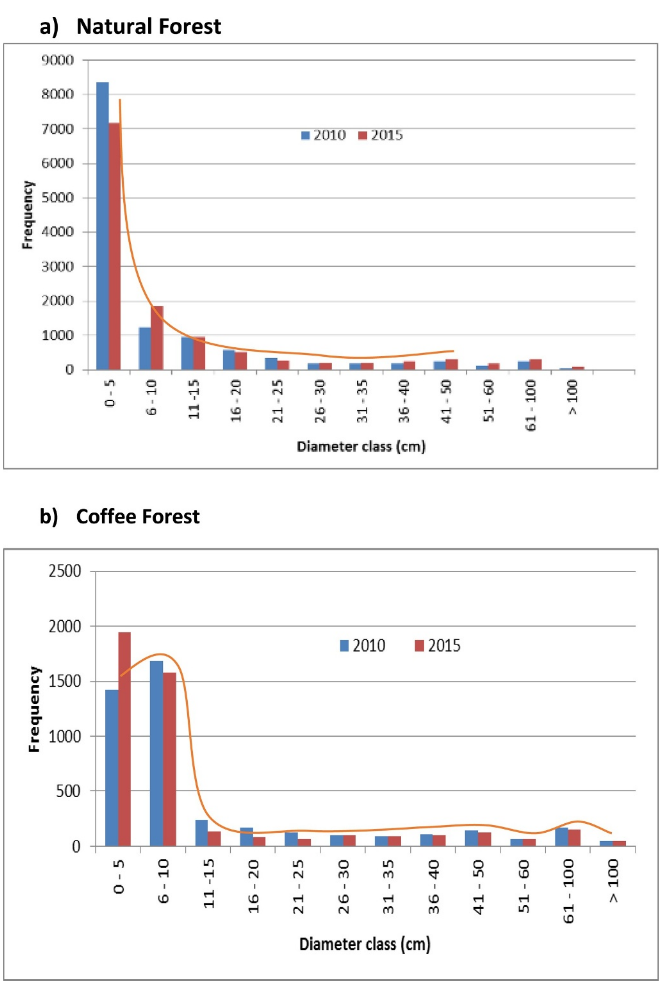


Fig. 4. Diameter distribution of woody species in (a) Natural Forest and (b) Coffee Forest in Sheko *wereda,* 2010 and 2015.

The other two assessments, of biodiversity and carbon stock, were conducted in the forests found within the 13 project *kebeles*. These assessments compared the situations in the two types of forest in Sheko, natural forest (NF) and the coffee forest (CF).

Biodiversity- Three indicators of forest stability and diversity were measured, namely the density of woody species, their diameter distribution and diversity. These were recorded in the CFM *kebeles* in 2010 and 2015. A comparison was made not just over time but also between the two types of forest, the natural forest with CFM and the coffee forest with restricted CFM (Tolera and Awas, 2016).

In order to assess the impact of CFM on biodiversity, a systematic stratified random sample method was used to locate 82 plots from which samples were taken across the forest in the project *kebeles*. The number of plots for the inventory area was calculated following the method used by the national Woody Biomass Inventory and Strategic Planning Project (WBISPP, 2000). Of the 82 plots, 26 were located in the coffee forest and 56 were located in the natural forest, reflecting the relative importance of the two types of forest.

Diameter at Stump Height, above and below 10 cm, was used to assess the density of woody species. Detailed analysis of the distribution of Diameter at Stump Height in 5 cm graduations also allowed the project to investigate the relative health of the two forest types. This involved eight diameter classes of 5 cm intervals and four larger category intervals to accommodate more mature trees (Zewdu et al., 2012).

The Shannon diversity index was used to compare the overall biodiversity in both inventory periods in the two types of forest. The index takes into consideration two aspects: species richness (number of species) and evenness (how evenly the species are distributed) (Table 6).

Carbon - An assessment was made of the impact of CFM on biomass and carbon stock (Table 7) (Zewdu et al., 2012; Sutcliffe et al., 2016). This used the same 82 plots established for the biodiversity assessment and applied the regression equation developed by the Woody Biomass National Inventory and Planning Project for 798 weighed trees in the relevant agro-ecological zone – the Moist *Woina Dega* (WBISPP, 2000).

All these studies had baselines undertaken in 2009/10 which were compared with end of project assessments in 2015/16. The results are explained in the following section.

6. Results

The results presented here cover the land cover mapping, biodiversity and carbon studies. This is followed by a discussion which uses

Table 5
Density of woody species in coffee forest and natural forest in Sheko *wereda* forests, 2010 and 2015.

	Natural forest						Coffee forest					
Years	2010	2015	Change	2010	2015	Change	2010	2015	Change	2010	2015	Change
Diameter at stump height (DSH) class	Less than or equal to 10 cm			Greater than 10 cm			Less than or equal to 10 cm			Greater than 10 cm		
Average	4027	4278	251	297	279	−18	2983	3394	411	242	187	−55
Standard deviation	2087	1529		134	87		1591	4232		105	86	

Table 6
Shannon diversity index applied to coffee forest and natural forest in Sheko *wereda*, 2010 and 2015.

	Natural forest			Coffee forest		
	2010	2015	Increase (↑) or decrease (↓)	2010	2015	Increase (↑) or decrease (↓)
Shannon diversity	2.85 (0.00)	2.97 (0.01)	↑	1.99 (0.04)	1.33 (0.03)	↓
Shannon evenness	0.62	0.63	↑	0.43	0.34	↓
Species richness	100	107	↑	106	65	↓

the outcomes of the Participatory Action Research and the social, cultural and political contexts to explore possible influences upon the CFM process in this case (Fig. 4).

6.1. Land cover mapping

For the *wereda* as a whole there was a relatively slow annual rate of forest loss of 0.4%, with 65.6% of the *wereda* classed as forest in 2015 compared with 68% in 2009 (Table 3).

However, there were big differences when comparing the rates of forest loss in the 13 CFM *kebeles* and the 12 *kebeles* in which CFM had not been applied. The annual forest loss was 0.18% in the *kebeles* with CFM, compared with a 2.60% rate of loss in the 12 non-project *kebeles* (Table 4). This major difference, with forest loss reduced by more than 90%, shows that through its institutions and actors CFM was able to have a major impact. This is a notable result given the strong demand for new farmland.

While these findings show the effectiveness of the CFM arrangements, it should be recognised that confounding variables and other factors may have influenced the results and the validity of the comparison. These include the higher population density and greater accessibility in the non-CFM *kebeles*, and the possible diversion of forest clearance activities to the non-CFM *kebeles* (Ameha et al., 2016).

6.2. Biodiversity assessment

Assessing the impact of CFM on biodiversity in the natural forest was a key goal given the importance of maintaining the biodiversity for the wild coffee stands within it. As outlined above, three indicators of forest stability and diversity were measured, namely the density of woody species, their diameter distribution and diversity.

6.2.1. Density of woody species

Small changes in the natural forest with CFM were identified but much clearer changes were seen in the coffee forest where CFM is restricted due to individual coffee–farmer rights (Table 5). In the natural forest the density of small woody species (≤ 10 cm DSH), declined by 6% (18/297) from 2010 to 2015. This may be due to saplings growing into the larger size category. The density of larger woody species (DSH class > 10 cm) increased by 6% (251/4027) from 2010 to 2015. Neither change is statistically significant. The overall situation in terms of tree density in the natural forest appears relatively stable.

In contrast in the coffee forest, with restricted CFM arrangements in place, the density of small woody species increased by 13.8% (411/2983) between 2010 and 2015. While this change is also not statistically significant, detailed analysis of the results of species in this category shows a major increase in the number of planted coffee saplings. In contrast, the density of larger woody species fell significantly, by 22.7% (55/242). This is probably a result of the death of over mature trees or the selective removal of trees to thin the canopy and create the 60% canopy conditions preferred for coffee cultivation. This suggests the situation in the coffee forest is not as stable as in the natural forest.

6.2.2. Diameter distribution

In a ‘healthy’ forest, which has the ability to sustain itself, the frequency of smaller trees is greatest and the frequency of higher diameter classes declines smoothly. This trend in frequency of size classes is characterized as an inverted "J" shape.

The diameter distribution of woody species in the natural forest with CFM showed a similar structure for both inventory years (Fig. 4a). It is characterized by a higher number of individuals at the two lower diameter classes and a gradual decline of numbers in consecutive classes. This is very close to the inverted J-shape structure of a ‘healthy’ forest. In the coffee forest in both 2010 and 2015 there was a large number of woody species in both lower diameter classes (*i.e.* 0–5 and 6–10 cm) reflecting the planted coffee bushes. All remaining diameter classes were characterized by a small number of individuals. The decline from the second to third (and

Table 7
Biomass and carbon stocks in coffee forest and natural forest in Sheko *wereda* in 2010 and 2015.

Parameters	Unit	Natural forest			Coffee forest		
		2010	2015	Change	2010	2015	Change
Density (DSH > 10 cm)	No ha^{-1}	276	296	7.2%	247	187	−24.3%
Basal area (DSH > 10 cm)	m^2 ha^{-1}	40	48	20.0%	43	50	16.3%
Density (DSH ≤ 10 cm)	No ha^{-1}	3690	4027	9.1%	3216	3014	−6.3%
Non coffee < 10 cm	No ha^{-1}	3558	3890	9.3%	442	46	−89.6%
Coffee < 10 cm	No ha^{-1}	132	137	3.8%	2773	2968	7.0%
Above ground biomass (AGB) (all)	t ha^{-1}	101	123.8	22.6%	116	102.3	−11.8%
Below ground biomass (BGB) (all)	t ha^{-1}	22	27.2	23.6%	25	22.7	−9.2%
Biomass (AGB + BGB)	t ha^{-1}	123	151	22.8%	141	125	−11.3%
Total carbon stock	t C ha^{-1}	61.5	75.5	22.8%	71	62.5	−12.0%

subsequent) diameter class is very sharp and does not depict the smooth decline and an inverted J-shape associated with a healthy forest (Fig. 4b).

6.2.3. Diversity of woody species

The Shannon diversity index was used to compare the overall biodiversity in both inventory periods in the two types of forest (Table 6).

These results show that in the natural forest CFM had maintained or slightly increased the diversity, while evenness and richness were maintained or increased slightly. In the coffee forest all three measures showed a serious decline. While some of the changes may be due to varying identification in the two inventories, the difference between the two types of forest is clear. The natural forest under CFM has maintained its biodiversity in terms of woody species, and maintained the conditions for the wild coffee stands to evolve *in situ*, while in the coffee forest there has been a deterioration in biodiversity and a trend towards a monoculture in the understorey.

6.3. Carbon stocks and biomass

The carbon and biomass assessments used the regression equation developed by the Woody Biomass National Inventory and Planning Project for 798 weighed trees in the relevant agro-ecological zone – the Moist *Woina Dega* (WBISPP, 2000).

In the natural forest with CFM, the mean biomass and carbon stock of trees increased by 22.8% during the survey period. There was also an increase in mean density and basal area of trees of 7.2% and 20% respectively between 2010 and 2015 (Table 7). This is probably due to the way CFM has limited human interference.

In the coffee forest, with major human intervention continuing, the mean biomass and carbon stock of trees decreased by 11.4% and 12%, respectively. These reductions were probably due to the removal of understorey vegetation and the selective cutting of certain fully grown trees to reduce resource competition and open up the canopy to enhance coffee production.

This positive experience with carbon storage is important in two ways. Nationally and globally the increased carbon storage, in the face of carbon-release driven climate change, makes a contribution to reducing the rate of climate change and supports the Ethiopian government's Climate Resilient Green Economic Approach (E.G., 2011). For the communities this positive contribution towards the national REDD + programme could lead to carbon income reaching them in one form or another, provided the global and national rules allow. This would support CFM and make it increasingly attractive for communities to maintain the natural forest (Sutcliffe et al., 2012).

7. Enabling factors

This recent experience in south-west Ethiopia, which shows that CFM can achieve multiple goals, has been influenced by a number of enabling factors which the authors have observed and explored since they started working with communities, government officers and project staff in this area in 2003 (O'Hara, 2016). Based on regular project reporting, periodic external reviews and evaluations, as well as discussions in the field, a number of factors have been identified which are important for the CFM work. Some of these are specific to the location and to the CFM process used, but there are also lessons of wider relevance for effective CFM.

Terrain and location - One local influence on the success of CFM in this case is the way the band of coffee forest surrounding much of the natural forest has created a buffer which makes conversion of the natural forest for agriculture less attractive. This is due to the relative remoteness, difficult access and presence of crop predators, such as wild pigs and monkeys. Such location specific influences, often terrain related, as well as linked to land use and access as in this case, can be important in facilitating CFM (Ameha et al., 2016).

Responding to felt need and socially embedded logics - CFM in Sheko wereda was timely given the recent loss of nearby forest to investors. This loss created fear amongst the communities and generated support for the way CFM could bring the forest under community control. The CFM approach was adjusted to prioritise obtaining clear rights to forest for communities. The threat of forest loss to outsiders is not new nor unique to this project area (Ayana et al., 2017) as the use of forest for state farms and resettlement goes back to the 1980s (Wood, 1983). Hence, the post-1991 government policy of allocating land to external investors was readily recognised as a threat by the communities.

Support for CFM also built on the long-term cultural links with the forest amongst indigenous groups in Sheko (Stauder, 1971; Dessalegn, 2013). There are often socially embedded logics in forest using societies with respect to ecosystem services and environmental stability which can help with the progression of CFM (Arts and Koning, 2017). However, as has been noted CFM must be introduced in a sensitive manner (Minang et al., 2019).

Devolution, identity and ownership - The highly devolved approach to CFM used in this area, as well as its evolution through a 10-year iterative process helped facilitate implementation. Specifically following the subsidiarity principle and devolving CFM to the lowest level appropriate ensured that the implementing *got* level groups identified with their forest areas and adapted CFM to their local conditions. Devolution to the *got* level is not common for CFM in Ethiopia, the predominant approach being to use the higher *kebele* level. The findings here reinforce points raised by others concerning governance in CFM and the need for local ownership and adaptation (Baynes et al., 2015; Arts and Koning, 2017; Ayana et al., 2017). In this area, having clear usufruct rights over the forest has been very important for helping communities overcome their past experience with top-down, militaristic exclusionary approaches to forest maintenance (O'Hara, 2016).

Community involvement in selecting institutional arrangements for CFM, and the adjustment of these to ensure representation at *got* and *wereda* levels also helped generate a clear sense of control of the CFM process by communities. This was reinforced by the democratic approach used in selecting CFM committees (Said and O'Hara, 2013).

Policy environment and community of practice - CFM was given critical support after the early years of implementation by the 2012 forest law for SNNPRS. As this became recognised, and as government staff were trained in its implementation, a new and common sense of understanding of CFM began to develop. However, this has been a slow process, with some conflicts between communities and government, as well as difference of opinion amongst government staff. This is changing now the 2018 Federal Forest law has been promulgated with both communities and government recognising that CFM is the norm, and blaming each other for not enforcing it when forest incursions arise (A. Said, pers comm, 2019). Thus after more than 10 years of CFM a common understanding is building up and a community of practice beginning to appear (Arts and Koning, 2017).

8. Discussion: the future of CFM in south-west Ethiopia

The experience in south-west Ethiopia shows that as well as maintaining forest cover by reducing the rate of loss of the natural forest, CFM has helped conserve biodiversity and improved carbon storage. In addition, by developing forest management groups who manage the forest and generate some revenue from it, human activities have been controlled. At the same time, through maintenance of the forest and conditions in which wild coffee grows, CFM is helping the coffee gene pool to evolve *in situ*. However, questions remain about the challenges to CFM and the ways to maintain and strengthen the process.

The future of the forests in south-west Ethiopia remains subject to influences both internal to the CFM process and external with respect to the economic, political and social environment (Baynes et al., 2015; Arts and Koning, 2017; FAO, 2016). A particular concern which has arisen relates to tenure arrangements. The present CFM agreements with the local government depend in part on the good will of government staff and they change regularly. These agreements also fail to require compensation payments if forest is alienated by the state. In response to two cases in neighbouring CFM districts, community rights are now being strengthened in Sheko by using communal land certification legislation which provides legal redress and rights to compensation from the state for the loss of CFM forest (Lemenih and Wood, 2013). This has already worked in one district in the south-west and is supported in the discussions around the new federal forest law (A Said pers comm. 2019).

While forest rights have been a sufficient incentive for communities to engage with CFM, more tangible economic benefits are probably needed to ensure its sustainability (FAO, 2016). CFM requires time and commitment from community members for which there needs to be compensation in terms of household income or community benefits. Trade has been growing in this area but often in the hands of a small elite. Wider engagement is now being sought through the establishment of community cooperatives and micro-enterprises linked to the *wereda* FMAs and the development of value chains to national and international markets for a range of non-timber forest products, including wild coffee, honey, spices, fruits and seeds (Lowere et al., 2018; Meaton et al., 2013). Further income may be generated through payments for carbon storage, protection of wild coffee stands, and sustainable timber harvesting. However, there are high level discussions on these issues as the state has strong interests in the carbon revenues and some officials are concerned whether communities can ensure sustainable timber offtake. This latter attitude is contrary to the current SNNPRS forest legislation which allows timber harvesting and also counter to experience in other countries which shows how timber is critical for making forest a competitive land use (Sutcliffe et al., 2012; FAO, 2016)

The continued operation of the community FMGs and their legal support at the district level – the FMAs, is also critical for sustaining CFM (Arts and Koning, 2017). However, with the further development of forest-based trade and enterprises there will be increased risks of elite capture or specific ethnic groups benefitting (FAO, 2016). This confirms the need for independent, democratic and transparent monitoring (Bowler et al., 2012) and strengthening of the community of practice in this area with common views about CFM (Arts and Koning, 2017).

Finally, a critical part of the framework which supports CFM is government policy, legislation and practice (E.G. 2018a). This has recently been strengthened by the 2018 federal law (E.G. 2018b) which should pressure the regional government to produce the guidelines needed to fully implement the 2012 regional forest law and so allow communities to use all forest products. While support for CFM groups is subject to personalities as well as legislation, recent attempts to crack down on corruption at the federal level may see some beneficial effects trickle down to CFM. Critical amongst the developments sought for sustainable CFM is better understanding between government officials and communities so that annual monitoring is undertaken as a joint exercise and forest enterprise is encouraged, including sustainable timber harvesting.

9. Limitations

While the overall findings from this study are positive, it must be recognised that there are often problems with the data available. In this case there were limitations on the way the natural experiment could be undertaken and a full comparison of the different forest types and use of CFM could not be undertaken (Table 2). In particular, the inability to distinguish between the different types of forest–coffee and natural - affected the comparison of forest loss, while ground surveys in non-project *kebeles* were not possible and so limited assessment of the biodiversity and carbon situations.

The research on the change in forest extent and rate of forest loss also suffered from the well-recognised problem of confounding issues, when circumstances are different in the sites being compared (Ameha et al., 2016). This affected the comparison of rates of forest loss between the 12 PFM *kebeles* and the 13 non-project *kebeles*. Different circumstances include the non-CFM *kebeles* being more accessible, having more degraded forest and also probably being affected by "leakage" or the redirection of deforestation pressures from CFM *kebeles*. Similar problems existed with the biodiversity comparison as the coffee forest was badly degraded from before the project, whereas the natural forest was quite intact. There was also a difference in the nature of CFM in the two types of forest.

10. Conclusions

CFM is now well recognised as a way to achieve the sustainable management of tropical forests. However, given the variable results and limited field data there is a need to build evidence of diverse and successful implementation to justify the wider application of this approach. The experience in south-west Ethiopia shows that CFM can have positive impacts on biodiversity conservation and carbon storage as well as slowing forest loss, thereby contributing to two of the sustainable development goals (SDGs). CFM also has the potential to contribute to the *in situ* conservation of wild coffee and through forest-based livelihood development reduce rural poverty thereby impacting multiple SDGs. In these ways CFM can provide a wide range of benefits for communities and society as a whole.

In addition, this case study shows that a number of specific factors may have influenced the success of this CFM work and they may contribute to the overall literature on effective CFM. These factors include the long-term and participatory nature of the CFM process as well as the development of a rapport with the local communities so that CFM has responded and evolved in response to changing felt needs. Subsidiarity and empowerment at the lowest appropriate level are also essential, as is building a community of practice from the *got* to the *wereda* level through the operation of the FMAs and seeing this reflected in national legislation which then influences the behaviour and attitudes of the government offices at regional, zonal and district levels.

This experience in south-west Ethiopia also shows that in CFM careful consideration is needed of both the context and the fine details of the approach, while the timing of any CFM initiative can also be influential as well as the duration of external support and the flexible adjustment to local circumstances. These aspects all need more attention than has usually been the case in studies to date.

Finally it must be recognised that evidence of the implementation of CFM over a much longer period, twenty or more years, is needed to obtain confirmation of the effectiveness of the approach in Sheko *wereda*. However, given the paucity of studies in the area of multiple benefits from CFM, these present findings are important for forest, biodiversity and carbon management in Ethiopia and have wider relevance for effective approaches to CFM.

Declaration of Competing Interest

None.

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Supplementary materials

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