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Human stewardship or ruining cultural landscapes of the ancient *Tula* wells, southern Ethiopia

WAKTOLE TIKI, GUFU OBA AND TERJE TVEDT

Noragric, Department of International Environment and Development Studies, Norwegian University of Life Sciences, PO Box 5003, N-1432, Norway

E-mail: gufu.oba@umb.no

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This article uses the concepts of 'human stewardship' and 'ruined landscape' as a theoretical framework for analysing the community's perception of landscape change in the ancient *tula* well system of Borana in southern Ethiopia. The ancient *tula* well system, the main permanent water source, has been in operation for more than five centuries and it closely links human activity and the environment. The welfare of the *tula* well system and the performance of the Borana pastoral system are directly related. Borana management of the *tula* wells uses concepts such as *laaf aadaa seeraa* and *laaf bade* to differentiate between 'land managed by customary laws' (hereafter human stewardship) and 'lost' or 'ruined' land (*laaf bade*). The cultural landscapes of the ancient wells have undergone changes from ecosystems featuring 'human stewardship' (before the 1960s), that is, *laaf aadaa seeraa* to 'ruined landscapes' (after the 1960s), that is, *laaf bade*. Our interest is in understanding how the Borana perceive the impact of land use changes from these two conceptual perspectives. In group discussions, key informant interviews and household surveys across five of the nine well clusters, we found that the society described the changed *tula* cultural landscape in terms of drivers of well dynamics (i.e. use and disuse), break up of land use zonations, patterns of human settlement (traditional versus peri-urban), expansion of crop cultivation, and changes in environmental quality. Using the two concepts, we analysed linkages between changing patterns of land use that transformed the system from *laaf aadaa seeraa*, which ensured human stewardship, to *laaf bade*, which resulted in ruined landscapes. From these we analysed environmental narratives that showed how the society differentiated the past human stewardship that ensured sustainable landscape management from the present ruining of *tula* well cultural landscapes.

KEY WORDS: cultural landscape, indigenous knowledge, landscape change, *tula* wells, water management

Introduction

Water sources for domestic use in arid zones are usually pressure points where the threat of overexploitation of the surrounding environment is ever present. Due to periodic concentrations of livestock and human populations, the lack of management mechanisms for regulating use and controlling the stock populations that depend on such water points could induce localised severe environmental degradation (Burmil *et al*. 1999). Furthermore the impact on water landscapes can be aggravated by uncontrolled patterns of settlement that create permanent pressures on the resources of the water points. In this article we discuss the indigenous well-water system of the ancient *tula* wells that has had a critical function in the sustainable management of savanna grazing lands in southern Ethiopia. The wells play a pivotal role in Borana pastoral production, cultural identity, and the institutional organisation of water management (Maud 1904; Hodson 1927; Watson 1927; Buxton 1949; Helland 1980; Dahl and Megersa 1990; Cossins and Upton 1987). The indispensable role of the wells is expressed by their connection to human and livestock fertility, continuity of lineages, clan solidarity, and the peace of Borana (*nagaa Borana*) (Dahl and Megersa 1990). In this ancient water system, water changes the meaning of landscape by transforming the land into a cultural landscape (Burmil *et al*. 1999) and it conserves useful

indigenous environmental knowledge for managing the water system (Goodall 2008). The combination of hydrological and engineering systems, social institutions, and regulatory customary laws (*aadaa seeraa*) that evolved around water created strong environmental–human systems that have been exploited by Borana pastoralists on a sustainable basis for several centuries (Helland 1998 2002).

The wells are vulnerable to periodic collapses during periods of environmental perturbations such as excessive rainfall, and the labour demanded by well maintenance reflects the environmental–human relationship. Thus, the society's capacity to organise labour for repairing, re-excavating and digging new wells, the proper location of human settlement, and systems of land use that regulated grazing, all created human–water and cultural–environmental systems that expressed human stewardship. In this environmental–human linked system, the welfare of the *tula* wells is directly related to the performance of Borana pastoral production as well as to the functions of cultural and customary rules and regulations (*aadaa seeraa*). The Borana pastoralists, whose deep-well engineering skills are beyond compare in African savannas, categorise human-managed systems into *laaf aadaa seeraa* where human stewardship is applied, and *laaf bade,* which we interpret as 'ruined land', where the regulatory rules are lacking. Indeed, the dichotomy of the two Borana concepts can have broader perspectives. The worldview of the Borana, where rules and regulations (i.e. customary law) are applied is referred to as *laaf aadaa seeraa* Borana. In the absence of rules and regulation such land is referred to as *laaf aadaa seeraa daawwe* (the land of the fools). In the latter, all human values of the environment and management are ignored, resulting in *laaf bade* (ruined land). We have, in this paper, applied these Borana concepts by linking them to well known theoretical discussions on human–environmental stewardship and ruined land, where the systems of stewardship have broken down (Plummer *et al*. 2007; Worrell and Appleby 2000; Perri 2009; Blondel 2006).

There is a growing interest in applying the concepts of human stewardship and ruined landscape in analysing the dynamics of landscapes (Farina 2000; Worrell and Appleby 2000; Blondel 2006). Burger and Gochfeld (2001, 437) describe stewardship of cultural landscapes as 'long-term wise use and protection of natural resources', while Worrell and Appleby (2000, 263) consider it to be 'responsible use . . . of natural resources in a way that takes full and balanced account of the interests of society, [and] future generations'. The authors further explain the central idea of the concept as 'looking after something in trust . . . for God . . . nature, society, or future generations' (2000, 266). Culture, ethics, and human knowledge are central elements in understanding stewardship (Barry and Smith 2008). Stewardship carries social responsibility and obligations of ensuring environmental sustainability (Wunderlich 2004). Some scholars characterise stewardship as flexible, adaptive and collective environmental management where human–environment relationships are reciprocal (Burger 2002). The existence of human stewardship implies environmental conditions that exist because of human intervention in ensuring sustainability (Barry and Smith 2008). These authors note the importance of traditional local knowledge where genuine community engagement maintains human stewardship of the environment or what they term 'humanised landscape' (2008, 579).

Human-induced land degradation (ruined landscape) by contrast shows the absence or breakdown of human stewardship (Blondel 2006; Hoben 1995; McCann 1997). The general literature on the grazing lands of Africa would claim that communal grazing systems under the control of indigenous resource management institutions would lead to environmental degradation or ruining of the land in the absence of regulations (Rohde *et al*. 2006). This idea reinforces Hardin's 'tragedy of the commons' (cf. Dougill *et al*. 1999), which influenced policy interventions but underestimated the importance of indigenous systems of land management that developed human stewardship in time (Batterbury and Warren 2001). Some authors attribute degradation to human misuse of the environment and put forward policy guidelines to reverse 'irrational and destructive' resource-use patterns (see discussion in O'Brien 2002; Fernandez-Gimenez 2000; Homewood 2004; McCann 1999; Wardell *et al*. 2003; Raynaut 2001). On the contrary, it is often the interventions that are responsible for ruining the land by disrupting human stewardship (Davies 2008; Homewood 2004; Carswell 2003). The failures are attributable to the weakening of indigenous resource management institutions (Watson 2003), the lack of willingness to understand local systems of production (Davies 2008) or to ignorance of indigenous systems of environmental management that consist of memory of past social–ecological adaptations developed from human–environment interactions (Briggs and Sharp 2004; Davidson-Hunt 2006; Berkes and Turner 2006). Political marginalisation and imposition of centrally planned development intervention weakened or disrupted the indigenous resource management institutions (Helland 1998 2002). The weakening or disruption of indigenous resource management institutions led to inappropriate land use patterns that caused degradation (Homann *et al*. 2008; Helland 2002). The Borana view of *laaf bade* implies that the land has lost its value for pastoral production, as far as it is not governed by *aadaa seeraa*. The ruined landscape is therefore the product of alterations of the system. We applied these two concepts in the context of the Borana notion of *laaf aadaa seeraa* (referring to human stewardship) and *laaf bade* (referring to

ruined land) as applied to the *tula* well cultural landscape.

In this paper, we utilised the Borana pastoralists' indigenous knowledge and their perceptions of change to examine how external interventions interrupted long established human stewardship in the management of the ancient *tula* well cultural landscape and resulted in 'ruined landscapes'. The main objectives of this study were to understand the Borana societal perceptions of human stewardships and the ruined landscapes in relation to: the drivers of well dynamics, patterns of human settlement, perceptions of environmental impact associated with changing patterns of land use, and the expansion of crop cultivation. We begin with brief geographical descriptions of the *tula* well cultural landscapes and their traditional management.

The *tula* well cultural landscape and indigenous management

Tula wells are geographically, culturally and technologically unique ancient water systems in southern Ethiopia (Figure 1). The wells are cut through limestone rocks to reach deep water aquifers that are brought to the surface through human chain for lifting water (Donaldson-Smith 1897). The wells are the main source of water in a region lacking surface water and characterised by variable rainfall and frequent droughts (Helland 1980). Such geographical conditions seem to have forced the Borana to build the unique water systems and management rules (*aadaa seeraa*) to ensure sustainability. We however lack documentations on when these ancient well systems were initially excavated, although we know that several Oromo communities before the Borana, perhaps earlier than the thirteenth century, may have excavated the wells. The types of wells are found stretching from southern Ethiopia, through northern Kenya and the Jubaland in southern Somalia (Gufu Oba unpublished).

In this article we combine the Borana concepts of *laaf aadaa seeraa* and *laaf bade* with theoretical concepts to analyse societal perceptions of environmental change in the cultural landscape of the ancient *tula* wells from the following perspectives: in our discussions with key informants (see below) we observed that the two contrasting concepts can be applied to the *tula* wells under strong *aadaa seeraa* when human stewardship sustained the functioning of the system. There are also time scales from when the system of stewardship became weaker and the system they

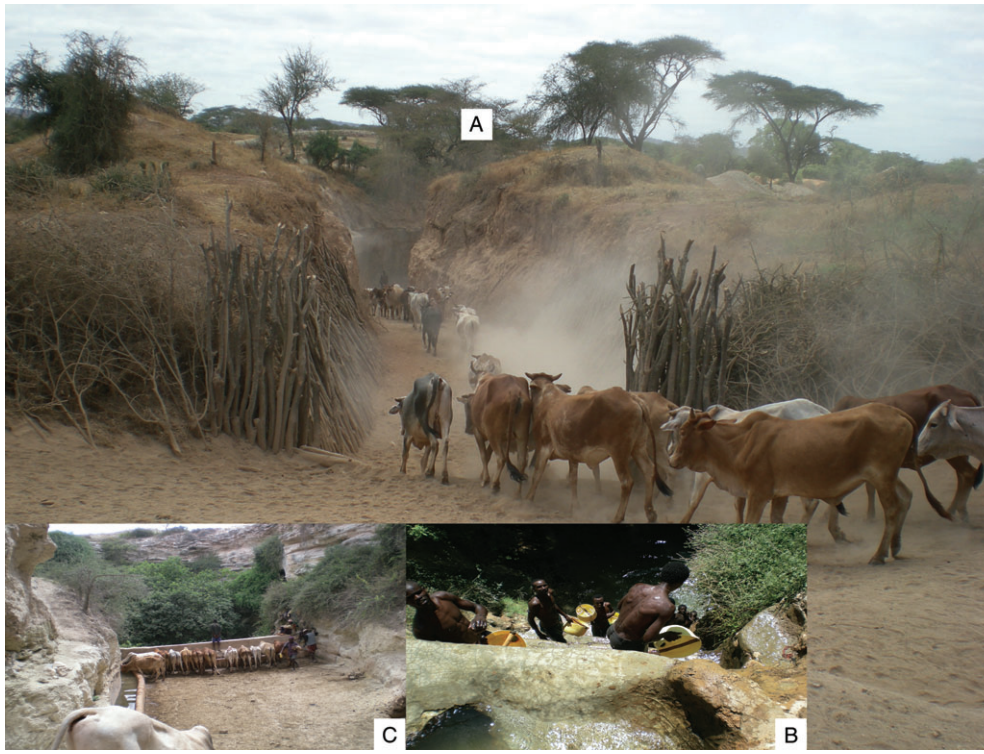

Figure 1 (A) Cattle walking into well through well ramp. (B) Insert showing men lifting water from 15 m depth of the well to the trough. (C) Cattle drinking at the troughs

identified as *laaf bade* began to be applied. The societal perceptions of the changes in the drivers that influenced the functioning of the wells and the processes that led to the 'ruining' of the *tula* wells cultural landscape were of particular interest in our research. The advantage of this approach is that we were able to use indigenous knowledge to reconstruct long-term environmental changes and relate the historical changes to the processes involved in changing well landscapes from human stewardship to ruined landscapes.

For the Borana, environmental stewardship is embedded in the cosmological belief that generations of users are obliged to be custodians of the environment and its resources and they have the clear objective of passing the wells on to future generations indefinitely (Bassi 2005). The *tula* wells cultural landscape has however been shaped by both human and natural forces such as epidemics and droughts that affected the landscape through their impact on human and livestock demography (Tiki and Oba 2009). Thus, in our analysis, the *tula* system has not been a static environment. On the contrary, its dynamic nature has been a reflection of the society's human stewardship.

The distribution of human and livestock populations within the region of the *tula* cultural landscape is organised with respect to the well clusters. The land use patterns are clearly delineated. Grazing is according to zones related to seasons of use that locate different management systems accordingly (Oba 1998). The well rangelands comprise less than 25% of the total grazing territory in southern Ethiopia but they support more than 1 million head of livestock and perhaps over 50% of the total Borana population during the dry season (Coppock 1994; Oba 1998). At the well cluster level, land use is separated into settlement areas, and wet season and dry season grazing zones (Figure 2). Accordingly, all well clusters and their associated grazing landscapes, *dheeda*, serve as resource management units (Hogg 1990). In traditional land-use classification, the area immediately surrounding a well (0–8 km) is reserved for dry season grazing known as *laaf seeraa dargula ela*, and so grazing is prohibited here during the wet season. The *olla* (encampments), are located at fixed radii from the well clusters in different compass directions, each having routes to the wells[1]. For pastures between settlements and well clusters, called *marra araara*, grazing for watering days is delimited and is for use in the dry season. The settlement zones known as *laaf seeraa ardaa* are 2–4 h walk from the wells (8–15 km) while the dry stock grazing zones known as *laaf seeraa foora* (beyond 15 km) are used by the dry herds in the opposite direction of the settlements and the wells. The *reera* (clusters of *olla*) have their own *ona gannaa* (wet season grazing rangelands) which they exploit using rain water. Thus, a community will move the herds to *ona gannaa* during the rainy season and return to *ona bonaa* (the dry season grazing rangelands), in the well rangelands, in the dry season. Areas around the wells may be overstocked during the dry season since the movement of herds during this period is towards the wells, but it is rested during the wet season, allowing recovery from the previous heavy pressure (Oba 1998). Management of the well clusters adheres strictly to these zonations, avoiding grazing the dry season zones before the right time. By means of these zonations the Borana avoided the usual land degradation found around water points in other parts of Africa (Nangula and Oba 2004). An early twentieth century traveller, Major C. W. Gwynn, was surprised by the distance between settlements and wells. He wrote:

> it is rare to find temporary villages in the immediate proximity to the wells, and it is extraordinary the distance cattle are driven from the grazing grounds to water. I have come across villages over 12 miles from the water . . . each drink entails a journey of 20 to 30 miles.
>
> Gwynn (1911, 120)

We considered how these systems changed in terms of changing settlement patterns, the establishment of new peri-urban centres within well clusters, and the expansion of cultivation that increased pressure points by de-regulating land use in the well rangelands. Reorganisation of traditional settlements into pastoral associations, crop cultivation and over utilisation of the landscape of well clusters radically altered the stewardship of the *tula* wells. Increasing crop cultivation within the landscape of the old and disused wells and the well rangelands is evidence of one of the systems of land use that was traditionally considered to violate the sanctity of the *tula* wells which the society uses as religious and ritual sites. Overall, the changes have influenced the perception of the Borana that the *tula* cultural landscape is changing from human stewardship towards 'ruined landscape'. The system of human stewardship did not prevent natural perturbations but it reduced their long-term impact by developing mechanisms for regulating well utilisation,

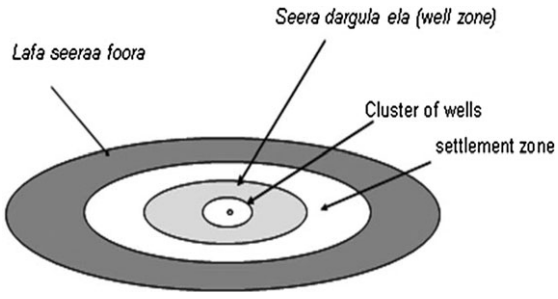

Figure 2 Land use zonation around *tula* wells. The *tula* well cluster is found at the centre while different land use zonation is fixed in reference to the wells

influencing patterns of settlements, setting land use zones and determining carrying capacities of individual wells based on water yields of the well aquifers.

Methods of data collection

The study was conducted from July 2007 to June 2008. Data collection involved interviews with key informants, group discussions, and household surveys in five of the nine *tula* well complexes locally known as *tula salan* (i.e. Dubluq, Melbana, Dhas, Web and Gayo) (Figure 3). The five well clusters were selected after conducting reconnaissance. The two well clusters (Gof and Le'e) were not included in the first visit due to logistic problems. Key informant interviews and group discussions were also conducted in a sixth *tula* well cluster of Erdar. In each of the first five well clusters about 30 households were interviewed using a structured questionnaire (n = 151). The informants from each household were asked to discuss the human–environmental stewardship of the *tula* well system during the past five decades and how the processes of land use change had contributed to the ruining of the *tula* well cultural landscape. The informants' ages ranged between 50 and 90 years, the majority of them being between 60 and 75.

The Borana informants used *gada* timelines to reconstruct environmental changes[2], referring to 8-year periods corresponding to the functions of the *abba gada* in power (Legesse 1973; Huqqaa 1996). The Gumi Gayo Assembly, which occurs in the fourth year of every *gada*, is responsible for regulating the management of the grazing landscape of *tula* wells, among other functions[3]. However, the changes in settlement patterns in relation to the location of wells, and the expansion of crop cultivation, were sometimes better remembered with reference to past

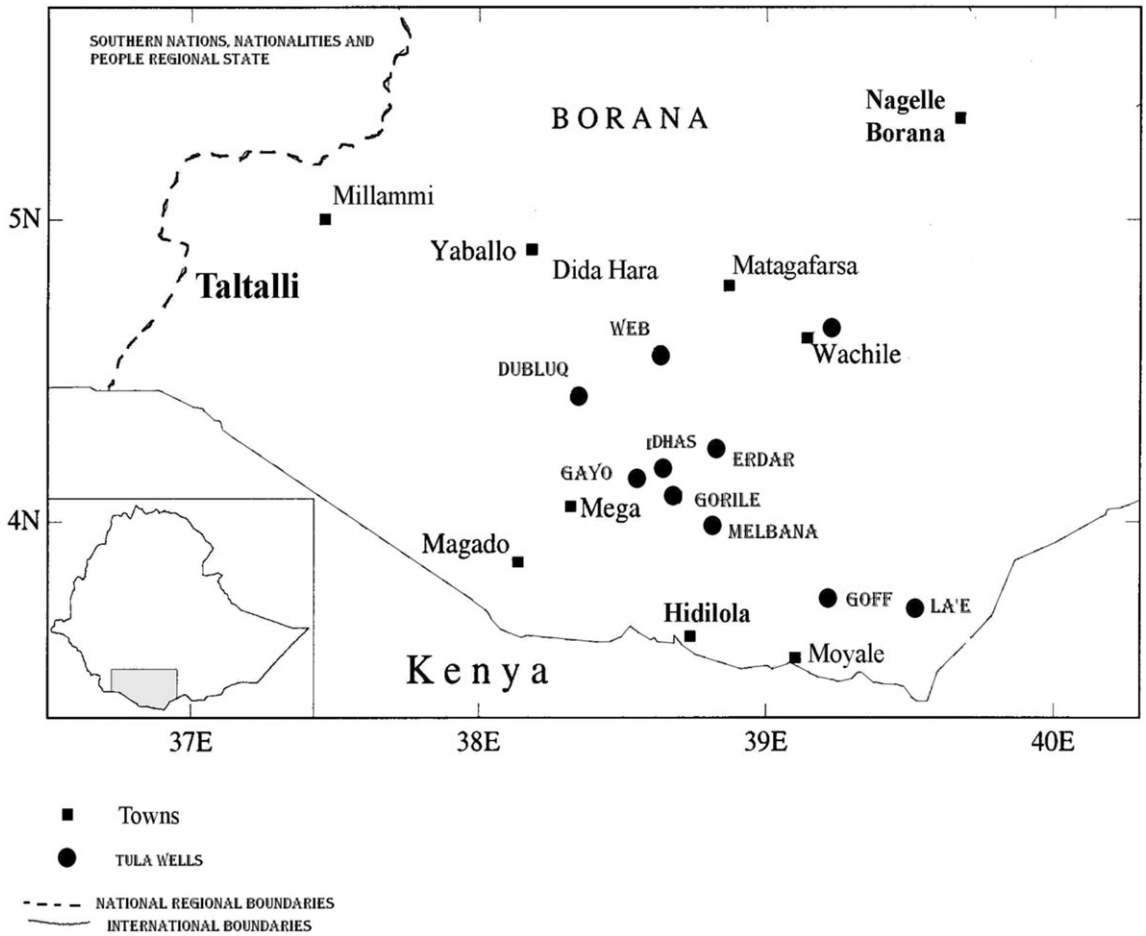

Figure 3 The distribution of *tula* wells in southern Ethiopia

governments of Ethiopia which had influenced change in land use. Accordingly, we used pre-1974 (corresponding to the imperial regime), 1974–1991 (the military regime), and post 1991 (the current government) to understand the changes. For the responses about changes in environmental quality and human populations, we used the *gada* timeline (Waktole Tiki, Gufu Oba and Terje Tvedt, unpublished). This enabled us to collect data in line with the pastoralists' conception of time. Using the interviews and household surveys we analysed the societal perceptions of landscape changes by addressing the main objectives as follows.

In order to address the first objective, (a), we reconstructed the dynamics of *tula* well systems corresponding to different keystone perturbations associated with excessive rainfall (flood) and drought that disrupted the pastoral economy and weakened the social institutions that coordinate labour and manage wells. We deduced that wells that collapsed in the absence of human stewardship remained disused for many generations. Given that the society associated well collapses with excessive rainfall and their lack of repairs with a decline in the pastoral economy, their perceptions of changes in rainfall during the previous five decades for which we had meteorological data were used to corroborate the oral information. We therefore compared deviation of rainfall from the long-term mean (negative for drought, positive for increased rainfall) with the informants' perceptions of rainfall changes. The informants were asked to rate rainfall on a scale of intensity expressed as 'excessive', 'normal' or 'below normal', while for drought they used 'very severe', 'severe', 'mild' or 'absent'.

We combined the interviews and discussion data with field censuses of the wells in the five well clusters to determine the percentages of wells that were operating and those that had fallen into disuse at the time of the survey. In the discussion forum, we analysed societal perceptions of whether or not these natural well dynamics had led to ruined landscapes and how they reflected human–environmental stewardship. From the discussions, it emerged that the community treated the wells not only as physical structures but also as cultural expressions. In this sense, how the people patterned settlements and conducted grazing regulations during the previous 50 years provided us with some sort of benchmark to make inferences on the maintenance of human stewardship or the ruining of land.

The second objective, (b), was addressed by understanding the dynamics of settlement patterns. We used the number of traditional settlements (*olla*) per well cluster, the number of households and total human population per *olla,* as well as the distances to wells as proxy indicators of changing land-use intensity since the 1960s. Traditional settlements around well clusters (see below) were fixed to regulate land use. Given that, traditionally, the settlements and grazing lands in the *tula* well clusters were associated with various land-use zones (as discussed earlier), the changes described assumed social and ecological significance on human perceptions of environmental change in two ways. Firstly, the most conspicuous change narrated by the informants was the establishment of peri-urban centres that affected land use of the *tula* grazing landscapes. Peri-urban settlements that are of recent developments altered patterns of grazing in the *tula* cultural landscapes. Secondly, the walking distances from traditional *olla* to well clusters may have varied in two ways. Firstly, if the *olla* settlements were not shifted, the distances would remain unchanged. Secondly, if the settlements had shifted in different eras that were identified by means of timelines of the different Ethiopian governments, we might expect the walking times to be shorter.

For the third objective, (c), we also used a semi-structured questionnaire to understand the society's perceptions of environmental impact associated with changing patterns of land use in the *tula* well landscapes. The household informants rated changes in grazing landscape sizes as 'extensive', 'reduced' or 'severely reduced'. The herders rated the varied productivity of the rangelands across the *gada* timelines as being 'very good' (*guddoo dansa*), 'good' (*dansa*), 'poor' (*hamtu barbadofte*) or 'very poor' (*barbada dilluuni huuba hinfune*)[4].

For the fourth objective, (d), we used focus group discussions, key informant interviews and household surveys to understand how the expansion of crop cultivation contributed to the ruining of *tula* well landscapes, following the reorganisation of the communities into different Pastoral Associations (PAs) following the societal reforms after the Ethiopian Revolution of 1974[5]. Informants from the five well clusters were asked about crop cultivation in the *tula* well system, which had traditionally been used only for settlement and livestock grazing, with reference to the timelines of different Ethiopian governments.

The rest of the paper is divided into four sections corresponding to the objectives. We first consider how the drivers of well dynamics prior to development interventions contributed to human stewardship of the *tula* wells. We analyse perceptions of the rates of change in terms of perceived rainfall variations in relation to actual records, changes in distances between settlements and wells, the perceptions of droughts of different categories across the *gada* timelines, perceptions of environmental changes and locations of crop cultivations with respect to wells according to recent changes in government in Ethiopia. We used chi-square (χ^2) as well as simple frequencies for analysing the response data.

The drivers of *tula* well dynamics

The field census showed that the actual number of active wells (80) in the five clusters was less than that

Table 1 Status of wells during field observation (2007–08)

Well cluster	Well in use (counted)	Well in use (survey report)	Well under re-excavation	Disused well (reported)	Disused well (counted)	Total
Erdar	8	–	4	–	35	47
Melbana	4	5	2	11	44	50
Web	18	19	2	17	30	50
Gayo	11	13	1	16	31	43
Dhas	10	15	3	18	33	46
Dubluq	29	48	5	14	51	85
Total	80 (25%)	100	17 (5%)	76	224 (70%)	321

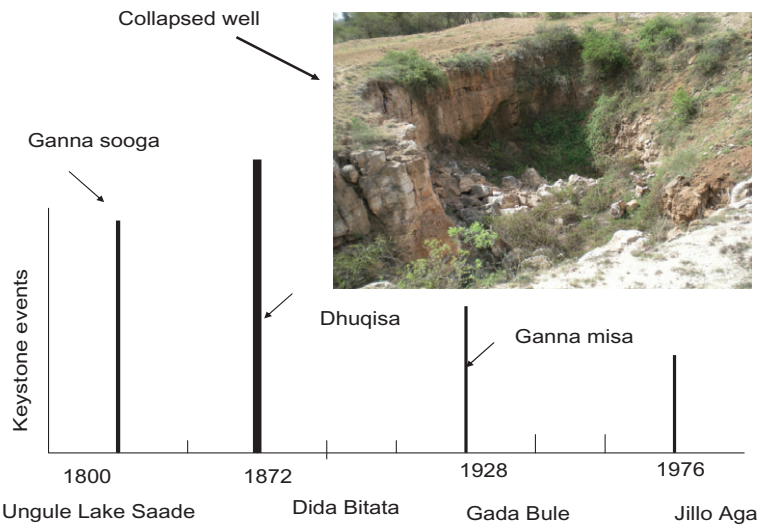

Figure 4 Disused *tula* wells showing timeline of well collapses. The disused well in the insert collapsed in the early 1960s and has not been rehabilitated. The longer the well stays in a disused state, the more it is filled with rocks and soil, demanding huge labour and capital investments to bring it back into a functional state

reported by the household survey as active (100), while the number of disused wells we counted with the help of an assistant (224) was found to be much higher than that reported in the household survey (76) (Table 1). The differences can probably be ascribed to social factors: the respondents often described the wells as 'ours' or 'theirs' in the complex and crosscutting social relationships. The clans that shared water but do not own a well would still report the well as 'ours', while those from different clans would refer to other wells as 'theirs'. We crosschecked the information obtained from the field census and with the oral historians' knowledge of the wells (Table 1). The cultural restraint in reporting disused wells is very complex as the right to reveal the ownership of disused wells is reserved for a few families in one specific clan[6], and this constrains people in the discussion about disused wells. Generally, we found that about 25% of wells were operational while about 70% were inactive at the time this fieldwork was conducted, with 5% under rehabilitation. The household surveys showed no significant differences in the numbers of wells operating since the 1960s in the different clusters ($\chi^2 = 7.487$, $df = 4$, $P = 0.85$).

From our perspective, the wells in the different clusters fluctuated from active (Figure 1) to disused (Figure 4) with the ratio of active to disused wells varying over time in relation to drivers such as flooding and the status of the pastoral economy. Some of the disused wells may have remained inactive for generations. Oral sources used major environmental perturbations corroborated with *gada* timelines as evidence of such long disuse of wells (see below). Some obvious reasons were structural difficulties in re-excavating after rock falls, or uncertainty of the *konfi* property rights (Waktole Tiki unpublished data). The reasons might also include decline in water demand, shortfalls in labour and increased productiv-

ity of existing wells. This might have forced users to pool labour to utilise the productive wells and to abandon the poorly yielding ones. Informants inferred that a falling water table was another threat to the functioning of *tula* wells. The Borana have been known to abandon some wells in the past because the falling water table did not support high numbers of cattle. The cost of upkeep and labour required by such wells also did not justify the investment. Furthermore, increased alternative water source development by the government (e.g. boreholes) might be drawing some users away from the traditional *tula* wells (Waktole Tiki unpublished data). Thus, currently, the main concern of the Borana is not how to re-excavate disused wells only but also how to ensure the continuous operation of the active ones. The informants associate the rate of well collapse with the intensity of rainfall, and rehabilitation with the capacity of the pastoral economy.

Impact of rainfall

Oral historians associated well collapses with excessive rainfall. The periods referred to by the Borana as *ganna sooga* during the *gada* of Ungule Lake Saade (1800–1808) and *Dhuqisa gada* Dida Bitata Mamo (1872–1880) were associated with major well collapses. Figure 4 is a sketch of time and space of the well dynamics from 1800 to the 1970s. The earlier period coincided with recorded high and frequent floods of the Nile River (Fraedrich *et al*. 1997), which imply heavy rainfall in Ethiopia. Another period of major well collapses occurred after the Great Rinderpest epidemic of the 1890s that decimated the pastoral economy and resulted in a human demographic collapse (Tiki and Oba 2009). In recent times, according to Borana oral informants, greater proportions of the earlier collapsed wells remained inactive. In the last century, wells collapsed during *ganna misa* of *gada* Bule Dabasa (1928–1936) and the *hagaya gabbo* of *gada* Jaldesa Liban (1960–1968)[7]. During *gada* Jilo Aga (1976–1984) floods collapsed all the wells in the Dubluq cluster[8]. Excessive rainfall was recorded in the whole of East Africa during this period (Indeje *et al*. 2000).

According to regional meteorological data, the period 1980–81 was characterised by a positive mean rainfall deviation followed by a high negative mean deviation during 1983–84 (Figure 5A). Informants also reported similar trends with the meteorological data, although not perfectly correlating (Figure 5B). Informants explained this in terms of the severity of collapsed wells. Since few days' excessive rainfall can cause the collapse of many wells, the pastoralists' perception may not be a good indicator of annual rainfall and can differ from the recorded data. The tests across time show significant difference in rainfall (χ^2 = 5.279, *df* = 6, $P < 0.001$). The pattern also confirmed a close relationship between the negative mean deviation of regional rainfall data (Figure 5A) and the herders' perceived droughts (Figure 6). The herders perceived that drought frequency and severity had increased since the 1970s. The chi-square test showed that there was a significant difference in the severity of drought over time ($\chi^2 = 2.399e^{-2}$, *df* = 6, $P < 0.000$).

Herders reported at least five major droughts during the last 40 years, each *gada* period experiencing at least one drought. Severe droughts occurred during *gada* Goba Bule (1968–1976), *gada* Jilo Aga (1976–1984). The droughts of *gada* Goba Bule (1968 and 1972) were the two most severe droughts Borana experienced in short period. These were followed by that of *gada* Jilo Aga (1983–84), causing massive cattle mortality. Following these droughts many *tula* wells fell into disuse due to lack of rehabilitation[9]. Other droughts were reported during *gada* Boru Guyo (1984–92), *gada* Boru Madha (1992–2000), and *gada* Liban Jaldesa (2000–08) (see Figure 6).

From the perspective of human stewardship of the *tula* wells, there was no evidence that the Borana are abandoning the wells or even considering it. In the society's view, human stewardship breakdown should be examined from the perspective of external political and economic drivers rather than natural perturbations. Thus, the Borana do not consider the collapsing of wells as ruining of the landscapes. The traditional system of human stewardship included the restoration of collapsed wells. In contrast, the external political and policy changes, instead of strengthening the ancient water management system, introduced alternative sources of water that are easy to exploit, making many users reliant on engine-pumped water (Waktole Tiki unpublished data) and depriving the wells of the regular maintenances. The society considered the changes to be ruining the *tula* well landscapes. Understanding changes in the human stewardship of the *tula* well cultural landscape can also be based on understanding changes of settlement patterns from indigenous *laaf aadaa seeraa* control of human settlements to *laaf bade* that originate outside the Borana pastoral system.

The patterns of traditional *olla* settlements

Respondents agree that the number of *olla* near wells has increased in recent years. About 14% of respondents reported that their *olla* is located less than 30 min walk from the wells compared with 3% of respondents during previous decades. In general, about 77% of the respondents reported that their *olla* is located in the settlement grazing zone (less than 2 h walk from the wells) (Table 2). However, we found no significant differences in distances between traditional settlements and wells in the last 50 years (χ^2 = 14.568, *df* = 8, $P = 0.068$). About two decades ago, Cossins (1983) estimated 30–70% of *olla* to be within 2 h walking distance. From the household surveys (Figure 7A) the number of *olla* reported by respondents during differ-

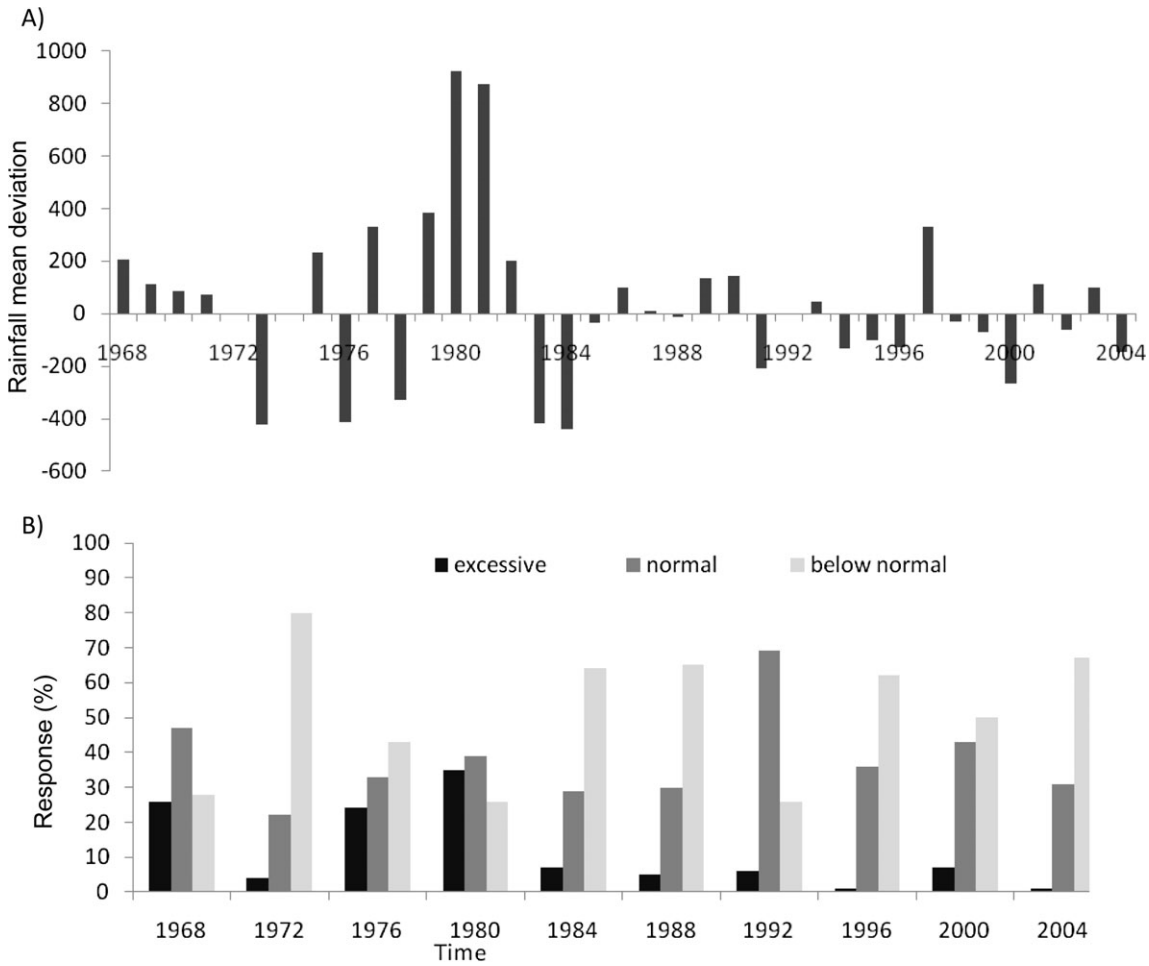

Figure 5 (A) Rainfall mean deviation. (B) Perceptions of rainfall conditions. Despite the correspondence between informants' perceptions and regional meteorological data, there was a difference particularly for the mid 1970s, which may be attributed to memory of informants or local variation in rainfall

ent *gada* periods has shown a slight increase in all the clusters, with the exception of the Web that showed a decline after the 1990s. The decline could either be due to the restructuring of administrative units (i.e. peasant associations after 1974) or to migration. The Dubluq and Dhas well clusters showed greater growth in the number of *olla*. The Gayo cluster attained the highest number of *olla* from 1976 to 1984, when the Ethio–Somali war displaced populations and was followed by their resettlement for security reasons. As a general rule, the number of *olla* per well cluster, which usually corresponds with the size of the human population, was relatively stable. The household survey showed that there had not been significant changes in the number of households per *olla* for the last five decades, while the total human population per *olla* had increased. This might suggest that at household level, the family sizes have increased since the 1960s (see Figure 7B). The Borana would suggest that the general increase in human population might have increased pressure on the *tula* landscapes but this was mediated though alternative forms of settlements such as peri-urban centres that were established in all the well clusters (see below). The Borana interpretation was however cautious for arguing that the populations around the *tula* systems may have been on the increase for the last six decades, but this alone did not contribute to the breakdown of human stewardship, while unregulated population centres springing up around the well clusters did.

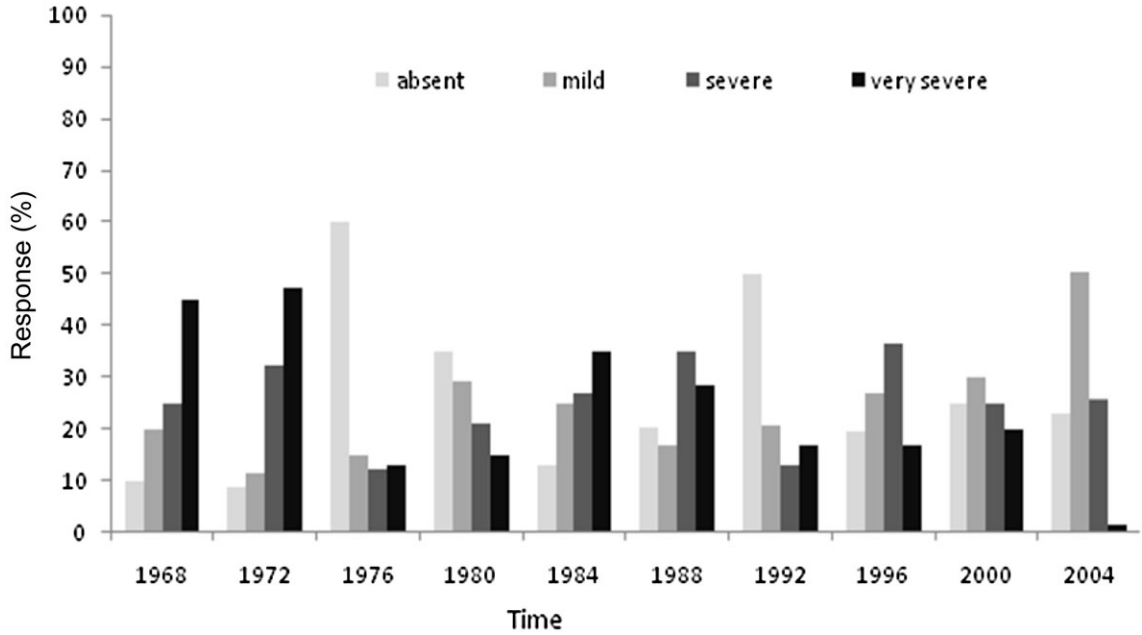

Figure 6 Perception of drought severity. The periods from the early 1970s to the mid 1990s show severe drought. In recent years, pastoralists perceived droughts to be more frequent

Table 2 *Olla* distance in walking hours from well cluster during three different periods (responses as %)

Walking hours between well cluster and *olla*	Pre 1974 *n* = 146	1974–91 *n* = 149	Post 1991 *n* = 149
Less than 30 min	2.1	3.4	14.1
30 min to 1 h	5.5	4.1	2.0
1–1.5 h	22.6	22.1	29.6
1.5–2 h	20.8	28.2	31.5
More than 2 h	49.3	42.2	22.8
Total	100	100	100

Establishment of peri-urban settlements in tula *well clusters*

In the system that we are describing, water sources were not traditionally the location of settlements. Settlements were located a distance away, creating a buffer between the water source and the area of continuous livestock grazing (see Figure 2). Yet, the current pattern of peri-urban settlement in the *tula* well clusters uses the historical model from elsewhere in the world where water sources are the focus of settlements (Kummu 2009; Dias 1981; Lightfoot 1997 2000). In these other systems the breakdown of water systems resulted in the abandonment of settlements (Birks and Letts 1977). In our case, the growth of peri-urban centres is externally driven. For example, Dubluq, one of the well clusters which has grown into an urban centre, lies 100–150 m from the well cluster. Its population is estimated to be 7151 (4421 male, 2730 female) (Dubluq mayor, personal communication). Dubluq has acquired town status with services such as electricity. The Dhas and Melbana well clusters have more than 130 permanent houses, while in the Web well cluster the urban houses have increased to more than 150. The Gayo well cluster, the most sacred site where the Pan Boran Assembly of Gumi Gayo holds its meetings every fourth year of each *gada* and where traditional settlements or other forms of human habitation were culturally prohibited, had at the time of the survey about 50 houses built in the vicinity of the wells. In 2001, there were only seven houses there (Waktole Tiki unpublished data). At the Erdar well cluster the established peri-urban centre has more than 70 houses. Besides the already constructed houses, many plots were being fenced for future development. The administration of each peri-urban centre, which is part of the Peasant Association authority, has started allocating land for individuals who wish to construct houses. According to our informants, in the 1940s and 1950s trading activities at the well clusters for purposes of livestock marketing were sporadic, but human habitation was absent. At that time the *aadaa seeraa* forbade the establishment of such permanent structures. In recent years the state policy

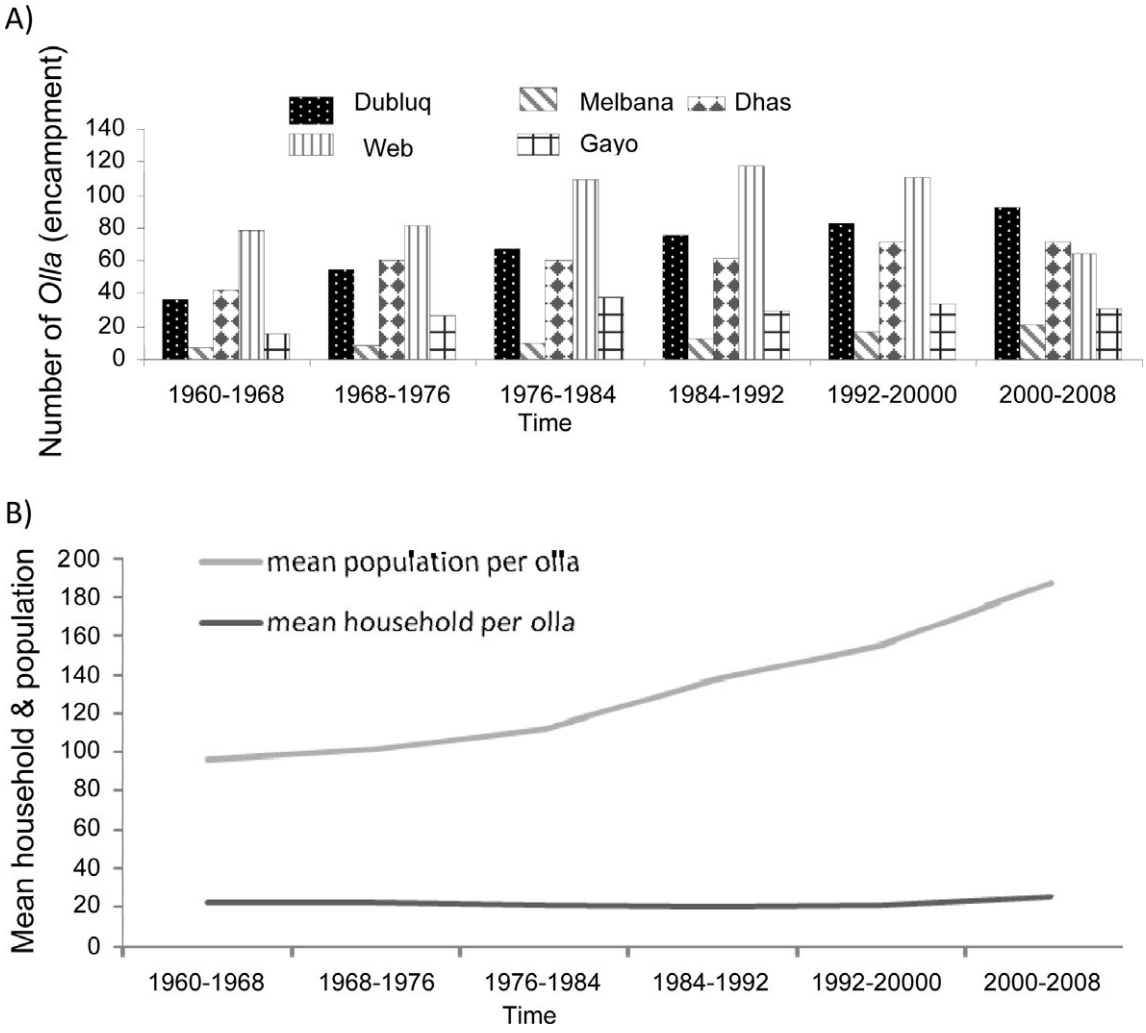

Figure 7 (A) Perception of change in size of *olla* over time. (B) Changes in mean number of households and size of human population per *olla* over time. The size of *olla* has not shown much change, while human populations have increased over time

appears to have overwritten the traditional protection, weakening *aadaa seeraa*.

In earlier years when *aadaa seeraa* was strictly followed, the *tula* rangelands served as grazing reserves for the dry season. The human and livestock populations using the *tula* well clusters would increase and then shrink again when the population dispersed during the wet season. Social, economic, political and security issues have played important roles in changing the settlement patterns. For example, the 1970s was a period of intensive insecurity because of the Ethio–Somali war. The period also coincided with the Sahelian drought that severely affected the Borana. These two factors forced the government to collect pastoralists together at the water points to provide them with food aid and offer security. This was termed as *gana madabi*, which referred to settlements in rows as opposed to the traditional *olla*. In time, some of the settlements became permanent. In the *tula* well clusters, the establishment of peri-urban centres is not governed by indigenous Borana institutions (*aadaa seeraa*) and traditional settlement rules, but falls into the category of *laaf bade*, even though currently they are accepted as a *fait accompli*.

The location of well clusters has become ideal for establishing such facilities as schools, health services, retail business, administration centres and semi-permanent houses. The existence of various facilities is attracting more people. All the goods and services needed by pastoralists are supplied in the shops, and

markets for livestock and consumer goods and grains are held at the well clusters. These peri-urban centres have created an opportunity for government representatives to collect taxes and hold political meetings. Activities that were previously suppressed by *aadaa seeraa* (customary law) have flourished. The long established tradition that encouraged every Borana to work towards strengthening traditional resource-use patterns has been eroded by external intervention. Rather than opposing the changes, the Borana participate in building more permanent houses within the well clusters while at the same time keeping their traditional *olla* at the distances prescribed by *aadaa seeraa*. For the Borana, tradition and change are not mutually exclusive, but rather they co-exist, and so the Borana play dual roles even when the society had choices to resist such changes. Instead, in order to exploit the economic opportunities associated with peri-urban centres, families locate some of their members (usually the younger married ones) in peri-urban environments, while for the purpose of pastoral production they maintain the *olla* settlements. In the process, the Borana lost control over the management of the immediate well rangelands that traditionally were reserved for grazing during the dry season. Thus, there is a growing conflict in land use between the traditional *olla* settlements and the new inhabitants of the peri-urban settlements. Because of increased competition between the traditional settlements and the peri-urban centres over the allocation of grazing land, the risk of land degradation has increased[10]. Thus, returning to the two concepts of human stewardship and ruined landscape, the urbanisation of the *tula* cultural landscape would contribute to the ruining of the landscape from the perspective of Borana environmental protection and pastoral range management.

In the view of the Borana, these changes have occurred with environmental costs that are not part of human stewardship but are indicators of the processes leading to the ruining of the cultural landscape of the *tula* wells. The self-regulating ecological balance seems to have been disturbed by the recent water resource development linked to peri-urban centres (Waktole Tiki unpublished data). The changes in settlement patterns and the breakdown of indigenous resource-management rules have implications for traditional resource-use patterns that have been altered from the wet–dry season grazing system to the year-round use of *tula* well rangelands. The disruption of the grazing system that rotated between the remote rainy season grazing rangelands and the dry season grazing zones in proximity to wells is increasing the possibility of land overexploitation. Since there are no grasses in the well zones that are reserved for dry season use, minor deviations in rainfall patterns could easily cause a collapse of the cattle economy (Cossins and Upton 1987; Oba 2001). The Borana consider these environmental changes to be ruining the *tula* wells cultural landscape.

Impact on environmental changes

The majority of the respondents (96%) considered pasture to have been very good in early 1960s, while only 2% considered it so currently (Figure 8A). There have been significant differences in pasture availability over time ($\chi^2 = 8.731e^{-2}$, $df = 6$, $P < 0.001$). According to one informant: 'when we were younger, we played "hide and seek" in the long grasses. Today . . . we see bare ground (*baarbadaa*) everywhere . . . [while the grazing lands are] covered with bush'. Herders further described grass conditions of the past in terms of high milk production; greater calving rates and calf growth (see also Roba and Oba 2009). Generally, the good livestock productivity of the past and its present decline was explained in relation to the changes in grass production. The majority of the respondents (Figure 8B) believed that the size of grazing land had declined over the past five decades. Informants attributed the change to conflict and internal land fragmentation as a result of farming and range enclosures that in turn affected the perception of pasture availability. There were significant differences in perceived changes in the size of grazing land over time ($\chi^2 = 1.50e{-3}$, $df = 8$, $P < 0.001$). Expansion of crop lands (Berhanu *et al*. 2007; Desta and Coppock 2004), the growth of peri-urban centres, expansion of settlements, pasture enclosure, and bush encroachment (Angassa and Oba 2008a), and externally the loss of Borana grazing land to Somali regional state due to regionalisation policy (Homann *et al*. 2008; Helland 1998 2002) were cited as reasons for the reducing size of grazing land. Reduced mobility by *foora* (satellite herding) and localised land use pressure by the *warra* herds (home-based herds) pose threats to the grazing lands of the *tula* well clusters as well as to the non-*tula* rangelands. An additional threat is the expansion of crop cultivation within the *tula* well clusters which challenges the traditional *aadaa seeraa* that prohibits the cultivation of *tula* rangelands. This has contributed to the ruining of the land.

Cultivation of *tula* cultural landscapes

About 6% of the respondents reported that they were involved in cultivation prior to 1974 (Table 3). The percentage of respondents engaging in cultivating now is about 68% (post 1991). From the perspective of the cultivators, about 9% started cultivation prior to 1974 (i.e. the imperial period) while 38% started during the period of the military regime (1974–90). The rest (53%) started cultivation after 1991(the present government). The result is that there were significant differences in the number of cultivators across the periods ($\chi^2 = 1.510e^{-2}$, $df = 3$, $P < 0.001$).

From the interviews, the distance between well clusters and cultivated land, as a proxy indicator of land-use intensity in the *tula* region, has shortened.

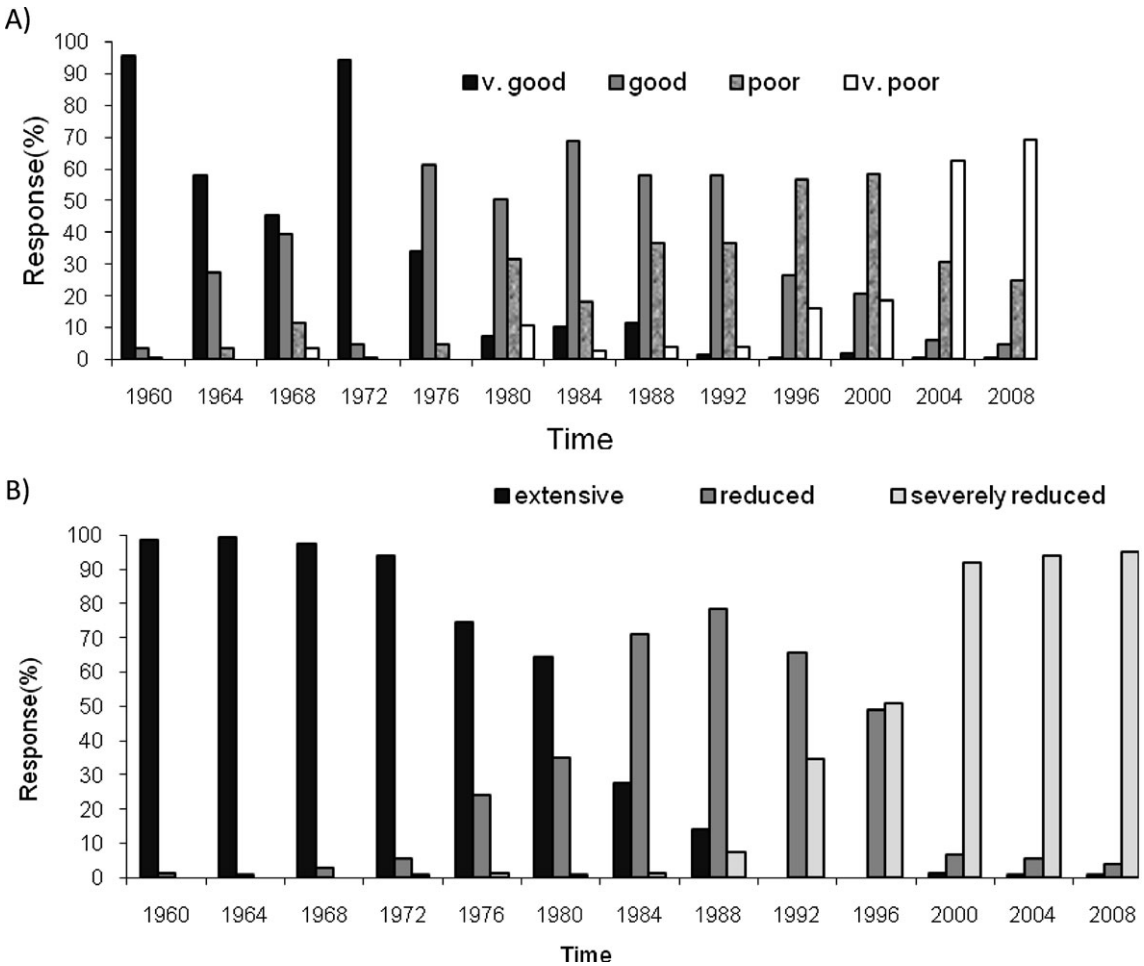

Figure 8 (A) Perception of pasture status over time. (B) Perception of changes in the size of home range grazing land. Informants perceived that the status of pasture availability changed from 'very good' in the 1960s to 'very poor' in recent years, the middle periods being characterised as 'good' and 'poor'. Perceptions regarding home range grazing land followed similar patterns (changed from 'extensive' in the 1960s to 'severely reduced' in recent years), showing links between the two

Table 3 Percentage of respondents involved in cultivation during different periods

Period started	*n* = 151	% within cultivators	% within the sample	Cumulative
Pre 1974	9	8.7	6.0	6.0
1974–91	39	37.9	25.8	31.8
Post 1991	55	53.4	36.4	68.2
Total	103	100	68.2	

Accordingly, about 8% of respondents cultivated within the immediate environment of the wells (less than 30 min walk), whereas about 15% reported cultivating within a 30 min to 1 h walk from the wells. Ten per cent of the respondents cultivated within the range of 1–1.5 h walk, while 19% cultivated in areas between 1.5 and 2 h walk. The implication was that more than 50% of respondents cultivated within a

Table 4 Percentage of cultivators at different walking hours from well cluster

Distance of cropland from wells	Dubluq $n = 32$	Melbana $n = 29$	Dhas $n = 30$	Web $n = 29$	Gayo $n = 31$	Total $n = 151$
<30 min	9.4	3.4	6.7	13.8	6.5	8.0
30 min to 1 h	18.7	34.5	3.3	13.8	3.2	14.6
1–1.5 h	6.3	34.5	3.3	3.4	3.2	9.9
1.5–2 h	18.7	20.7	16.7	20.7	16.1	18.5
>2 h	21.8	–	13.3	31.	19.4	17.2
Not cultivating	25.1	7.0	57.3	17.1	51.6	31.8
Total						100

distance less than 2 h walk from a well cluster (Table 4). There were differences in the proportion of respondents involved in cultivation across the well clusters. For example, 93% of Melbana respondents cultivated crops, whereas only 43% of Dhas respondents were involved in cultivation (Table 4). At Web 83% of the households cultivated crops. Web is close to Dida Hara, a pastoral association known for adopting land semi-privatisation from its neighbouring agro-pastoral communities in the north (Homann *et al*. 2008), while Melbana is close to Mega and Tuqa highlands that are known for historical practices of land cultivation. The percentages of cultivators at different walking distances from a well also differed across the five well clusters (Table 4). From our analysis we confirmed the inter-cluster differences (χ^2 = 26.21, $df = 4$, $P < 0.001$). Cultivation is expanding into the well grounds, to the extent that even some of the long disused well landscapes were being converted.

Holden and Coppock (1992) found 33% of their respondents were engaged in cultivation in the early 1990s whereas the synthesis of different studies by Coppock (1994) shows an increase in the proportion of respondents cultivating (35%). In a more recent study, Tache (2008) found that 95% of sample households were involved in the cultivation of non-*tula* landscapes. Another study by Angassa and Oba (2008b) showed that 87% of the households interviewed were involved in cultivation of non-*tula* landscapes. The percentage of respondents cultivating (68%) in the *tula* landscapes was less than that reported for non-*tula* landscapes. This might reflect the past Borana reluctance to cultivate in *tula* regions, which has only begun to change recently. A brief survey conducted in two *madda* in 2001 showed only 40% of the respondents in the *tula* region cultivating (Tiki 2002). Traditionally, the Borana considered the tilling of land to be a violation of sacred rules of land use and it was regarded as the work of evil (*falfala*). However, repeated collapses of the pastoral economy as a result of drought and external development interventions have forced the pastoralists to start cultivation (Kamara *et al*. 2004). In the 1980s, the pan-Borana assembly (Gumi Gayo) acknowledged cultivation as one acceptable form of livelihood in response to declining cattle holdings (Tache 2008; Berhanu *et al*. 2007). This might be driving the rapid adoption of cultivation.

From the interviews we conducted, we found that most individuals who were cultivating within the well grounds (particularly at the Dubluq and Web clusters) were pastoralists who had lost cattle during recent droughts. Some of the cultivators used irrigation from the excess water in watering troughs of wells and motor pumps installed in well grounds. They cultivated seasonal crops such as maize, pepper and groundnuts, as well as permanent crops such as coffee, papaya, avocado, mango and *khat*, which is used as a stimulant.

From the changes we observed, three important issues regarding cultivation of crops in the well clusters might be raised. Firstly, individual cultivators were using formal government agricultural land use policy to support the expansion of crop-raising in the *tula* well rangelands against threats of removal by the community, which believed that the cultivators were ruining land (*laaf bade*). Secondly, irrigation has the potential to influence how the *tula* wells might be used in the future. This might of course mean that the Borana could be forced to accept the use of motorised diesel engines for pumping water. Thirdly, there is the possibility of conflict between the use of well landscapes for livestock or for cultivation. Cultivation around disused wells is in violation of well property rights set down by *aadaa seeraa*. There is therefore a possibility that clans contest the right to use the land for purposes of crop cultivation.

But as the trend of increasing adoption of crop cultivation by the community shows, crop production is likely to take over the well grazing rangelands traditionally reserved for livestock brought to the wells for watering during the dry season. As farming practices expand, the society considers that crop cultivation in the *tula* well clusters poses a threat to sustainable human stewardship, resulting in the ruining of the land. The perceived threats are that crop cultivation and pasture enclosures will ultimately result in privatisation of the *tula* well rangelands.

Moreover the Borana blame cultivation for fragmenting grazing lands and causing overgrazing. The changing structure of vegetation composition from grassland to bush-encroached landscapes is given as evidence for their view (Waktole Tiki unpublished data). Shrinkage of available grazing lands is threatening the sustainability of the remaining rangelands (Berhanu *et al*. 2007; Tache 2008). Cultivation in well grounds is also likely to impact on resource-use rules and practices. Primarily, it violates the basic principle of resource use by competing with pastoralism. It does this by triggering conflict by blocking access of livestock to the well points. There are no rules that govern cultivation or land allocation for cultivation in the *aadaa seeraa*, and as a result, cultivators adhere to the government rules while those in favour of pastoralism adhere to traditional resource-use rules. This creates contradictions between the two categories of resource use, and the outcome is the ruining of the cultural landscape of the *tula* wells (*laaf bade*).

Conclusion

The concepts of human stewardship and ruined landscape have been applied to analyse the human-induced dynamics of cultural landscapes. However, in the past, indigenous knowledge and the perceptions of local people have not been given much attention in understanding these concepts. We used Borana pastoralists' indigenous knowledge and their concepts of *aadaa seeraa* and *laaf bade* in relation to human stewardship and ruined landscape to discover how they perceive the dynamics of cultural landscape change within the ancient *tula* well system. The findings show that the human stewardship that maintained the landscape of *tula* wells in a functional state (through land-use zonations, well rehabilitation, re-excavations of collapsed wells and proper management), and sustained large human and livestock populations for several centuries, has been disrupted during the last five decades, threatening the *tula* wells' cultural landscape with ruin. The change from *laaf aadaa seeraa* to *laaf bade* is a result of the disruption (through external interventions) of the community's ability to manage the *tula* wells' cultural landscape, and hence land degradation ensues. It shows the lack of enforcement or absence of *aadaa seeraa* (customary laws) that would otherwise have regulated the use and management of *tula* wells and their environment. The change from human stewardship to ruined landscapes is manifested in land-use changes in terms of settlement patterns, abandonment of traditional wet–dry season grazing zonations, and the expansion of cultivation. The new land-use patterns disrupted long-established resource-use patterns and altered the functional symbolism of the *tula* wells. The loss of human stewardship has implications for the protection and management of the ancient water system that in earlier times made land use sustainable.

Acknowledgement

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Notes

1 The wells are clan resources and access to water for livestock is not automatic but is negotiated using principles of reciprocities and social networks. However, because each well in a cluster only has a specific capacity, the community must limit the number of animals using each well cluster. Traditionally, in different well clusters, human and livestock populations fluctuated in correspondence with the fluctuations of active and disused wells.

2 Gada is a socio-political institution where a different luba-generation class assumes power every 8 years, rotating among the five *gogessa* into which the Borana are organised. Details of this complex system are described in Legesse's classic book of the same name (1973).

3 The well clusters are used for society-wide assemblies that are critical for the discussion of social, political and economic issues related to human stewardship of the wells. The Pan Borana Gumi Gayo Assembly, for example, has met at the Gayo wells for several centuries.

4 The extent of land being ruined was expressed in terms of severe levels of degradation where 'even the after birth cattle', which are sticky, would not pick up litter.

5 Major changes in land use and patterns of settlement occurred in Ethiopia during the Derg government (1974–91) that radically changed the political system throughout the country.

6 Discussions on the property rights and ownership of wells are highly restricted because of the tradition that 'not all individuals are allowed to tell ownership of long disused wells except the adula Karayu' (group discussions). There is the belief that only one particular family in the Karayu clan is 'blessed' and authorised to reveal the ownership of disused wells. This particular family is said to have extraordinary and mythical knowledge in 'telling' the ownership of wells that have been inactive for several centuries.

7 This was a period when heavy rainfall flooded all wells and the subsequent cold weather killed many horses. It was named *hagaya michu gada Jaldessa*. Re-excavation of collapsed wells after this rain took many years and demanded a huge investment of labour and cattle. Some wells that could not be rehabilitated have remained in a disused state.

8 More recently, almost all the wells in Dubluq were flooded during the short rainy season (October–December) of 2008. The water had not yet receded when the long rainy season (April–May) of 2009 arrived and floodwater filled the wells again. It was difficult to determine the extent of collapse since all wells were filled with floodwater.

9 The earlier drought was known locally as *olaa midhan diimo* (drought of brown maize), a reference to the yellow maize supplied as food aid. The latter was referred to as *gaafa lafeen karaatti yaate*, or the period when 'Borana collected bones along main roads to convince aid agencies for help'.

10 The Borana *tula* wells have traditionally been one of the most sustainable systems of resource management. Despite the well rangelands having been in use for several centuries, there was no evidence of land degradation until a few decades ago when changes in settlement patterns occurred.

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