The Dynamics of the Ancient *Tula* Wells Cultural Landscape: Environmental and Social History, ca. 1560 to the Present

Philosophiae Doctor (PhD) Thesis

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To my wife Ayelech and our daughters:

Darartu, Bontu, Bilise and Hinsene

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Part B: List of Papers

Paper I. Waktole Tiki, Gufu Oba and Terje Tvedt. 'Reconstructing the impact of disasters on the *Tula* well cultural landscape in Southern Ethiopia, 1560–1950' (revised, *Environment and History*)

Paper II. Waktole Tiki and Gufu Oba. 2009. '*Ciinna* − the Borana Oromo narration of the 1890s Great *Rinderpest* epizootic in North Eastern Africa', *Journal of Eastern African Studies*, 3(3): 479-508

Paper III. Waktole Tiki, Gufu Oba and Terje Tvedt. Human stewardship or ruining cultural landscapes of the ancient *Tula* wells, Southern Ethiopia' (In press, *The Geographical Journal*)

Paper IV. Waktole Tiki and Gufu Oba. 'Labour and technological transformation in utilizing ancient water systems in southern Ethiopia (submitted to *Water Resource Management*)

Abstract

This thesis on the dynamics of ancient *tula* wells cultural landscape is an attempt to integrate Environmental and Social History. The thesis advances knowledge on ancient water systems, of which past recorded knowledge is meagre. The thesis has two fundamental sections: A (introductory) and B (individual study papers). The first part introduces important concepts and provides background and theoretical information for reconstructing the environmental and social history of ancient water systems. The thesis approached environmental reconstruction using oral time recall systems based on the indigenous time recall system of the Borana for understanding the impacts of natural disasters, socio-political perturbations and human responses on this ancient water system. This thesis has followed the tradition of previous historians working on environmental history of the lacustrine lakes of East Africa which used oral sources to reconstruct several centuries of environmental and social change. With brief discussions of the roles of the ancient water systems in transforming the water deficient regions of the world, the thesis situates the dynamics of ancient *tula* wells in the contemporary debates of African environmental and social history. The second part (Part B) comprises four articles. The individual papers present an analysis of the impacts of natural disasters, socio-political perturbations, human responses (Papers I & II), human perceptions of land use changes (Paper III), and labour and technological transformations in the utilizations of *tula* wells (Paper IV).

Paper I reconstructs environmental and social history of the ancient *tula* wells. The *tula* well in southern Ethiopia represents a unique water-cultural landscape wherein the well is linked to sustainable pastoral production, clan social identity, religious and ritual practices, and political debates of the community. The Borana pastoralists explain the pivotal role of *tula* wells by linking the wells to family, cattle economy, and peace of Borana (*nagaa Borana*). This water system has been modified by centuries of natural disasters, socio-political perturbations and human actions. The dynamics reflect the historical imprints of natural disasters (epidemics, droughts, excessive rainfalls or floods, famine, etc.) and socio-political perturbations (social disharmony, disunity, and political perturbations) that induced human adaptive responses. The Borana oral sources explain the dynamics of *tula* wells using three interrelated Borana concepts: *gogessa* (patri-class), *maqabas* (cyclical name) and *dhaaccii* (predestined event repetitions). The concepts provide time experts with tools to

memorize and narrate environmental and socio-political perturbations and human responses in understanding the dynamics of *tula* wells. These interconnected and complex concepts define the cycles and replications of events in historical perspectives. In the cycles of *maqabas* and *gogessa*, natural disasters and socio-political perturbations that affected at least one of the three interdependent and important aspects of Borana pastoral system (wells, cattle economy, and family or human demography) served as historical markers and references for time recollection. Corroborating the oral sources with proxy environmental data, the thesis reconstructs the impact of natural disasters, socio-political perturbations, and human responses on the cultural landscape of *tula* wells.

The study shows that Epidemics, droughts, famines, and excessive rainfall or floods are key environmental perturbations in the ancient *tula* wells cultural landscape. Epidemics and droughts collapse cattle economy and human demography, denying the *tula* wells the most important inputs forcing the Borana to abandon many *tula* wells. Floods on the other hand have repeatedly hit *tula* wells, filling the well shafts and collapsing the walls. The Borana pastoralists responded to such environmental vagaries through rehabilitation and re-excavation of the collapsed wells. This has been dependent on the status of the pastoral economy and availability of human labour. The imbalance between the number of collapsed and re-excavated wells caused higher proportion of the wells to remain dysfunctional. The natural disasters are closely linked to socio-political perturbations that influenced the operation and management of *tula* wells. Socio-political perturbations weakened the social institutions and society's capacity to mitigate disasters or cope with and manage recovery processes, revoking human stewardship.

Paper II presents detailed descriptions of the impact of the rinderpest epizootic on cattle economy, the consequent famine, and human responses. The impact is remembered by the Borana oral sources as *ciinna* − termination or discontinuity. *Ciinna* refers to the total collapse of social, economic, political and cultural lives of the pastoral society. The collapse of cattle economy and consequent famine created social disorientation and disharmony that dispersed the society into bush, exposing them to wild beasts. The term *ciinna* explains not only the extent of damage caused to the pastoral economy but also the incapacitation of the social system that limited the human responses to the multiple disasters that occurred simultaneously. The damages are remembered in terms of economic collapse, human

demographic decline, dispersion of families and clans, the practice of pawning children, and the crises in social identity. The social disorientation and disorganization was reversed soon after the disaster by Borana indigenous institutions that reorganized the society, enabling concerted actions. Despite the historical facts that show the resilience of Borana social institutions, the combined effect of repeated natural disasters, socio-political perturbations, external intervention, and internal dynamics have played significant roles in transforming *tula* wells cultural landscape and the institutions that mobilized human labour and cattle economy to re-excavate collapsed wells or rehabilitate the functional ones.

Paper III presents societal perceptions of *tula* wells cultural landscape changes. In recent years, the dynamics of *tula* wells and the cultural landscapes are associated with land use changes (e.g. change in settlement patterns and expansion of crop cultivation). Peri-urban centres have been established in every well cluster in the last four decades, while traditional settlements have shown steady movement into well zones during the same period. Similarly, crop cultivation has shown dramatic increase in the well zones, particularly after 1991. These changes disrupted the traditional resource use pattern that reserves the well zones exclusively for livestock grazing during the dry seasons. These changes are considered as severe threats to the operation of *tula* wells, as they are not governed by *aadaa seeraa* (customary law) and compete for land resources with livestock. The transformation occurred concomitantly with technology used to dig wells and lift water from the deep *tula* wells, as well as institutional transformation.

Paper IV describes how labour and technological transformations in the utilization of ancient *tula* wells influenced changes in the operations of these ancient water systems. The technological transformations include changes in water bucket (*okole*) technology from giraffe hide to plastic jerry cans, tools for well digging changing from rudimentary hand tools to improved metallic tools or heavy earth moving machines. The institutional transformation is revealed in changes in labour organization (from clan-based to hired labour) while the role of the clan in organizing labour shifted to pastoral associations, particularly when external organizations fund the well digging. The Borana also adjusted the economic contribution to fit the timely demand. They now contribute in cash rather than in kind (cattle) for well digging. The transformations brought structural transformation in the wells that increased water yield and eased access to water. However, the long term impacts of the transformations

are not clear. Currently, pastoralists use the most yielding wells, which is more likely to leave many of the less yielding wells in a disused state. In conclusion, the dynamics of *tula* wells cultural landscape are the cumulative effects of natural disasters, socio-political perturbations, and human actions. The human-environment relations are reciprocal and the influences are not linear.

1. Introduction

Reconstructing environmental and social history of ancient water systems in regions lacking archival documentations presents methodological challenges. Environmental historians suggest the use of oral sources corroborated with other sources in addressing the challenges. This in turn depends on the time reckoning systems of the local community and depth of the oral sources. This is particularly relevant to human-environment linked water systems in African savannahs.

In the dry lands, water plays indispensible roles in agricultural productions, patterning human settlements, influencing land use, and hence the transformation of cultural landscapes.[1] Throughout the world, diverse and complex water management systems that are uniquely suited to the particular ecological settings have been developed.[2] These skilful water management practices enabled people to shape and transform the landscape of water deficient regions.[3] The sustainable use and continuous operations of water systems in many parts of the world over centuries is an indication of successful human adaptive responses to changing socio-environmental conditions through innovative institutional and technological adaptations.[4] Due to the crucial roles water plays in transforming arid and semi-arid environments into habitable places, some scholars have described it as a"… meaning giving element to arid environment".[5] In regions that are characterized by a lack of, or a limited source of surface water and erratic and variable rainfall, the values attached to water transcends its life sustaining role, the socio-cultural dimension attributing sacred and divine values to the water.[6] These are expressed in terms of religious, spiritual, and sacred meanings of water.[7] Water sources such as springs and wells are frequently mentioned in religious worships and blessings.[8] They are centres of production, reproduction, social gatherings, and places of worship.[9]

The landscapes of ancient water systems in those arid regions reflect both the current and historical natural and socio-political changes and human actions that have influenced landscape dynamics and processes.[10] Natural disasters (e.g. epidemics, droughts, excessive rainfall or floods, famines), socio-political perturbations (e.g. social disharmony, disunity, and political perturbations), and human actions in response to these disturbances to ensure human survival and the continuity of the water systems have played major roles in the dynamics of the ancient water systems and the surrounding landscapes.

Understanding the impacts of natural disasters, socio-political perturbations and human responses on the ancient water-cultural landscapes requires an interdisciplinary approach that integrates environmental and social history approaches. This is what Steinberg refers to as an "environmentally minded and socially sensitive approach".[11] People often explain historical events by connecting the landscapes in which they live with socio-political processes that shaped the landscapes. As Stephen Mosley agues, the society develops a sense of identity with the environment that helps to narrate its history.[12] William Beinart and Joann McGregor described landscapes as sources of social unity in time and space. This is particularly true in Africa where societies identify themselves as people of mountain, river, or other geographic region or resource endowment.[13] In addition to the conventional methods of environmental history, Beinart and McGregor call for the inclusions of African environmental perceptions, myths, legends, and narratives to understand the environmental and social dynamics in the intricately linked human-environment relationship.[14]

There is a growing interest for integrating environmental and social history approaches and tools for better understanding of the complex and reciprocal human-environment relationships.[15] Natural environment plays significant roles in influencing humans' interaction with one another and the natural environment.[16] It provides both opportunities and constraints to social development.[17] On the other hand, beliefs, perceptions, attitudes and human actions are key factors in the dynamics of the ancient water-cultural landscapes.[18] It is these reciprocal influences that necessitate the integration of environmental and social history approaches to accurately map more complete reconstructions of environmental changes.

Reconstructing the environmental and social history of the human-environment linked water cultural landscapes therefore requires understanding a community's perception of the environmental changes and the indigenous knowledge of the local people. Indigenous knowledge reflects the local dynamics and society's deep understandings of human-environment relations and ecosystem dynamics that require skilful adaptive responses.[19] Julian T. Inglis noted that people understand, predict, and describe cultural landscape changes caused by both ecological disturbances and human interferences.[20] In narrating disasters like epidemics, droughts, floods, and famines that impacted on the environment, oral historians use locally set indicators such as unusual human practices as well as extent of death to explain the severity of the impacts. For instance, famines were explained in terms of human

death, unusual change in food habits like the practice of cannibalism, changes in survival strategies (e.g. from pastoral to hunter-gatherer), and migrations. Excessive rainfall and consequent floods were explained by the number of wells they collapsed or the flooding incidents that filled up the wells. The socio-political perturbations are explained in terms of the disruptions they caused to the social systems and consequent abandonment of *tula* wells. The events are put in time perspective by referring to indigenous time reckoning systems of the local people.

Drawing on Stephen Mosley's strong recommendation for integration of social and environmental histories and suggestions of Beinart and McGregor, this thesis applies environmental and social history approaches to analyze the impact of natural disasters, socio-political perturbations and human responses on the unique savannah environment associated with ancient water system – *tula* wells.[21] Highlighting the resilience of *tula* wells in the phase of repeated disturbances; the thesis situates this ancient water system in the contemporary debates of African environmental and social history. Examining the environmental and social history of this ancient water system in African savannahs, the thesis contributes to African environmental and social history debates. While African environmental history in the past mainly focused either on the roles of colonial expansion or destructive land use practices of African indigenous people,[22] this thesis focuses on the environmental and social history of ancient wells' water-cultural landscape in relation to disasters and socio-political perturbations. The main challenge in this regard is lack of an appropriate methodological approach.

This thesis uses the uniquely adapted time reckoning system and oral narrations of the Borana Oromo corroborated with proxy environmental data to develop a methodological framework to examine the dynamics of the ancient *tula* wells' water-cultural landscapes and human responses to disasters and perturbations in the savannah environments of southern Ethiopia. Reliance on oral sources and the intertwined nature of natural disasters, socio-political perturbations and human response to the perturbations requires integrating environmental and social history of ancient *tula* wells. I begin by presenting the context of the study and background information on *tula* wells.

1.1. Background and context of the study

Tula well complexes are concentrated in the central Borana Plateau, at an elevation of 1000 to 1500 m.[23] The region is arid and semi-arid with bimodal rainfall.[24] The long rainy season that covers more than 60% of the annual rainfall is expected during March to May, whereas the short rainy season covers the months of October and November. The region is characterized by erratic and unpredictable rainfall that is spatially and temporarily variable, recurrent droughts, and absence of permanent sources of surface water.[25] The annual rainfall average ranges between 400 and 700 mm.[26] Drought is anticipated once in every five to ten years but in the last three decades, it seems to occur once every five years or less.[27] The absence of surface water, spatial and temporal variability of rainfall, and the frequent droughts seem to influence the pastoralists to develop permanent water sources and manage them sustainably.

Wells (*ela*) and ponds (*haro*) are the major sources of water in the region. The ponds mostly serve for a period immediately after the rainy season while wells are used during the dry season (Helland, 1980). Two types of wells (*ela*) can be identified in Borana, namely *adadi* (shallow) wells, and (*tula*) the deep wells.[28] Layne Coppock recorded about 543 hand-dug wells grouped into more than 35 clusters.[29] Among the different sources of water in the region, *tula* wells provide more than 90% of the water supply during dry seasons. They comprise the last fallback areas during severe droughts and are therefore fundamentally important to Borana pastoral production. This study focused on six of the nine *tula* well clusters (Dubluq, Melbana, Erdar, Dhas, Web, and Gayo) (see Figure 1). The *tula* wells support more than one million heads of livestock and more than 50% of the Borana population.[30] Although their exact dates of excavation have never been confirmed, *tula* wells are estimated to be several hundred years old. Without exaggeration, it is possible to say that *tula* wells are the centre of production, ritual and religious practices, social organization, and political gatherings. They are also central reference points in Borana land use classifications: patterning the settlements and dividing the rangelands into wet and dry season grazing zones.

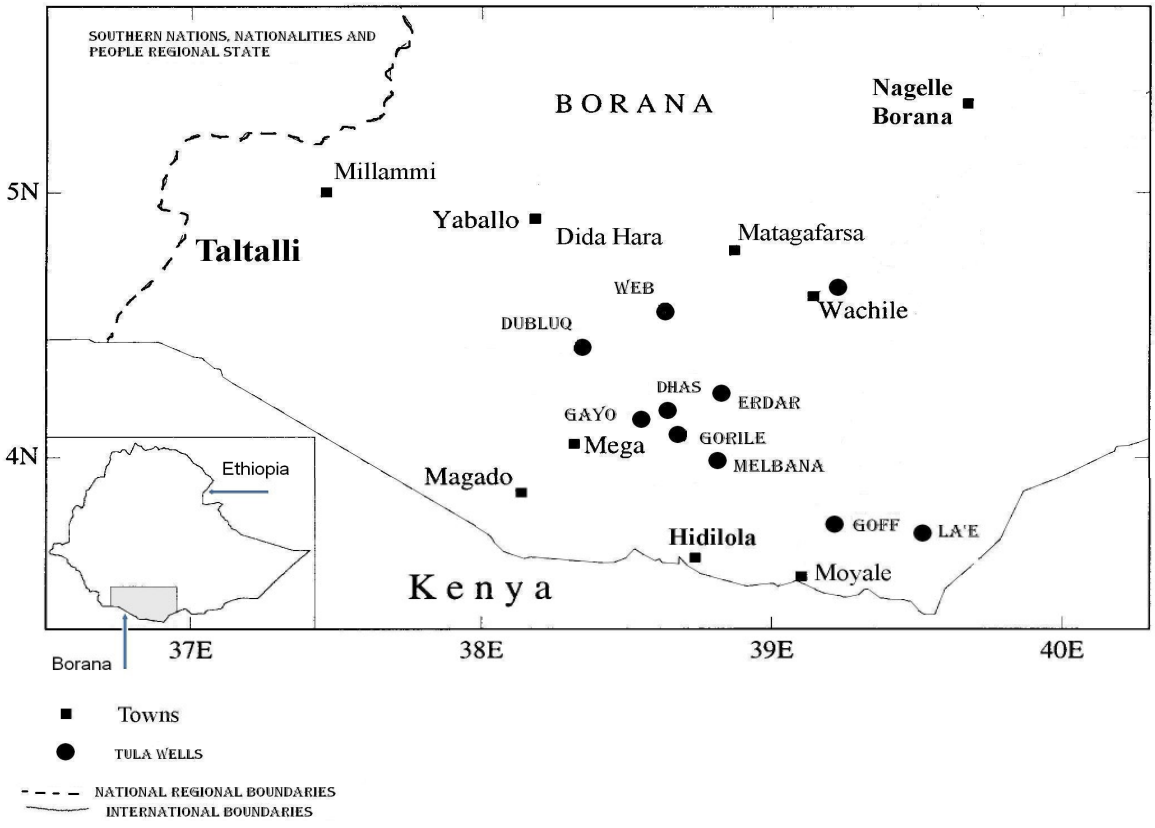

Figure 1. Location of tula wells in Borana, southern Ethiopia

The land use classification for grazing separates the livestock into satellite herd (*loon foora*) and home based herd (*loon warra).* The *foora* herd, characterised by non-lactating livestock moves away from the homestead in search of water and pasture (during the wet season), whereas the *warra* herd, mainly comprised of lactating cows, calves and weak animals, remains in the immediate vicinity of the settlements.[31] The composition of the herd is dynamic between *foora* and *warra* herds depending on water and grazing availability and household milk requirements, where some milking cows are either returned to *warra* or even sent to *foora*. This system is designed to ensure year round availability of pasture and control overgrazing near the water points. This management system ensured the continuity of *tula* wells and hence human survival in this water deficient savannah environment of southern Ethiopia for several hundred years.

The social organization and technology used to dig *tula* wells puzzled many writers.[32] The ancient engineering skills of well diggers and their water management institutions drew

appreciations from early travellers as well as recent scholars.[33] The ancient *tula* wells are products of indigenous water engineering technology that cut through solid gypsum rock or limestone bedrock to exploit groundwater aquifers (see Fig. 2). The ancient well system, which has been studied very little, occurs across a series of limestone bedrocks that are referred to as "*bisaan qa'aa biyye adii"* literally translated: "water of the valleys of white soils".[34] A great deal of sophistication was involved in the digging, rehabilitation and utilization of *tula* wells. They were the result of human adaptive responses to water scarcity.[35] The *tula* well clusters in Borana exemplify landscapes where human beings created a habitable environment in a region devoid of naturally occurring permanent sources of surface water. Ownership of wells and access to water are key factors in the management of *tula* wells.

Figure 2. A *tula* well that cut through limestone rocks at Erdar cluster. The picture was taken in January 2008.

Tula wells are owned by the clans whose members initiated the digging. The Borana use the terms *konfi* and *coqorsa ela* to refer to the ownership of the well.[36] Even though the terms are used interchangeably, they have different connotations in explaining well ownership. *Konfi* refers to a caretaker, in the absence of the original owner, while *coqorsa ela* refers to the original owner or his rightful inheritor. However, both terms do not imply exclusive property rights. They are forms of trusteeship, where the holder of *Konfi* or *coqorsa ela* has the responsibility of ensuring proper functioning of the well and fair access for clan members. The main difference lies in the inheritance rights. Unlike *coqorsa ela*, the caretaker has no right of passing the property rights to his descendents. In this case, the clan elders appoint another caretaker. Gufu Oba presents the existence of two dimensions with regard to the ownership of *tula* wells in Borana. The first is the individual well owners (the family of *coqorsa ela* for the old wells, and the family of the person who initiated the digging ceremony and slaughtered a ceremonial bull first in the case of newly excavated wells); whereas the second dimension is that of the clan of *coqorsa ela* who participate in digging, maintenance and management of the wells.[37] The property right of well ownership in Borana is inherited inter-generationally without interruption to the initiator of the digging ceremony (*coqorsa ela*) and unlimited inter-generational usufruct to clan members who invested their resources and labour.

Clan membership is sufficient but not a necessary condition to access and use water. A complex web of social relations and cross-cutting social organization such as *bisaan jaala-sodda* (water right gained through marriage ties), and *bisaan maala* – water of the dewlap (watering right gained due to providing the bull slaughtered to feed the work forces) are some of the enabling arrangements to get access to well water that does not belong to ones clan.[38] Access rights gained because of labour and cattle contributions are inheritable by descendents of the contributors. However, individuals might be obliged to look for water elsewhere when the management thinks that the number of animals in watering queue is beyond the watering capacity of the individual well. This can be quantified by livestock drinking units (*bu'a*) which are queued.[39] Referring individuals to other wells is not random, but based on the established rules. The rules ensure sustainable use of well water by regulating stocking density and users' behaviour to avoid conflicts on watering order and access rights. The well management council comprised of sub-clan elders (*kora ela*) and other users carry out the

overall management of wells, while *abba herega* (father of the watering order) oversees the daily use of the wells.[40]

The *tula* wells play a central role in the Borana range resource management, ritual performance, cultural identity, political debate, human and livestock fertility, and above all the peace of the Borana (*nagaa Borana*).[41] Asmarom Legesse describes the *tula* wells as "centers of social activity and an emotionally charged focus of Borana society….central feature of their [Borana] collective life".[42] Symbolically the *tula* wells are not only hydrological systems in a water scarce land but are also metaphorically human habitations or ritual sites.[43] Legesse quotes the Borana elders saying, "Home is the well, not the hut". He considers the wells as central links between *gada* leaders and the clan. The wells are described as the "engine of Borana history".[44] They create strong bonds that tie clansmen together and to the water-cultural landscape, with strong ideological solidarity among the Borana. Therefore, the wells provide the basic framework for analyzing "recurring themes" of environmental and socio-political perturbations, human and livestock demographic changes, land use changes, changes in settlement patterns, perceptions of environmental changes, and institutional transformations from historical perspectives.

Despite the cultural, religious, social, and production roles the *tula* wells play in the Borana pastoral system, there is a lack of historical investigation to understand the dynamics of this ancient water system and its cultural landscapes. The skilful alteration of the environment into suitable habitat by the inhabitants has not been the focus of historical investigations. The social history of water landscapes in African savannahs in the past focused mostly on rivers and lakes but rarely on landscapes associated with ancient well systems.[45] Research has been lacking to understand the impact of natural disasters and socio-political perturbations on the functioning of the water system, cultural landscapes and human responses. Many studies have been conducted on Borana pastoral production, resource management, political organization and ethnographic aspects.[46] However, none of them emphasized the impacts of natural disasters and socio-political perturbations on *tula* wells. Furthermore, there is lack of information with regard to cultural landscape changes and institutional and technological transformations in the utilization of *tula* wells. This study reconstructed the environmental and social history of this unique and ancient water-cultural landscape from 1560 to present. The study focused on the natural disasters, socio-political

perturbations, and human actions (e.g. external interventions and local land use changes) as the drivers of changes on this water-cultural landscape. The multiple drivers were examined using *gada* timelines and environmental and social history approach. The human historical narratives were analyzed to understand the impacts of extreme natural events on human survival strategies that ultimately transformed the well water-cultural landscapes.

The thesis has two parts: part A (introductory) and B (individual study papers). The first part presents the theoretical and methodological perspectives of the thesis. It also presents the synthesis of the main findings of individual research papers. This part is divided into six sections. In the first section, a brief description of the objectives of the introductory part of the thesis (see part B for objectives of individual papers) is presented. Moreover, concepts used in the thesis are defined and described. Section two presents a description of environmental and social history of ancient water systems, followed by theoretical perspectives in section three. Section four presents methodological perspectives followed by the synthesis of the main findings in section five. Section six comprises general conclusions and suggestions for further research. Individual study papers follow in part B.

1.2. Objectives of the study

The main objective of the introductory part (A) of the thesis is to develop theoretical and methodological frameworks for the individual papers. The specific objectives include:

A) Develop theoretical and methodological frameworks for reconstructing environmental changes of human-environment linked ancient water systems. The key questions posed include: what indigenous time reckoning systems can be used to reconstruct the impact of disasters on ancient water systems? What major natural disasters affected the ancient water systems? What were their environmental and socio-political implications?

B) Synthesize the socio-political perturbations, Borana Oromo perceptions and narrations of crises and recovery, perceptions and driving forces of water-cultural landscape changes, and adaptive responses of Borana pastoralists to changing social, ecological and technological conditions in the context of ancient *tula* wells. Key questions include: How do the Borana pastoralists understand the impact of socio-

political perturbations in relation to the dynamics of the *tula* wells? How the Borana community members the crisis and recovery processes? What major driving forces of cultural landscape changes of ancient *tula* wells can be identified? Was there any transformation in the technological, labour organization, and resource mobilization of the ancient *tula* wells?

1.3. Contextualizing concepts

In this thesis, different concepts and phrases are used to examine the dynamics of *tula* wells and human responses. Some of the concepts or phrases are from the Borana vernacular languages for which there are no equivalent words or phrases in English. Therefore, there is a need to clarify and contextualize the concepts and phrases. In this sub-section, contextual meanings in which the concepts and phrases used are presented, but they, under no circumstances, are meant to give universal definitions of the concepts. The variations are clarified in the text.

Ancient water systems: people in different parts of the world have relied on different sources of water for millennia. Some harvested rainwater, others diverted the course of rivers, and still many more relied on groundwater.[47] The tools used in digging were either locally made or diffused technologies, probably through migration or trade. They also relied on indigenous knowledge or mimesis and locally crafted social institutions that organized labour. In the context of this thesis, ancient water systems refer to the water systems developed by indigenous communities using relatively ancient tools and indigenous social institutions in the digging and management of the water systems. It may be termed a water system that existed without 'central planning' as we consider it today. The phrase 'water system' in this context refers mainly to the humanly modified system with its management systems and institutional setups. It also includes the water-cultural landscapes that have been affected due to the human involvement in the construction and management of these water systems.[48]

Cultural landscape: human beings have been continuously interacting with the natural environment for thousands of years, shaping and reshaping the landscape on which they live. The cultural landscape retains the imprints of the past and present human-environment

interaction.[49] Cultural landscape is the result of long term interactions between society and the natural environment.[50] It implies the modification of the natural environment due to human actions.[51] Alice E. Ingerson describes the cultural landscape as: "… fashioned from the natural landscape by a culture group. Culture is the agent, the natural area is the medium, and the cultural landscape is the result".[52] UNESCO defines cultural landscapes as the "Combined works of nature and of man", illustrating the evolution of human society, that have in turn been influenced by constraints imposed or opportunities presented by the natural environment.[53] Almo Farina defined cultural landscape as "…geographic areas in which the relationships between human activity and the environment have created ecological, socio-economic, and cultural patterns and feedback mechanisms…".[54] In the book *Principles and Methods of Landscape Ecology*, Farina notes the importance of human disturbances for several years in creating cultural landscape.[55] Cultural landscape (which includes water-cultural landscape) is therefore the reflection of long term human-environment interaction. Terje Tvedt describes water landscapes as "products of engineered interaction between physical water sources and human agency".[56] This implies the significant roles played by human agency in the creation of cultural landscapes.[57] The *tula* wells water landscape is an example of a water-cultural landscape created through human action that changed the savannah into a human habitable environment. The cultural landscape is characteristic of dynamic changes in response to environmental and anthropogenic drivers.

Drivers of cultural landscape change: the transformation of cultural landscapes depends on various cultural and natural forces that often differ in origin, nature, geographical extent, duration and intensity.[58] The drivers of change can be environmental, social, or political in nature.[59] Marc Anthrop describes these driving forces as accessibility, urbanization, globalization, and calamitous disasters.[60] Change in land use patterns and use of tools have been important aspects of cultural landscape changes.[61] Cultural landscape dynamics are the results of historical processes that reorganized the landscape in order to adapt to the changing demands for the land use patterns. Understanding cultural landscape change therefore involves examining the history of how lands have been appropriated, cultivated and modified by humans.[62] Natural disaster is one of the key drivers of landscape change in *tula* wells region.

Disasters: there is no universally agreed definition as to what constitutes disaster.[63] Fikret Berkes, for example, describes disaster as "…the propensity to suffer … degree of loss from hazardous events"[64] that works at the interface of society and environment.[65] Philip Nel and Marjolien Righarts define disaster as "…cataclysmic events or situation which overwhelm local capacity, often (although not necessarily) resulting in a request for external assistance".[66] This definition implies the severity of the disaster and the failure in the capacity of social system to deal with the disaster. According to this definition, understanding disasters requires not only the natural calamities that strike the society but also the capacity of the social system either to take proactive measure or respond to the disasters timely.[67] This is what Carr describes as "the collapse of cultural protections".[68] In more recent disaster research, failures in cultural protection are explained by the concept of vulnerability – exposure to natural hazards – that is influenced by intertwined social, economic, political, and ecological factors that either reduce or aggravate the level of devastation and affect human responses.[69] Thus vulnerability to environmental hazards implies 'potential loss' that varies in space, time and across social groups.[70] This can be exacerbated by failure of the social systems to respond to perturbations, while successful responses imply institutional resilience.[71] In the context of this paper, disaster includes epidemics, droughts, famines, and floods that have had impacts on the pastoral economy, human demography, the social system and cultural landscapes of ancient *tula* wells. The thesis intends to follow neither environmental deterministic approach nor perceive society as passive victims of destructive environmental processes.[72] The aim is to understand the roles of natural disasters as well as social systems, and how they were perceived by Borana pastoralists. In this thesis, reconstruction of natural disasters is based on indigenous knowledge.

Indigenous knowledge: Pastoralists have vast and extensive indigenous ecological knowledge developed through centuries of interactions with the environment.[73] Olsson and colleagues define indigenous knowledge as "cumulative body of knowledge, practices and beliefs, evolving by adaptive processes and handed down through generation…."[74] Indigenous knowledge consists of the memory of past social-ecological adaptations that developed as the result of human-environment interactions.[75] Indigenous knowledge is considered to be a

reservoir and a memory of long-term environmental dynamics and processes of changes.[76] Borana pastoralists have developed unique indigenous knowledge that enabled them to manage the well systems and the surrounding rangelands for sustainable livestock production in a fragile savannah ecosystem. Borana indigenous knowledge is linked to the ancient water system – the *tula* wells. The Borana also developed indigenous time reckoning system that can be utilized in narrating and reconstructing natural disasters and socio-political perturbations. In this thesis, pastoralists' indigenous knowledge was used to understand the complexities involved in the dynamics of ancient *tula* well system and institutional transformations. Reconstructing environmental and socio-political perturbation was done using the *gada* timeline.

Gada: is a social-political institution that guides rituals, cultural practices, political leadership, and pastoral production.[77] It is the central and most significant Borana indigenous institution.[78] Asmarom Legesse has described in greater detail the roles *gada* plays as social engine that drives events in Borana through the generation class (*luba*).[79] In the *gada* system, political leadership positions are occupied through election. One *gada* period is eight years long and is named after the *abba gada* (father of *gada*) who rules during these years. In the recorded history of the Borana, more than 560 years can be recalled by oral historians. Each *gada* period represents events that are remembered and passed from generation to generation orally.[80] The events that occurred during a given *gada* period is marked as 'event X that occurred during *gada* Y'. Using such links between the leading council and environmental and socio-political perturbations, oral historians narrate historical events. The Borana are remarkably aware of time and history, despite the history largely remaining oral.[81] In this thesis, *gada* timeline refers to the use of *gada* periods to remember and narrate historical events. Remembering the events is assisted by the use of concepts such as *gogessa*, *maqabas,* and *dhaaccii*.

Gogessa: is one of the many complex classifying systems of Borana society.[82] The Borana society is divided into five patri-classes called *gogessa*.[83] These classes assume political leadership (*gada*) on regular and rotational basis. In a modern political concept these patri-classes (*gogessa*) may be termed as political parties. The difference is that the power is

assumed on a regular rotation, but competition can take place among the members of the same class (*gogessa*). Membership is acquired through birth, sons automatically entering into *gogessa* of their fathers. The sons are expected to assume a leadership position forty years after their fathers. The Borana use such regular power rotation to encode events in relation to the *gogessa* in power and expect similar occurrences when the sons or grandsons return to leadership positions. Each group that comes to power every forty years within the *gogessa* is known as *luba* – generation class. The members of *luba* are the same generation class (grouped intra-generationally) while the membership in *gogessa* is vertical (inter-generational). Each *luba* is associated with particular *maqabas* – cyclical names.

Maqabas: refers to cyclical names that rotate in regular manner, the *gogessa* in power (represented by *luba*) being associated with one particular *maqabas* during the term in office. When the same *gogessa* returns to power after forty years, it is associated with another *maqabas*, since there is no one to one correspondence (i.e. five *gogessa* and seven *maqabas*).[84] According to Megersa and Kassam, the seven *maqabas* have different characteristics that relates with prosperity, war, epidemics, ecological catastrophe, famine etc.[85] This causes the society to expect events associated with particular *maqabas* when it returns. The possibility of events repeating is however wide, and not deterministic. Whenever the cyclical name repeats itself (after 56 years, i.e., 7*8), similar historical events are expected. This is known as *dhaaccii*.

Dhaaccii: refers to predestined occurrence of events (mostly associated with bad luck) due to persistent influence of the past on the present and future. It is the repetition of events (wars, droughts, epidemics etc.) either influenced by *maqabas* or *gogessa* that is said to have occurred in the past.[86] For instance, if severe drought had occurred during *gada* period of *abba gada* Y (associated with particular *gogessa* or family) and *maqabas,* the predestined repetition is expected to occur when the son assumes the *gada* leadership or when the same *maqabas* associated with the bad event returns to *gogessa* in power. The Borana oral sources record events as *dhaacciitu itti mare* (enduring curse) to indicate the predestined repetition of the previous events during the later period. To record events in the oral sources, *dhaaccii* must be associated with *gada* timeline (the influence of fathers' fate on sons) and *maqabas*

associated with particular misfortunes. It is said to have a "mythical influence …on the present and future courses of events".[87] The *dhaaccii* of the fathers is expected to return with the sons (within the same *gogessa*), or within the cyclical return of *maqabas*. Positively seen, event repetition within the family is explained by Asmarom Legesse as "People expect the blessings they received when the father was in control to recur when the son assumes the same position….until the fortunes of the lineage and its ritual attributes fail to satisfy the needs of the community".[88] However, the exact timing of the repetition differs. The exact repetition of events like epidemics are expected during every third repetition of *maqabas* that spans about 112 years or when the same *maqabas* returns to the same *gogessa* that takes about 35 *gada* periods (280 years). These concepts also implied changes and transformation within the context of the *tula* wells.

Labour transformation: labour is the main input in digging, re-excavation, rehabilitation, fencing wells, and lifting water from the deep wells. *Tula* wells have been dependent on labour from the clan and sub-clan who own and use the wells communally. Users contribute workers for the tasks needed to keep the wells operational. In recent years, such clan based labour organization is changing. The Borana have introduced hired labour into well digging where individual labourers are paid on a daily basis. In the context of this thesis, this is referred to as 'labour transformation'. The implications of labour transformation are linked to the transformation of *okole* technology for water extraction.

Okole technology: traditionally, the Borana used *okole* (leather buckets from giraffe and buffalo hides) to lift water from the deep wells. *Okole* is also used to milk cows and hold milk for ritual purposes. It is the most valued household possession. It is made by cutting freshly skinned hide of giraffe or buffalo into suitable size and shape. *Okole* is an indigenous technology that has played a crucial role in Borana pastoral production. Through time, access to this material became difficult, forcing the Borana and development organizations operating in the area to look for substitutes. In the process, the traditional *okole* has been substituted by plastic jerry cans. The Borana have now totally adopted the plastic jerry can for lifting water, while reserving the old *okole* for important cultural and ritual practices. The transformation of *okole* technology generated mixed responses from the pastoralists. As a valued cultural item,

it is remembered with nostalgia, while for the practical role it plays in increasing water yield, it is accorded respect. In this thesis, the concept of '*okole* technology' is used to refer to this indigenous technology. The transformation of *okole* technology on the other hand refers to the replacement of traditional water bucket with plastic jerry cans for lifting water from the deep *tula* wells. Finally, I make distinction of technological transformation for well re-excavations, and rehabilitations.

Technological transformation: Borana pastoralists use indigenous technology to dig new wells and re-excavate collapsed ones. This includes use of rudimentary hand tools made up of woods and small metallic tools. They also use fire for breaking rocks, whereas hides and skins were used to remove the excavated earth. In recent years, the technologies have transformed to simplify the digging works. The Borana can either hire heavy earth moving machines or use improved metallic hand tools. In this thesis technological transformation simply refers to the shift from the use of rudimentary tools to improved digging machine or hand tools. I shall now consider these concepts within the wider environmental and social history related to human-environmental linked ancient water systems and their management in comparison with the subject of ancient *tula* wells.

2. Ancient water systems and management institutions

2.1. Environmental and social history of ancient water systems

The ancient water systems such as the Nabataean waterworks and the *qanat* systems in the Middle East, the Maya waterworks in the arid lowlands of Amazonia, and the Roman waterworks in the deserts of North Africa and the Middle East have created water-cultural landscapes.[89] The Mesopotamians waterworks were also among the notable ancient water systems.[90] Complex waterworks were reported among many other ancient Asian societies who shaped their landscape either by altering natural courses of rivers or using groundwater.[91] These water systems are examples of human-environment linked systems where indigenous knowledge evolved over generations, thus creating sustainable water use and environmental management practices. These water systems testify that the ancient waterworks were technically and technologically capable of solving the problems of water

scarcity of arid regions through harvesting rainwater or using groundwater.[92] These water systems spread over many water deficient regions of the world.[93] Even though many of the ancient water systems in the arid regions of Africa and Middle East are not operating today, they altered the landscape on which they occurred and left their imprints on the cultural landscapes.[94] The water systems are human adaptive responses to the environmental constraints to facilitate human settlements, agricultural productions, and livestock herding in such regions.[95]

The origins of most of these ancient water systems and technologies used have been the subject of debate. However, there is no conclusive agreement among the scholars as to the origins, diffusion, and technologies used in the constructions of many of these ancient water systems.[96] In Middle East, Dale Lightfoot attributes the *qanat* systems to the technology of Persians, the origin of which he estimated to be around 6th century BC, pre-dating the Roman Empire and the diffusion of knowledge along trade routes. However, he acknowledged the existence of some schemes that are known as "*qanat* Romani – the roman canals",[97] which further complicates the origin of this water system. Iwao Kobori on the other hand attributes the origin of *qanats* to central Asia and its diffusion to be along the expansion of Arab empire or immigration of the Persian engineers.[98] Paul English argues that *qanats* originated in western Iran, northern Iraq and eastern Turkey about 2500 years ago.[99] Writing about the origin of ancient wells, Grahame Clark explains "They [wells] represent a revolutionary innovation which can only have come about through the play of powerful social forces". Clark adds "The sinking of a well involved a definite break with everyday experience, an incursion into the unknown, and until comparatively recently, the unpredictable. … The well shaft itself had to be bored historically by hand augers and only since 1832 by machine. The greater depth of wells made it more necessary to enclose their openings, if only to prevent children falling down the shafts [the Borana use fences]". Clark attributes the necessity of digging of wells to population increase that forced human beings to occupy water deficient marginal lands.[100] John W. Eadie and John P. Oleson also explain "They [Nabataeans] have dug wells at convenient intervals and have kept the knowledge of them hidden from the people of all nations….know about the places of hidden water and open them up…".[101]

In east Africa, James de Vere Allen attribute the establishment of settlement to well excavation ca. 800 AD. Even though the ethnic identity of the well diggers was not clearly

described, Allen believes that they were pastoralists, whose diet consisted of blood mixed with milk and raw meat from oxen. Allen describes them as people having skills of locating places where water can be found.[102] These water systems were successful ecological adaptations that influenced not only the production systems but also human settlements and the landscape on which they occurred.[103] Cultural imprints of such waterworks testify the dynamic historical process of human adaptive strategies in water deficient regions of the world.[104] The waterworks show the interdependence of technology, ecology and social organization in these arid regions of the world.[105]

Many of these ancient water systems benefited from the cumulative local knowledge gained through experiences to evolve over time. Zvi Ron explains evolution of ancient water systems as improvements: "the vast experience gained brought about a greater understanding of the characteristics of the aquifers, groundwater and areas which they encompass" – attributing the dynamics and improvement of ancient water systems to accumulated knowledge that enabled the community to develop sustainable water supply systems.[106]

There are similarities as well as differences among these ancient water systems separated by thousands of kilometres. The majority of these water systems (with few exceptions, for instance see Wittfogel) were dependent either on groundwater or harvesting rainwater.[107] Most, if not all, of these water systems required periodic rehabilitation, maintenance, and works that aimed at improving water yield (e.g. deepening the mother well in *qanat* systems) where users cooperate to undertake the jobs.[108] Depending on the severity of natural disasters such as floods and the capacity of the users to rehabilitate the water systems, temporary abandonment and restoration characterized their history. The users share the water on the basis of pre-agreed water distribution schedules (for irrigation) and watering orders (for livestock use).[109]

On the other hand there are differences in terms of water harvesting systems and the topographical sites selected by the construction workers. Most of the ancient water systems in the Middle East and North Africa (*foggara*, *kariz*, *qanat*, *khattara*) and Maya waterworks in the Amazonia, supply water through gravity for household as well as irrigation purposes. They were constructed at the foothills and water was channelled from source to field using underground aqueducts.[110] Zvi Ron for instance, described the digging of *qanats* as "….excavated in alluvial fans or gravel outwash in foothill regions, where infiltration

capacity of runoff into the ground reservoir making an excellent shallow aquifer".[111] Others depended on cisterns to collect and store rainwater or groundwater channelled from the foothills.[112] The mechanisms of lifting water from deep wells also vary depending on depth and structure of the wells.[113] In Algeria for instance, "chains of buckets revolving on geared wheels" were used, while in other parts of the world, scooping and ropes have been used.[114]

The water systems experienced externally induced disturbances and transformations. The introduction of new water harvesting technology that uses diesel engine has been common threats to most of these water systems.[115] The new technology over pumped the aquifer resulting in falling of water tables and reduced availability of groundwater. The increase of motorized water supply altered the land use patterns that evolved over centuries, resulting in loss of ownership control by the local people.[116] Moreover, the changes were blamed for weakening the indigenous water management institutions, affecting leadership roles and the social relations that organized the society around the water systems.[117] Internally, continuous socio-cultural dynamics facilitated the replacement of old and labour intensive technology by the new ones.[118] Despite causing the abandonment of ancient water systems and disrupting indigenous water management institutions, the new water harvesting technologies have simplified access to water.[119] Critical to the consideration of water harvesting technologies is the institution of water management.

2.2. Water management institutions

The management systems and technologies of ancient water systems that transformed water-cultural landscapes have been of great historical interest.[120] There are varied views regarding technologies used and social institutions that accomplished these historical feats. Among scholars of the ancient water systems, the argument that attracted much debate has been that of Karl A. Wittfogel, described in his book – *Oriental Despotism*. In his hypothesis, Wittfogel associated the origin and success of ancient hydraulic societies in Asia with despotic and centralized states that developed complex water management institutions.[121] Leadership was the key element in Wittfogel's hydraulic society where success was attributed to the capacity and skill in mobilization and organization of work forces to develop effective and sustainable water management systems that the 'despotic states' used to intensify

agriculture. According to Wittfogel, by weakening non-governmental institutions and organizations, despotic states of hydraulic societies controlled political power, creating stronger states than the society that controlled water systems.[122]

Contrary to the theory of centralized state or forced labour to intensify production through centralized water management systems, Erickson argues that the pre-Hispanic water management system in the Lake Titicaca basin developed in the absence of state organization.[123] Other studies argue that the Persian Empire and other ancient Middle Eastern states depended on rules that guaranteed the right to transfer the property rights to limited generations for those who mobilized labour for water construction works.[124] Paul English argues that the strength of a political leader was evaluated on the basis of the number of *qanats* he was able to excavate.[125] Other scholars associate the origin and development of ancient water management institutions with environmental limitations. Vernon L. Scarborough suggests water scarcity as the driving force in the development of the ancient Maya water management systems in Amazonian semi-arid lands.[126] Patricia A. Garcia calls the water management institution developed by the Purepecha community in Mexico "the culture of water scarcity".[127] Other studies also show that societies developed water management institutions in response to scarcity.[128]

Despite lack of agreement as to the origin, development, and forms of institutional set-up of ancient water management systems, the capacities to mobilize and organize labour and regulate access to water have been central to the debates. Continuous investments both to maintain and improve the water systems were a crucial part of ancient water management systems.[129] The strength of the institutions was vital in persuading members to bear the burden of work and resource contribution, without which the sustainability of the water systems would have been questionable.[130] There was no doubt that the institutions mobilized resources and labour to construct, rehabilitate and periodically maintain the water systems. This required particular and adaptive skills and strong institutions.[131] Human skills passed from generation to generation appear to have been fully ingrained into the societies' social institutions, economies and local leaderships around which water management is organized.[132] Many factors are said to have contributed to the strength and continuity of the institutions.

Social solidarity, economic interest, and the labour required to use the water played significant roles in strengthening water management institutions. This unity is strengthened by building trust and emotional attachment which put common welfare before that of the individual.[133] Group solidarity is also strengthened through participation in water rituals that facilitate interactions among the members. Patricia A. Garcia summarizes the role of rituals in water management as: "Though the purpose of [water] festivals is to demonstrate just how greatly water is appreciated and valued, the collective work involved also tends to solidify a spirit of cooperation and participation among the people… Envies seem to be forgotten and all the tasks are carried out with joy and solidarity".[134] Face-to-face interactions promote tolerance and interdependent use of water resources.[135] On the other hand, reduced physical contacts and participation in rituals that bring members together are said to weaken the social solidarity. If we use the Borana pastoralists of Eastern Africa as example, they developed effective water management institutions that enabled them to alter the savannah landscapes of Southern Ethiopia.

2.3. Ancient water systems in Africa

In Africa, through emphasis on the indispensable life sustaining roles of water, its religious, spiritual, and symbolic meanings, pastoralists and agro-pastoralists created water-cultural landscapes. For example, Sonjo and Engaruka in Tanzania, Marakwet in Kenya, and Borana and Konso in southern Ethiopia have altered their landscapes through organized water constructions and management systems that relied on indigenous institutions.[136] The Borana in particular have managed the *tula* well system for centuries which enabled them to change the arid and semi-arid environment of southern Ethiopia to suitable habitat for both human and livestock populations. But when and who dug these wells remain unknown.

The ancient diggers of *tula* wells and the time of excavation are shrouded in mystery. Indeed, various questions have been posed with regards to their origin: whether a foreign technology or locally developed or mimesis of ancient technology introduced from external cultures, but copied and practiced by their ancestors and the present day Borana Oromo. Haberland suggest that the well engineers were ancient megalithic cultures.[137] One of the early travellers, Donaldson-Smith, suggested that "The wells were dug by the ancient

colonists".[138] Similarly, C.B.G. Watson noted the existence of ancient civilizations that were responsible for excavating *tula* wells. Watson characterized them as wealthy, numerous, and clever water diviners.[139] Some scholars repeat the information from oral sources that the *tula* wells were originally excavated by Warda Oromo.[140] Lieut L. Aylmer, who was also puzzled by the engineering skills of the unknown ancient well diggers, quoted elders saying the wells were excavated by Warda Oromo.[141] Another traveller, Philip Maud, noted that the *tula* wells are the legacy of the Warda.[142] David Buxton seemed to be convinced that the ancestors of the present day Borana dug the *tula* wells.[143] Neither the scholars nor the Borana informants are in agreement as to 'who excavated the wells and how'.

Some Borana informants are evasive on the question of 'who dug *tula* wells' and provide vague answers. Others suggest that their ancestors dug the wells, or that the original well diggers were the Warda Oromo.[144] However, some informants doubt the capacity of the Warda Oromo to dig such complex structures using ancient technology. This group of informants attributes the diggers to unknown, but giant tribes, who they describe as 'white people' who used better tools that were said to have been buried in the region. Other informants are aware of the repeated population displacements and migrations that complicated the issue of 'who dug the wells'.[145]

From the discussions, it is possible to suggest that individuals existed among the Borana, formerly of the clans of the well diggers who, after assimilation, continued to maintain their social identity through secretive knowledge. Because they served as keepers of the technical knowledge and the rituals necessary for the functioning of the *tula* wells, the Borana continued to rely on them as advisers. They were incorporated into Borana clans with new social identity.[146] Oral history claims that the Borana or their ancestors drove out the *sidii salan* (the nine historical enemies) the last expulsion being that of the Warda.[147] Regardless of the identity of the excavators and the means of excavation, the *tula* wells provide evidence of remarkable engineering skills, theoretical knowledge, and viable social organization. They are one of the outstanding achievements in the arid regions of Africa.

Another important question that has remained unanswered is 'why and how they dug the wells'. The social organization that mobilized labour and resource also remained unexplained. It is also not clear whether the ancient well diggers were forced to dig the wells because of desiccation or if the region was devoid of permanent surface water from the

beginning. The only available hypothesis was that of Richard Wilding regarding the possible reason of excavation. Wilding hypothesizes the possible desiccations around 10th century AD that might have forced the inhabitants of the region to excavate the wells. However, the same author puts the known date for the existence of *tula* wells to be 17th century.[148] Lack of information regarding when the wells were excavated has obscured the effort of corroborating the information with historical climatic changes. Another probable cause is an increase in population size that could force the pastoralists to marginal lands devoid of permanent water sources, or another form of population displacement which forced the less powerful to such environments. However, better information can be deduced from examining the socio-environmental and management system of ancient *tula* wells.

2.4. Borana water management

The Borana pastoralists developed successful bottom-up and participatory water management system, based on lineage and clan organization with detailed but unwritten customary water management rules – *aadaa haraa-ela* (rules governing ponds and wells). Water management institution in Borana is embedded within the broader socio-political institution – the *gada.* The well water belongs to the clan, and clan members are responsible for managing and ensuring the continuity of the wells for the benefits of present and future generations. The institution has proved to be capable of mobilizing resources (labour and cattle economy) for digging of new wells, rehabilitation of damaged wells, and re-excavation of the disused ones. Once built, the wells require periodic rehabilitations and maintenance that involve fencing, cleaning siltation, removing collapsed walls, deepening the source, repairing troughs and reservoirs, widening the well shaft as well as the ramp.[149] These works are dependent on clans' economic status and institutional capacity to mobilize resources and organize labour. The continuous overall operation of *tula* wells for centuries indicates that the Borana pastoralists were not only capable but also committed to the maintenance and rehabilitation works.

Factors that contributed to the strength and sustainable management of *tula* wells might be categorized under one or more of the following: firstly, the political leaders are much attached to the mobilization of labour and resource for the re-excavation and

rehabilitation of wells.[150] This is evident from the fact that well management and re-excavations are among the central campaign themes for the Borana in contesting for political positions in the *gada* institution. When the retired political leaders campaign for their sons, they use the phrases like *elli narratti hinbadne* (wells were not disused during my term in office) or the number of wells re-excavated or rehabilitated during their term in office. The implicit assumption is that if the father had fulfilled his responsibilities, the sons are likely to do so during their terms in office. It is believed that descendents try to keep the reputation of the family line, hence manage clan affairs properly, including *tula* wells. Secondly, individual well owners who pass the property rights for generations to their descendents involve both in the re-excavation and daily management of the wells, ensuring regular maintenance and upkeep. They play important roles in organizing the re-excavation and rehabilitation works. As inheritance follows the first born on the male line, every successive generation tries to ensure the continuous operation of the wells they inherited from their forefathers.[151] Ownership of wells is one of the most prestigious positions in Borana. It is considered as carrier of family history, linking the past, present, and future generations. The deep rooted and complex historical importance placed on the continuity of individual family lines strengthens the water management institutions in Borana. Thirdly, the cosmological belief that considers water as collective property accords all Borana with usufruct rights and obliges them to involve themselves in the improvement of the wells. Each generation is considered a custodian of the wells.[152] Fourthly, besides the socio-cultural and religious significance of *tula* wells, the economic cost of digging a single well and the human chain needed to lift water from the deep well may have strengthened cooperation and hence social institutions, deterring the abandonment of the wells for centuries.[153]

The social institutions that organize re-excavation, maintenance and rehabilitation of wells are fundamental not only to ensure the continuity of the well systems themselves, but also for the adequate and continuous supply of water. Without continuous investment and rehabilitation, the periodic collapse of wells due to heavy rain fall or flood and other natural hazards may leave the wells in disused state for decades. Being aware of such naturally imposed hazards, the obligations to maintain the wells, and the dire need for water, the Borana developed a strong water management institution. The institution plays crucial roles in the restorations and rehabilitations of *tula* wells, despite repeated environmental and socio-

political unrest. The strength of the Borana water management institution can be seen more clearly when contrasted with other ancient water management systems.

2.5. Borana water management contrasted with other ancient water systems

The Borana water management system has many resemblances with other ancient communities in arid regions of Middle East, the Nabataeans, the classic Maya water management system, and the Purepecha community in Mexico.[154] For example, much like the Borana, the Purepecha community considers water as collective property where everyone has access rights while sharing the responsibility of conserving and maintaining the source of the water.[155] Among this community, water is considered as a gift from God, and should be cared for. Everyone is obliged to care for the water and limit consumption to a minimum level. Wastage is not tolerated. Patricia A. Garcia noted that water users have usufruct rights and an obligation to ensure its sustainability for future generations.[156] Decisions regarding use, management, and distribution are made in community meetings. Another similarity is that of the Nabataeans to the Borana. Both societies scheduled watering intervals for their cattle every third day. They also sealed the wells when the water was not needed and reopened when need arose.[157] These striking similarities among societies separated by thousands of miles with no communication systems remind us that societies develop similar solutions to similar problems. Even some similarities could mislead observers to mistakenly perceive as the existence of a 'general plan'.[158]

Despite the similarities, the water systems also show marked differences. For instance, *tula* well complexes in Southern Ethiopia are cut into the ground through open ramps made by cutting limestone rocks where animals practically walk deep into the well. Water is lifted to watering troughs using human chains, for both livestock and human use. On the other hand, most of the ancient water systems (for instance *qanats* in the Middle East, and the Maya waterworks in Latin America) were constructed mainly for irrigation of crops, using gravity. With the *qanat* and other waterworks that use aqueducts, water flows continuously, wasting a large proportion of the water, particularly when there is no need to irrigate fields.[159] Contrariwise, the Borana seal wells during the wet season and open then only when they need water during the dry season. The British consul in southern Ethiopia during the early 20th

century explained the methods which the Borana used to conserve the well water and avoid disuse as: "It was covered with a layer of earth, then of branches and then of logs. Upon removing these, we found a copious supply of excellent water".[160] This strategy enabled the Borana to preserve water, keep it clean, and avoid incidence of collapse as well as dangers it might pose to people and cattle.

Ancient water systems played fundamental roles in altering cultural landscapes of arid regions. The water systems mediated between society and their environment, shaping not only the ways society interacted with its environment, but also the environment itself.[161] Through skilful water construction and management practices, people have altered arid environments into habitable places.[162] In the next section, theoretical perspectives for reconstructing environmental and social history of the ancient water systems are presented.

3. Environmental and Social History: Theoretical Perspectives

A theoretical framework that provides analytical tools for analyzing the complex human-environment interactions over time and space is crucial in reconstructing the environmental and social history of any region.[163] Human-environment relationships are intricate and non-linear which necessitates historical research that would help to understand the dynamics of the relationships and provides a frame of reference for examining patterns and processes over time.[164] Understanding the reciprocal relationship between human society and the environment is crucial in the study of environmental and social history.[165] Natural forces play significant roles in changing the environment or the cultural landscapes and modifying human adaptive responses while human societies also impact on the environment through their actions.[166] Donald Hughes emphasizes the importance of examining such reciprocal influences over time and in space.[167] William Cronon described nature and society as co-actors and co-determinants of historical processes.[168] After examining the complexity of human-environment relationships, Stephen Mosley noted the necessity of "breaking the nature-culture [society] dichotomy", suggesting the integration of environmental and social histories to understand environmental changes and social transformations.[169] Understanding how people use, manage or interrelate with their environment and examining the places of human society in a changing environment is at the forefront of environmental history.[170] A

comprehensive understanding of processes and extent of cultural landscape changes and identifying affected landscapes and human societies requires knowledge of both natural disasters (epidemics, drought, diseases, floods etc.) and human agencies (land use changes, tools used, human responses to disasters etc.).[171] Natural disasters sometimes severely affect the human-environment relationships, impacting on human responses to perturbations or disasters. Nature is active in shaping human adaptive responses and has been shaped by the socio-political environment.[172]

Natural disasters such as epidemics and droughts are major environmental perturbations in African savannahs that affect human-environment relations.[173] They disturb human-environment relationships through impact on human and livestock demography and physical environment.[174] Using ecological models to analyze disasters, Margie L. Kiter Edwards noted the interdependence of natural and social environments both in terms of vulnerability to and recovery from disasters.[175] In characterizing hazards and risks that cause disruption of human-environment relations, James Short considered hazards as: "... threats to people and what they value".[176] Axelrod and colleagues described natural hazards as "…forces that disrupt the communities they strike".[177] Disasters often vary in origin, nature, geographical coverage, magnitude, frequencies, spatial distribution, predictability, and intensity.[178]

Eastern and Southern Africa have experienced different natural disasters that shaped human-environment relations. However, the end of the19th and beginning of the 20th centuries were marked by a series of disasters such as the rinderpest epizootics, droughts, smallpox, cholera, and devastating famines. The exceptionally dry years devastated the livestock and human populations.[179] Various authors have used various expressions to characterize the severity of the disasters.[180] Some describe the period as "a decade of population disasters …that climaxed the long process which loosened the grip of people over their environment".[181] David Anderson and Douglas Johnson describe the disasters of this period as "the most significant historical marker".[182] In Ethiopia, it was termed as *kefu qan* (the cruel day). The period was described as the worst in human history, though such expressions drew critics.[183] The Borana referred to the period as termination, or extinction (*ciinna*) of all that was living.[184]

The dramatic decline of human, livestock and ungulate species' population changed the human-environment relationship. The loss of human environmental stewardship changed

human managed savannah grassland into bush land.[185] Such environmental change was followed with infestation by tsetse fly, which further forced the surviving human and livestock population to retreat.[186] The most serious problem was the change of food habits of carnivores. The crash of the ungulate population changed the natural food chain; a situation in which carnivores had no option but to eat famine weakened people.[187] There are varied views as to the causes and meanings of disasters.

There are two main perspectives: the first in which, environment is considered as the main agent of disaster where the causes are externalized and community seen as passive victim whereas the second perspective while acknowledging disaster as natural, does not consider disasters to be inevitable phenomena.[188] The former perspective emphasizes external causes and solutions, while the later perspective considers disasters as emanating from vulnerability because of exposures that are dependent on social and political processes.[189] This later perspective emphasizes the level of exposure to hazardous events (vulnerability) that cause disasters, which varies in space, time and across social groups.[190] Other scholars emphasize the political dimension of vulnerability where social inequalities are considered as main factors exposing people to disasters.[191] In recent years, a comprehensive approach that avoids environmental determinism and incorporates socio-political processes is gaining popularity.[192] There is a growing interest to understand the intertwined social, economic, political and ecological factors in influencing the level of devastation and human response to natural disasters.[193]

Disasters test the adaptive capacity of social, economic, and political institutions.[194] Some scholars attribute successful response to institutional resilience and the capacity to absorb shocks.[195] Resilient institutions are characterized by the capacity to draw lessons from historical encounters in reorganizing the society struck by disasters.[196] Many scholars agree that natural hazards cause disasters only when there is absence or failure in the social system to mitigate risks and vulnerabilities.[197] Anderson and Johnson for example argued that famine is a failure in wide-ranging long term human strategies, emanating from failure of the social system which could have taken proactive measures either to mitigate or minimize the impacts.[198] This is what Amartya Sen termed as “failure in entitlement”.[199] Among the local communities, strong social networks, support mechanisms, and social solidarity provide

individuals not only with material, but also emotional and psychological support, whereas disunity and social disorganization limits access to such opportunities.[200]

Understanding the social dynamics in response to disasters in coupled human-environment systems requires examining human adaptive strategies, responses to disasters as shaped by perceptions, and attitudes and meanings attached to the causes of the disasters.[201] For example, if a society considers the disaster as an act of God, efforts for disaster preparedness and management might not exist, whereas explaining the disaster as punishment from God because of human transgression might encourage the society to re-organize itself by reviving cultural and religious practices.[202] However, some authors consider this as a means of justification for human weakness in responding to disasters.[203] Thus, understanding communities' perceptions and the meanings they attribute to disasters would help to examine the rationale of their responses and the recovery processes. This approach could lay the foundation for future mitigation and amelioration actions.

Disasters pose challenges to social structures and institutions.[204] The degree to which the society is exposed to natural disasters influences post disaster recovery efforts and their reciprocal impact on the environment.[205] Societies' capacity to mobilize resources effectively during disaster and post-disaster periods determines not only the speed of recovery, but also the formation of viable social systems.[206] Societies vary in terms of endowments and entitlement and use diversified strategies to cope with disasters.[207] The capacity to absorb shocks and maintain certain structures and functions also varies in repeated disturbances.[208] Sometimes, crises may necessitate the reconstruction of new social networks or even transformation of identities for survival.[209] This is highly dependent on the capacity of the society to re-organize and undertake collective actions through social learning.[210] However, the relationship between natural disasters and human vulnerability is not linear. For example, famine is the result of either a failed social system or of natural causative drivers that undermine socio-economic production.

The integration of environmental and socio-cultural information, therefore, helps to understand the constraints imposed on people by the environment while trying to respond to disasters, how people changed their environment, and how the consequential changes limited the options available for human beings then after. This would require the analysis of environmental and socio-political perturbations over time, human responses to disasters and

perturbations, and the perceptions of local people about the changing environment, using historical information.[211] Figure 3 is a simplified scheme of the interactions among the drivers that influenced the cultural landscapes of the ancient *tula* wells. The society may respond to natural disasters and socio-political perturbations through changes in land use, institutional re-adjustment or transforming the labour organization.

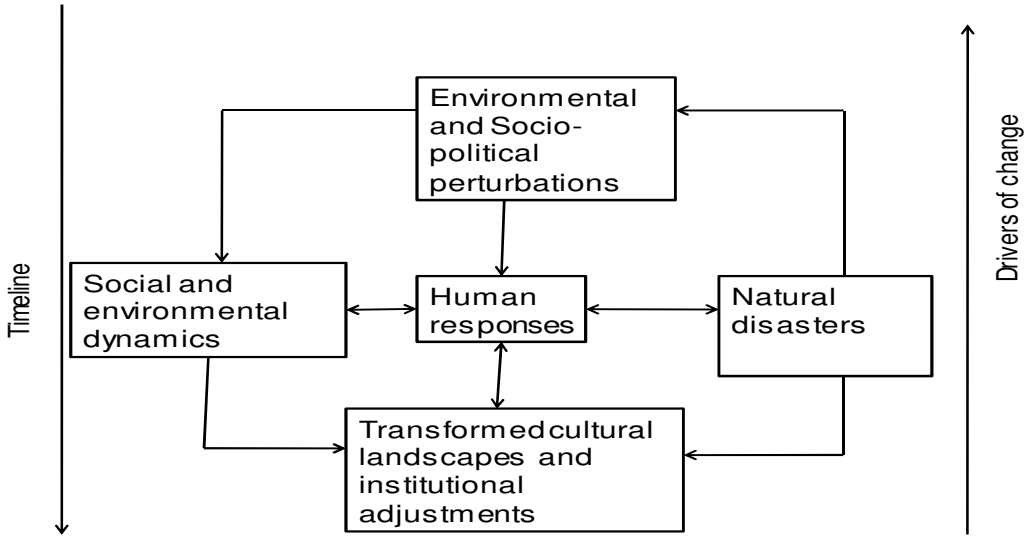

Figure 3. Schematic representations of human-environment interaction and socio-environmental dynamics

Past human-environment relationships have profound implication for both current and future policy as well as land use patterns.[212] Ideas and decisions are translated into human actions where the landscape retains the evidences of cultural imprints of the society.[213] Bruno David and Harry Lourandos present the importance of examining human action on the landscape as: "The landscape is signed by our actions….The activities of people in this landscape informs us not only as to the things that people did, but of those very relationships, of the way their lives were structured…. The changes that have taken place through time consequently reflect a reformulation of the relationships between people and their environmental settings".[214] The repeated perturbations and human responses underlie the degree of resilience in vulnerable environmental settings. Such extreme events therefore reflect past human adaptations in responding to perturbations over time.[215]

Many Eastern African communities were forced to change their land use and settlement patterns as a means of adaptation to changing conditions.[216] In recent years, changes in land use patterns are presented as far reaching effects of human activities on cultural landscapes.[217] Human labour, use of tools, and change in land use patterns have been important aspects of cultural landscape changes in African savannahs.[218] Since the landscape we observe today is the result of centuries long human-environment interactions and processes that require inclusions of the history of past land uses, environmental perturbations, and human responses, separating the current landscape patterns and environmental changes from past human activities is difficult.[219] Thus, understanding the intricacies of human-environment relations in historical perspective requires examining natural disasters, socio-political perturbations, environmental changes, and human responses to disasters that shade light on the reciprocal relationships that existed in time and space.[220] The next section describes methodological perspectives for reconstructing the environmental and social history of ancient water systems in general and the ancient *tula* wells in particular.

4. Methodological perspectives

In regions where archaeological findings and archival documentations have been scarce or lacking, use of oral history has been vital in reconstructing environmental and socio-political perturbations.[221] Historical events related to environmental perturbations such as calamitous droughts, epidemics, excessive rainfalls or floods, and sudden shocks which are sometimes marked by particular forms of environmental and social transformations, develop into oral narratives that can easily pass from generation to generation.[222] Oral histories record the economic, social and political institutions, societies' perceptions of the environmental changes and their worldviews that shape human-environment interactions.[223] Oral histories incorporate indigenous knowledge that is important to reconstruct past environmental conditions.[224] These include legends, narratives, songs, rituals, genealogies, generation sets and age sets that help in recalling and reconstructing past historical events.

Oral histories served, in non-literate societies, as the main source of historical information.[225] They recorded important historical events that affected the natural environment and the social system or both.[226] Oral histories are told at public gatherings, ritual performance sites,

initiation ceremonies, and during interaction in households.[227] Young people are taught about their past, its importance, and how to preserve and pass it on to the next generations. The chains of transmission are kept in a continuous flow where old as well as young members play crucial roles.[228] According to Thomas Spear, lessons from the past are acknowledged in every occasion by old people.[229] Jeffrey A. Fadiman vividly expresses the role of elders in preserving historical information in Africa by equating the death of an old man with the loss of a library to that society.[230] Spear notes that oral traditions are the "main vehicle for remembering history".[231] Despite this, they are not without limitations.

One of the limitations of oral sources is selection of memory. Not everything from the past is equally valued and remembered.[232] The most conspicuous events (for instance disasters which caused widespread and serious devastations) are remembered and narrated vividly. Valerie R. Yow acknowledges the impossibility of reconstructing the past in its entirety.[233] Events are also susceptible to lapses in memory and manipulations of the story tellers.[234] Corroborating the oral information with other sources, however, can minimize the errors created due to such limitations.[235] Checking the consistency of oral sources by relating them to factual information and consulting available written sources increases their validity.[236] Use of king lists, chiefly lists, genealogies and generation sets are important to remember historical events and cross reference with other sources to minimize the problems that may emanate from the limitations of oral sources.[237] The role of historical places and sacred sites (landscapes) are also acknowledged in assisting historical memory and minimizing the limitations of oral sources.

Landscapes play a significant role in people's mode of historical memory. Oral historians may narrate important historical events by referring to particular sites or landscapes. In analyzing how historical memory is transmitted among the Paez, Rappaport asserts that "They locate their historical records in sacred sites…which served both as mnemonic devices for remembering history and as clear-cut boundary markers for the indigenous communities".[238] Pamela Stewart and Andrew Strathern explain how the value attached to landscapes help in remembering history: "Signs of the landscape are sometimes as the symbols of the ancestral past; they can be seen as the codes of memory…people are connected to landscape, because of what their ancestors have done".[239] Fernando Santos-Granero also describes the role of landscape in reinforcing historical memory as "…a means

of encapsulating and transmitting memory… not only evokes memory but is written upon it, thus becoming memory".[240] Stewart and Strathern explained the process by which values attached to landscape shape memory as "Perceptions and values attached to landscape encode values and fix memories to places that become sites of historical identity. … A place is socially meaningful and identifiable space to which a historical dimension is attributed… [Landscape] encompasses environment plus relationship to it and the cross-cutting ties of relationships that emerge from or exist in a space".[241] Ancient water systems are examples of such historical and sacred places on which historical memories have been imprinted.

The role of water systems in assisting memory becomes more crucial when the water systems are inherited inter-generationally, representing ancestral inheritance and key resources of the clan.[242] In such cases the water-cultural landscapes play crucial roles in shaping historical memory, where events are codified and stored in oral memories. The water systems are one of key links of past, present, and future generations, hence the carrier of historical memories. Using oral sources and water cultural landscape as aid to memory, it is possible to reconstruct environmental and social history of a region. Examining the dynamics of *tula* wells provide an opportunity to understand such water-cultural landscape on which societal memory is written.

4.1. Dynamics of tula wells: Implementation of the framework

Tula wells provide unique water-cultural landscape that has been modified by centuries of human-environment interaction. The environmental and social history of the ancient *tula* well complexes reflects layers of natural disasters and socio-political perturbations that induced human adaptive responses, but have left their imprints on the water cultural landscape. The cultural landscape of the *tula* wells experienced periods of altering disasters and recoveries which influenced the overall dynamics of the wells. There are historical periods that are distinctly marked in human memory with regard to the ancient *tula* wells. For instance, the collapse of wells during the *gada* Ungule Lake Sade (1800–1808) by excessive rainfall is vividly narrated by all Borana informants. Similarly, the second half of the century is marked by repeated collapses of *tula* wells, either due to excessive rainfall (floods) or the collapse of the cattle economy.[243] Natural disasters such as epidemics and droughts collapsed both

human and livestock demography and hence *tula* wells.[244] When the cattle economy collapses due to droughts or other natural disasters, the demand as well as capacity to rehabilitate the wells dramatically decline. For instance, the rinderpest epizootic (*ciinna*) which occurred at the end of nineteenth century collapsed the cattle economy, while the consequent famine and wildlife attacks devastated human demography.[245] This dispersed the society and weakened the social institutions.[246] Consequently, all the nine *tula* well complexes were abandoned, either lost to silting or sealed by the community.[247] The restoration of the wells started during the recovery period, implying the indispensable roles of human labour and cattle economy for the operation of *tula* wells.

The Borana social institutions have been perturbed at different historical periods which affected the management of *tula* wells, resulting in the abandonment and disuse of many *tula* wells.[248] In spite of repeated perturbations and collapse of many *tula* wells, resilient social institutions played crucial roles in maintaining the functional wells and re-excavating the collapsed ones.[249] This is what Almo Farina describes as existence of human stewardship that enhances the resilience of cultural landscape.[250] When disaster strikes the society, such capacity, at least temporarily, diminishes. The collapses of human and livestock demography deny the *tula* wells the labour and resources needed to re-excavate collapsed wells or rehabilitate functional ones.[251] In recent decades, changes in land use patterns constitute a new challenge to the operation of *tula* wells. The introduction of cultivation into previously protected dry season grazing regions and changes in settlement patterns, and violation of traditional settlement rules, are relatively recent but pose threats to the operation of *tula* wells.

The combined effect of natural disasters that repeatedly collapsed the pastoral economy and human demography, socio-political perturbations which affected social solidarity and institutional capacity (Paper I &II), external interventions to change the pastoral ways of life in the last five decades and consequent change in land use and settlement patterns that weakened the indigenous water management institution (Paper III), and labour and technological transformations in the re-excavations and utilizations of *tula* wells (Paper IV) constitute the major causes of *tula* well dynamics. From the perspective of *tula* wells, both natural disasters and human agencies acted concomitantly and synergistically to transform the cultural landscapes of ancient *tula* wells and the indigenous water

management institutions.[252] The dynamics are reflected in use and disuse of *tula* wells (Papers I & II), periodic re-excavation and rehabilitation of *tula* wells (human stewardship), labour and technological transformations, and cultural landscape changes of ancient *tula* wells (Papers III & IV) which left their imprints on the cultural landscape. As any other ancient water system, the periodic collapses and rehabilitations of *tula* wells have caused greater morphological and structural evolutions and transformations in the social institutions which governed the management of *tula* wells.[253] Various earlier structures can be observed as footprints of the periodic rehabilitations and modifications. The oral sources and the ongoing rehabilitation works are other testimonies for the structural evolutions that increased water yields.[254] They were also accompanied by transformations in social organization that managed the wells and technologies that have been in use for centuries.[255] The basis for continuous operation of these water systems, despite their susceptibility to environmental vagaries and socio-political perturbation, is the existence of locally crafted water management institutions. Figure 4 is the schematic representation of the interacting forces of *tula* well dynamics in the implementation of the framework. The transformed water-cultural landscapes of ancient *tula* wells reflects the imprints of historical markers reconstructed using indigenous time reckoning systems and the cultural landscape as aid to memorize the events.

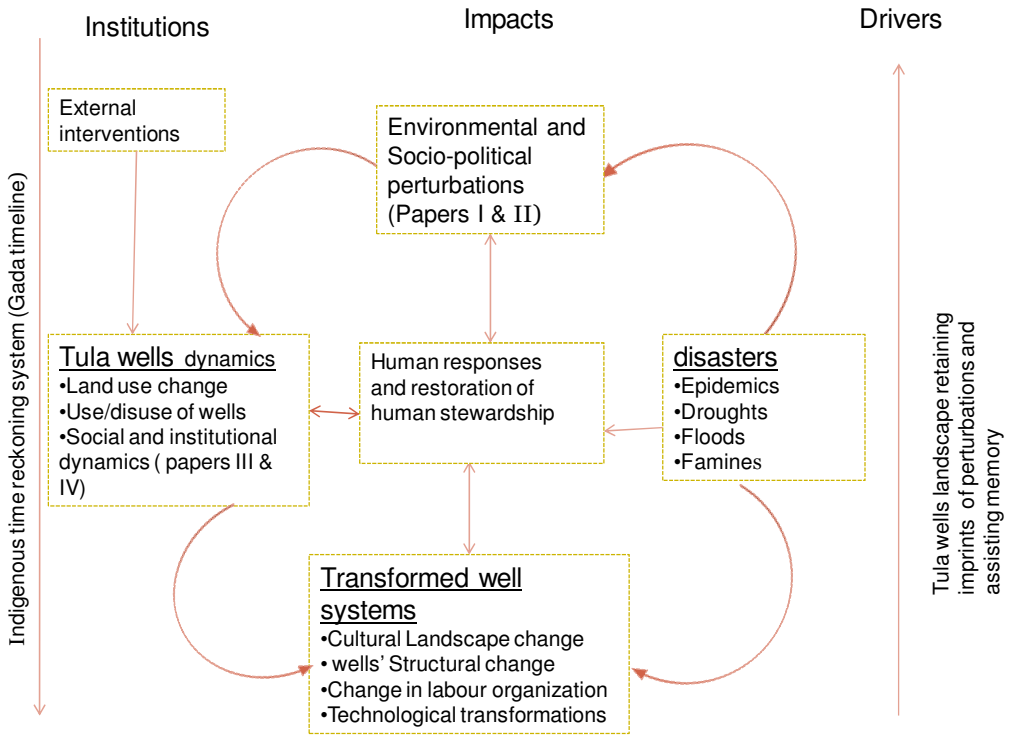

Figure 4. Schematic representation of *tula* wells dynamics.

The interacting forces influence the dynamics of *tula* wells and the cultural landscape. Both natural disasters and human agencies play indispensible roles in these transformations. The influences of the two forces are intertwined and reciprocal. Reconstructing the dynamics with any degree of accuracy relied on using the Borana indigenous time reckoning system.

4.2. The Borana indigenous time reckoning systems: Framework for reconstructing environmental and social dynamics of ancient water system

Despite the limitations of oral history discussed earlier, the unique time reckoning system of the Borana is an opportunity to use oral sources in reconstructing environmental and social history of ancient *tula* wells. The unique time understanding of the Borana and the cross-referencing they use makes their oral history reliable in analyzing environmental and social history of *tula* wells. The innovative way of understanding time by Borana gives us not only a methodological tool but also a broader understanding of the sophisticated calendar of this

indigenous society.[256] The mechanism of the Borana indigenous time reckoning system is the *gada* timeline.

Acknowledging the lack of written documents, Richard Wilding noted the possibility of reconstructing Borana history using the *gada* timeline and oral history.[257] Gunner Kjaerland also suggested the use of *gada* timelines in reconstructing historical events in Borana.[258] In explaining the Borana understanding of time in historical perspective, Gemetchu Megersa and Annessa Kassam noted "Time is not only the 'first cause' of all things; it also determines what something will become. It gives things their essential qualities and attributes. It encodes their destiny".[259] In appreciation of the richness of Borana oral history, Asmarom Legesse wrote, "Their oral traditions proved to be rich and highly systematic. The techniques of time reckoning promised to be one of the most sophisticated systems devised by man".[260] He adds further that the Borana system is one of the few indigenous institutions identified so far that provides a comprehensive understanding of the relationship between time and human society.[261]

Using oral sources and narratives, this thesis examines the impacts of natural disasters and socio-political perturbations on the ancient *tula* wells cultural landscape, water management institution, and the environmental and social transformations in *tula* wells cultural landscape. *Gada* timeline is used to guide interviews and discussions in reconstructing major environmental and socio-political perturbations, land use dynamics, labour and technological transformations. The concepts of *gogessa*, *Maqabas* and *dhaaccii* were also vital in assisting memory and narrating historical events. Key informants interview and group discussions were conducted by referring to these time reckoning concepts. Household surveys, livestock census and measuring well structures were also used to collect data.

4.3. Data collections

4.3.1. Key informants interviews

Key informants were interviewed, to understand environmental and socio-political unrest in the cultural landscape of *tula* wells. Informants were selected on the basis of their historical

knowledge, roles in well management (well council, owners of wells, and supervisors of watering order), and positions in the local socio-political institution – the *gada*. Key informants helped to reconstruct major historical events (e.g. epidemics, droughts, excessive rainfalls or floods that collapsed wells), and understand resource management institutions that govern use and management of *tula* wells and their transformations.[262] Using information from key informants, major threats to use and management of *tula* wells were identified. This included historical, present as well as future threats. Some of the threats were identified as external while others were attributed to internal dynamics. The external threats relate to disasters and policy interventions, while the internal dynamics emanate from the divergent interests of members, changes in perceptions with regard to pastoralism, and shortage of labour.

For several centuries the exploitation of *tula* wells by the Borana relied on indigenous labour organization for digging the wells and lifting water from the deep wells using *okole* (water bucket made up of giraffe and buffalo skin). Both labour and *okole* are crucial inputs to the exploitation of well water. Labour is important in the digging, rehabilitation, and use of the *tula* wells. Labour coordination is also crucial, as lifting the water from the source to watering trough requires human chains.[263] Key informants discussed the traditional labour organization for well re-excavations, rehabilitations, watering animals, its transformations, and the major challenges the Borana pastoralists encountered regarding labour organization as well as availability of *okole*. The informants also helped to understand how the community coped with the problems of *okole* and labour shortage. Informants discussed the transformation of *okole* technology and introduction of heavy earth moving machine in well re-excavation, and their implication on water yield. Information from key informants that was deemed to be incomplete or inconsistent was further clarified at group discussions.

4.3.2. Group discussions

Group discussions were conducted at six well clusters. The participants were selected based on their knowledge of Borana oral history in general and their memory of the impact of the natural disasters and socio-political perturbations on *tula* wells and the socio-economic lives of the community in particular. The group discussions were organized thematically to collect

information according to set objectives. However, as most of the objectives were interrelated, the participants often discussed issues related to other objectives, which was used as an opportunity to enrich inquiry. In all the discussions, general questions were posed followed by increasingly specific questions to clarify issues under discussion. Information from some discussants which lacked sufficient detail was augmented by others with more information. Folklores, narratives, songs and genres were used to reconstruct use and disuse of wells and key drivers of the well dynamics. The group discussions covered major natural disasters (e.g. epidemics, droughts, and heavy rainfall or floods), socio-political unrest, land use changes, labour and technological transformations in utilizing *tula* wells, and the impact on the cultural landscapes of the *tula* well systems. The information is supplemented by household surveys.

4.3.3. Household surveys

Household surveys were conducted among communities reliant on five of the nine well clusters to understand the community's perceptions of cultural landscape changes in *tula* well system. Pastoralists' perceptions of environmental change during the last five decades (1960s to present) were examined to identify the major changes and how such changes affected the *tula* wells system.[264] The timeline was divided into *gada* periods and environmental changes during each period were assessed using societal perceptions. One hundred and fifty one household heads were interviewed. A structured questionnaire was prepared and administered to household heads. Environmental events were assessed in terms of rainfall patterns (i.e. excessive, normal or below normal), severity of droughts (absent, mild, severe, or very severe), size of grazing home range (extensive, reduced or severely reduced), and pasture availability (v. poor, poor, good, or v. good). Herders' indigenous knowledge was vital in identifying environmental changes around the well clusters.

The focus was on the changes in resource use patterns. Expansion of settlements and crop cultivations in to the protected *tula* well sites (dry season grazing zones) were presented as externally imposed changes of resource use patterns that threatened the sustainability of *tula* wells, while excessive rainfalls (floods) and droughts were naturally imposed threats. According to Borana resource use rules, human settlements are expected to be within the radius of 8 to 15 km from the wells, whereas the area within 0 to 8 km is reserved for dry

season grazing for both *foora* (satellite herd) and *warra* (home based herds).[265] The changes in location of settlements, the number of *olla* (encampment), and human population were used as proxy indicators of changes.

4.3.4. Measuring well structures, and labour and livestock census

Measurements of different well structures were taken during fieldworks. The variables measured include depth and length of watering trough (*naniga*); length and depth of reservoir (*facana*); ramp length; depth of the well and others.[266] The measurements assisted in describing the wells and relate the structural changes to perceptions of changes in water yields. Censuses of human labour and livestock watered at individual wells were conducted during the dry season of 2007/2008 to describe the labour needed and the capacity of individual wells.[267] Brief outlines of the results that are fully reported in part B of the thesis are presented in the next section.

5. Synthesis of the main findings

5.1. Use of indigenous knowledge to develop methodological framework for reconstructing the impact of disasters on the ancient tula wells

Paper I uses the Borana Oromo indigenous time reckoning system corroborated with proxy data such as excessive rainfall and severe droughts to develop a methodological framework to reconstruct the impact of disasters and socio-political perturbations on the ancient *tula* wells in southern Ethiopia. The unique time reckoning system of the Borana combines three concepts (*gogessa*, *maqabas* and *dhaaccii)* that are cross-referenced in summarizing events into memorable formats to assist memory and narration of historical events chronologically.[268] According to the Borana time recalling experts, historical time clock would read events through cycles of *goggesa* and cycles of *maqabas,* marking the repetitions as *dhaaccii* of X or Y (Table 1 of Paper I). Therefore, the three concepts play a major role in organizing and systematizing the history of the Borana into memorable formats that can easily be remembered and narrated.[269]

These interrelated concepts provide time experts with tools to analyze environmental, social and political perturbations. These intertwined and complex concepts are used to understand the cycles and repetitions of events for reconstructing environmental and social history. In each cycle, natural disasters and socio-political perturbations that affected at least one of the three interdependent elements (wells, cattle, and human demography) served as the markers of time recollection. Using the concepts of *Maqabas*, *gogessa*, *dhaaccii*, and *gada* timeline, and the Borana indigenous knowledge of time reckoning as a methodological framework, the impacts of disasters on the ancient *tula* wells were reconstructed.[270] The indigenous environmental knowledge of Borana Oromo is incredibly detail and rich in historical information. Linking the water system to the surrounding grazing land and sustainability of pastoral production, the Borana knowledge of the indigenous environment provides a comprehensive understanding of the impacts of disasters on the human-environment linked system.

Natural disasters such as epidemics and droughts affected human and livestock populations, indirectly impacting on the operation of *tula* wells whereas excessive rainfall (floods) directly caused the collapse of *tula* wells for several centuries. When natural disasters affected human and cattle populations, lack of labour and economy forced the pastoralists to abandon *tula* wells.[271] The sustainable use of *tula* wells has been ensured through periodic human interactions, such as re-excavation of collapsed wells and rehabilitation of operating ones. The disasters are mostly remembered by the damage they caused to *tula* wells, pastoral economy, and human demography. The major disasters that decimated human and livestock population were summarized in Table 2 of Paper I. Those human and livestock demographic collapses were followed by abandonment and disuse of many *tula* wells due to lack of human labour and cattle economy. Drought is another natural disaster that repeatedly collapsed cattle economy, causing famine to human population and abandonment of *tula* wells. The repetition of events (*dhaaccii*) was correlated with *gogessa* and *maqabas* to test the claim of oral sources (i.e. *dhaaccii* of the past *maqabas* and *gogessa* were said to have influenced the later historical occurrences). Most of the events found to replicate themselves, but not deterministically as claimed by oral sources. However, the cross-referencing of events using the indigenous knowledge found to be crucial in reconstructing the impact of disasters on the cultural landscape of *tula* wells. This

methodological approach may apply to reconstruct other historical events in the context of Borana. Oral sources revealed that most of the natural disasters were closely tied to social and political perturbations that affected the social solidarity, impeding cooperation in the utilization and management of *tula* wells.

5.2. Socio-political perturbations and dynamics of tula wells

Oral sources revealed that Borana social institutions experienced numerous perturbations and reorganizations. The perturbations were explained as unusual disunity and lack of consensus among the community members. Oral sources also recall the impacts of political perturbation on the ancient *tula* wells. The emphasis was on the most notorious historical events in the Borana history of political perturbations. One of such unforgettable historical incidence narrated almost by all informants occurred during *gada* period of Madha Boru Dadoyi (1752-1760) that resulted in the demise of the whole generation set coming to power in the war with neighbouring tribes. This tested the innovative capacity of Borana institutions. Soon after the incidence, the leaders re-established the perished generation set by new recruits from 'retired generation sets', to avoid the anomalies that would have disrupted the regular power rotations among the five *gogessa*. [272] The unsuccessful attempt to stay in power by Liban Jilo (1840-1848) beyond the normal *gada* period and consequent conflicts makes the other aspect of political perturbation in Borana. The disunity that persisted throughout the second half of the 19th century affected the Borana social solidarity and well management institutions, finally culminating in the conquest of Borana by external forces at the turn of the century. This total shift of political power from indigenous system to the external party influenced not only the management systems of *tula* wells, but also the ownership by forcing some well owners to migrate across the international border to the neighbouring British colony (present day Kenya), creating ownership ambiguity.[273]

The socio-political perturbations were blamed for weakening the Borana social institutions and society's capacity to respond to disasters. They affected the capacity of the society to mobilize labour and resources to rehabilitate and manage *tula* wells, leaving many of them in disused state.[274] Despite periodic efforts to re-excavate collapsed wells following every disaster and socio-political perturbations, increasing numbers of *tula* wells have been

added to the category of long disused wells; reducing the operating wells to twenty five percent of known maximum, when this fieldwork was conducted.[275] The number of operating wells has fluctuated from time to time in relation to the drivers of well dynamics. It also depended on the Borana institutional capacity in responding to disasters and socio-political perturbations. This study shows the resilience of the social system in responing to disasters and facilitating recovery. This was apparent from the magnitude of the economic and social suffering the Borana pastoral system endured towards the end of the nineteenth century, when rinderpest collapsed cattle economy, disrupting the social system.

5.3. Perceptions and narrations of rinderpest epizootic and famine

In Paper II, we used oral history to reconstruct the impact of the rinderpest epizootic that devastated eastern and southern African regions during the end of 19th century. The pandemic swept through Borana, collapsing the pastoral economy and exposing the pastoralists to dreadful famine, man-eating predators and a smallpox pandemic. The Borana oral sources summarized the events as *ciinna* − termination. *Ciinna* refers to the total collapse of social, economic, political and cultural structures, and discontinuity of pastoral life that created social disorientation and disharmony.[276] The term describes not only the extent of damage caused to the pastoral economy but also the failure of the social system which limited human responses to the multiple disasters occurring simultaneously. The damages are remembered in terms of economic collapse, human demographic decline, dispersion of families and clans, the practice of pawning children, and the crises in social identity.[277] The consecutive disasters left historical imprints on human memories. The Borana social memories provide us with detailed explanations of the devastation of the cattle economy; impact of man eating predators; human responses to the disasters; society's determination to prevail; and institutional resilience which facilitated fast recovery of pastoral systems and re-excavation of collapsed wells.[278] Examining the disasters is important not only to understand the impacts, but also how the meanings and interpretations influence the societal responses to disasters. By examining narration of the devastation, perceptions, human responses, and recovery processes, Paper II suggests that the institutional resilience of the Borana was the cornerstone of the recovery and reconstruction of a viable pastoral system.

As coping and survival strategies, diversified means were implemented: hunting, gathering, migration, food sharing, and changes in food habits (e.g. violating the food taboos). As means of protection from wild beasts, the victims gathered together and established big settlements, referred to as *olla magallata*. The settlements enabled the community to send alarms to each other and defend themselves as a group, as opposed to the individual efforts which were more common prior to the establishment of the settlement.[279] The head counting that was done at clan level assisted in identifying survivors and reclaiming individuals who had migrated to neighbouring ethnic groups to escape the disasters. Merging clans and sub-clans was another strategy used by the Borana to create a viable social system that facilitated the recovery. This created a benchmark for the re-establishment of the social system and the recovery processes by re-organizing the people to take concerted actions. The Borana tried not only short term strategies but also long term ones which aimed at protecting the wells from collapse and disuse. The attempt included sealing of wells and diverting flood catchments away to avoid siltation.

After the period of the aforementioned crisis, the Borana utilized all the opportunities and knowledge systems they had in order to reorganize and strengthen social institutions. The prevailing conditions necessitated the introduction of new rules which guided relationships among community members by overlooking the violation of food taboos, sexual norms, and cultural traditions that had taken place during the disaster periods. Punishment was not an option for the Borana leaders. They decided to forgive all past violations of customs and traditions pronouncing all people *qulqullu* (all are clean), but putting in place stricter social regulations and rules to guide future actions and interactions.[280] The unity was cemented by ritual and cultural practices which strengthened the social solidarity and unity of the survivors. Being aware of its importance, the Borana leaders organized cultural and ritual practices where sacrifices were symbolically represented because of lack of the cattle that would customarily have been presented as a sacrificial object. This helped to create social harmony and promote pastoral recovery.

The impact of disasters on *tula* wells was fundamental and long lasting. Firstly, the collapse of cattle economy and human demography disrupted the human stewardship of the *tula* well systems. Secondly, the destruction of families and lineages owning the wells created ambiguity of well ownership. Lack of clear evidence as to the ownership caused claims and

counter claims which left many wells in disused states. In recent decades, changes in land use and settlement patterns are known to have posing threats to the ancient *tula* wells.

5.4. Cultural landscape changes of ancient tula wells

Paper III considers how weakening of the previous systems of human stewardship of the *tula* wells resulted in the ruination of the *tula* wells' cultural landscape. The ecosystem of the *Tula* wells represents an ancient water system where the customary resource management rules ensured sustainable use of water and range resources for centuries. According to the Borana, the sustainable management system has been enhanced by the concepts of *laaf aadaa seeraa* (land managed by customary law) that promoted human stewardship.[281] The human stewardship informed wise use of water resources, regulation of land use and settlement patterns. In this human-environment linked system, the human stewardship is characterized by adaptive, flexible, and socially and environmentally responsive management systems. The failure of this responsive management system is termed by the Borana as *laaf bade* – ruined land. External imposition and internal dynamics caused the shift from human managed (*laaf aadaa seeraa*) to abandoned land (*laaf bade* or ruined land). The Borana indigenous knowledge and perceptions of environmental change were utilized to understand these two opposing concepts in the analysis of cultural landscape changes of ancient *tula* wells. Changes in land use patterns which violate the traditional land use classification is the one interpreted as *laaf bade* – ruined land.[282] The previous dry season grazing zones are partly settled or cultivated, while the rest are utilized for year round grazing.

Paper III shows that one of the changes is the establishment of peri-urban centres at every well cluster. These peri-urban centres that are growing fast are not governed by traditional settlement rules – *aadaa seeraa*. They are externally imposed as the result of government sponsored land use changes that advocated for cultivation and private grazing lands. Furthermore the security problem of 1970s and droughts that affected Borana pastoralists also created an opportunity for the government to collect people together and settle at water points to provide security and food aid. Over the course of time, the peri-urban centres attracted many people due to the services they provided: schools, human and animal clinics, marketing services, and tea rooms at the well clusters. Borana pastoralists, who at the

beginning opposed such changes in land use patterns started to appreciate the benefits. However, expanding cultivation into well rangelands poses threats to communal grazing lands, through privatization and fragmenting the grazing lands. Despite being used as one of the coping strategies by the Borana, crop cultivation in the *tula* well clusters impact on the human stewardship, resulting in an overall deterioration of the land.[283]

The changes in land use patterns have drastically altered the traditional resource use patterns in the *tula* wells ecosystem. They are perceived by the pastoralists as processes of ruining the *tula* cultural landscape through the incapacitation of human stewardship. The disruption of seasonal grazing systems and introduction of year-round utilization of the well-landscapes resulted in grazing pressures and overexploitation of the landscape around the *tula* wells. The Borana expressed such overexploitation and changes in the environmental quality using indicators such as pasture scarcity; shrinkage of home range grazing zones; declining livestock productivity; declining milk production; calving rates and calves growth.[284] Change in land use patterns occurred together with institutional, labour and technological transformations in the utilization of *tula* wells, which is assessed in Paper IV.

5.5. Human adaptive responses to labour, technological and institutional transformations

Paper IV considers labour and technological transformations that brought structural transformation to the *tula* wells and increased water yield and labour efficiency. The structural transformations were partly imposed in response to the periodic well collapses necessitating frequent modifications and partly due to external financing institutions in the 1980s and 1990s that introduced heavy earth moving machines and hired labour into well re-excavations.[285] Internally, the need for increased water yield and cultural obligation to ensure continuous operation of the wells motivated the Borana to invest in improvement. The structural transformation involved digging deeper following the dropping of water tables, and modifying well structures. This is done using hired labour instead of clan based labour organization and heavy machinery for moving huge volumes of earth. The causes of the changes in labour organization emanated from internal dynamics and external impositions. Internally, the Borana were compelled by water scarcity and labour shortage. Externally, development and aid organizations introduced a cash economy into well re-excavation,

setting the stage for labour commercialization. A new institution (Pastoral Association) was imposed, overtaking the roles of indigenous institutions, but creating ambiguities in power relations between the indigenous and the imposed institutions. This is particularly true when well re-excavation is financed by external organization.

The traditional leather bucket (*okole*) was also replaced by the plastic jerry can. Initially, the Borana were forced to adopt the changes due to a shortage of *okole* made from giraffe skin. The new substitute later drew the attention and appreciation of the Borana, to the extent of replacing all the hide *okole* for lifting water from the deep *tula* wells. The plastic jerry can is favoured for many reasons. Firstly, it is accessible and cheaper compared to the traditional *okole*. Secondly, it is convenient to handle and holds more water than the traditional one. Thirdly, it solved the problem of uniformity among *okole* contributed by users. In the replacement process, the Borana were cautious enough to preserve cultural values attached to the services of traditional *okole*. They reserved the traditional *okole* for milking and other cultural practices while replacing the tool for lifting water with plastic jerry cans.

The transformations are said to have improved the use of wells in many ways: firstly the structures that were susceptible to collapse were redesigned reducing the need for frequent rehabilitation. Secondly, improvement in the structures such as well shafts enabled the labour force to operate freely and fast as opposed to the earlier narrow well-shaft which physically limited the labour forces. Thirdly, it increased the water yield of many wells by deepening the well and reducing wastage through constructing *facana* (reservoir) and *naniga* (watering trough) from cement, and making access easier than before, but leaving many low yielding wells in a disused state. Fourthly, the transformation reduced human labour needed to operate individual wells. Parallel with the transformations, the old priority based use of the wells declined and the broad based (*ballitti*) system became widely used.

Despite the multifaceted transformations in the utilization and management of *tula* wells, the flexible and adaptive responses enabled the Borana indigenous water management institutions to remain central and irreplaceable. The Borana indigenous water management system, although unwritten, provides basic management rules that details duties, responsibilities, and rights of individual users, how to handle excess herds, prioritize users and livestock species, and manage and solve conflicts.[286] The interconnectedness of clan

(family), the economy (cattle) and the environment (*tula* wells) provides the basic frame of reference for cementing the unity, coordinating the management of and ensuring sustainable use of the wells. This interdependence elevated the meaning of wells and strengthened peoples' commitment to their maintenance.

6. Conclusions and the need for further research

6.1. Conclusions

The dynamics and transformations of cultural landscapes of ancient water systems are the cumulative effect of historical processes where natural forces and human agencies are the drivers. Understanding the dynamics of the cultural landscapes of water systems is constrained by methodological challenges that integrate environmental and social histories of the water systems. Lack of written materials presents another methodological challenge. This is particularly true in African savannahs where past historical occurrences pass from generation to generation orally. As a result, there have been few investigations which combine the agencies of both natural forces and humans as the drivers of cultural landscape changes. This has hindered the holistic understanding of the water system dynamics. The *tula* wells cultural landscape in southern Ethiopia is one of the ancient water systems of east Africa, but little is known about its environmental and social histories. The Borana indigenous time reckoning system and oral history as reservoirs of historical knowledge, present an opportunity to reconstruct the dynamics of this water system. In this thesis, Borana pastoralists' indigenous knowledge and time reckoning systems were used to examine the impact of natural disasters, socio-political perturbations, and roles of human agency in the cultural landscape dynamics and institutional transformations of *tula* wells.

Historically, *tula* wells have been perturbed by extreme weather conditions – excessive rainfall (floods) and severe droughts. Excessive rainfall (floods) collapsed many wells, the re-excavation demanding organized societal responses. The collapse of wells has never been considered as unmanageable disaster, given the healthy pastoral economy and human labour to rehabilitate and restore the wells. Unfortunately, the cattle economy and human labour are not immune to epidemics and the other extreme of the spectrum of weather, droughts. The dramatic reductions of human and cattle population by such extreme natural events requiring

long term recovery left many *tula* wells in abandoned and disused states. The interdependence of *tula* wells, cattle economy, and human population in the region is therefore built on strong reciprocal basis. The interdependence and sustainable management of *tula* wells is mediated by capable, adaptive, flexible and resilient indigenous institutions.

The Borana institutional capacity that mobilized resources and human labour to re-excavate disused wells and rehabilitate damaged ones ensured the sustainable use of *tula* wells. The social institutions proved to be resilient and responsive to disasters and perturbations. This was evident from the repeated natural disasters and socio-political perturbations that hit the *tula* wells and Borana pastoral system over the course of centuries. One may ask: 'if the Borana institutions were capable of responding to disasters and recovering from, do they disclose the same capacity'? If not why? There may not be direct and conclusive answers to these questions. The main reason is that the Borana indigenous institutions have been transformed due to external impositions and internal dynamics.[287] The transformations may also be attributed to social, cultural, economic and ecological transformations that forced the institutions to adjust. First and foremost, the role of natural disasters such as drought is significant in exposing the Borana pastoral system, forcing it to seek external aids, opening opportunities to governmental and non-governmental organizations to impose their institutional and organizational set-ups in providing food aid and organizing labour for the re-excavation of collapsed wells. The interventions shifted the focus from traditional leaders to local government representatives (Pastoral Associations), rendering the traditional institutions redundant. This is closely linked with the declining cattle economy due to droughts and epidemics which damaged the capacity of the pastoral economy to accommodate the interest of many needy members through traditional restocking mechanisms, forcing many of them to involve in other non-pastoral activities which were previously considered as evil works. Such transformations are also attributable to changes in attitudes and perceptions towards pastoralism. Hired labour, as opposed to the clan based organizations has been introduced to Borana well re-excavation. The interventions of development and humanitarian organizations caused changes in land use and the institutions which manage natural resources, particularly water. Cultivation and wage labour which were previously considered as evil works are now part of their livelihood strategies. Changes in the perceptions and values of young people with regard to pastoral ways of life is also attributed

to growing urban centres and increased interaction with other people of different cultural backgrounds, increased access to education and diversified livelihoods. These factors are loosening the social ties which held clan members together for centuries. The ecological capacity could also be different in facilitating the economic recovery. The dynamics and transformation of *tula* wells, therefore, are the results of the interaction between natural disasters and socio-political processes. The incapacitation of indigenous water management system may pose a danger to sustainable water management in the future.

6.2. Development implications

The intricately linked human-environment water system of *tula* wells is the result of the interplay between natural forces and human agencies. Local ecological knowledge and the indigenous time reckoning system of the Borana appear to be fundamental in the sustainable management of this water system in the fragile savannah ecosystem in southern Ethiopia. However, the water system has been threatened by natural disasters, socio-political perturbations, and external interventions. The interventions have contributed to the solutions for the water needs of the society, through introduction of better technologies in the re-excavation of wells, or providing alternative sources of water. However, the replacement of traditional and sustainable water management system or technological transformations have so far been adopted by pastoralists selectively and cautiously. This is due to their concern regarding the sustainability of the new water schemes and technological transformations. The concern partly emanates from the increased alternative sources of water, and partly from the marginalization of the indigenous water management systems.

Therefore, there is a need for future development efforts to learn from past historical processes and the Borana water management system which proved to be resilient in the phase of repeated natural disasters and socio-political perturbations. Developing a sustainable water management system that benefits from the modern technology requires incorporation of Borana indigenous ecological knowledge. This cumulative knowledge can be used to design effective methods of responding to natural disasters and socio-political perturbations. On the other hand, modern water construction works can benefit from this indigenous water management system.

6.3. Future research

Understanding the historical dynamics of *tula* wells and the driving forces is a key element in the management of the precious cultural heritage of the Oromo nation in general and the Borana Oromo in particular. Therefore, there is a need for further research, particularly archaeological research that can cast more light on the possible age and tools used in the construction of these wells of antiquity. Moreover, the following points may deserve further research:

- Some informants claim the original diggers of *tula* wells as gigantic, who buried the tools in the well clusters. Archaeological research may caste light on such claims. This may provide more information on the history of the wells and past settlement patterns in relation to the well clusters.
- Further research is needed to provide concrete evidence regarding the original well diggers. If Borana were not the original wells diggers, how the Borana adopted their technology, social organization, and water management systems need to be examined.
- There is a need for further research to explain the social organization that mobilized labour and economy for digging the wells in the past.
- Further research is required to understand why the Borana or their predecessors needed such a huge number of wells, the majority of which are disused today.
- Historical analysis is needed to understand what forced the well diggers to excavate the wells (climatic, political, ecological, or cultural causes). If the hypothesis of desiccation holds true, why did they not migrate to neighbouring regions more reliably endowed with surface water.

7. Notes

[1] Juuti *et al.*, 2007: 4; Tvedt, 2010.
[2] See Davis-Salazar, 2006; Lightfoot, 1996*a*, 1997 & 2000; English, 1968.
[3] Kreike, 2004: 9-16.
[4] Potkanski & Adams, 1998.
[5] Burmil *et al.*, 1999.
[6] Cowal *et al.*, 1997, Lightfoot, 2000; English, 1968; Burmil *et al.*, 1999; Garcia, 2007: 427.
[7] Goodall, 2008; Tvedt & Oestigaard, 2010.
[8] Juuti, 2007: 17.
[9] Ibid.
[10] Jacobs, 2003; Crumley, 1994.
[11] Steinberg, 2002.
[12] Mosley, 2006.
[13] Beinart & McGregor, 2003: 4-5.
[14] Beinart & McGregor, 2003: 5; Mosley, 2006.
[15] Mosley, 2006; Beinart & McGregor, 2003*;* Steinberg, 2002.
[16] Fay. 2003; Haberle & Lusty, 2000.
[17] Tvedt, 2010.
[18] Mosley, 2006.
[19] Semali & Kincheloe, 1999.
[20] Inglis, 1993.
[21] Mosley, 2006; Beinart & McGregor, 2003.
[22] See discussions by Jacobs, 2003; Anderson, 2002.
[23] Coppock, 1994.
[24] Oba *et al.*, 2000.
[25] Oba *et al.*, 2000; Cossins & Upton, 1987.
[26] Coppock, 1994.
[27] Ibid.
[28] Cossins & Upton, 1987; Helland, 1980.
[29] Coppock, 1994.
[30] Coppock, 1994.
[31] Helland, 1980; Coppock, 1994.
[32] Detailed discussions can be found in Buxton, 1949; Hodson, 1927; Donaldson-Smith, 1897; Watson, 1927; Aylmer, 1911; Maud, 1904.
[33] See Cossins & Upton, 1987; Helland, 1980; Watson, 2003.
[34] Helland, 1980.
[35] For further information on human adaptation to water deficient regions, see Kassas, 1978.
[36] Bassi, 2005; Coppock, 1994; Helland, 1980; Oba, 1998; Cossins, 1983.
[37] Oba, 1998.
[38] Bassi, 2005; Cossins, 1983; Oba, 1998.
[39] See Paper IV in this thesis.
[40] Oba, 1998; Helland, 1980.
[41] The symbolic roles of the *tula* wells are detailed by Dahl and Megersa, 1990.
[42] Legesse, 1973: 43-50, 87.
[43] Legesse, 1973: 87.

[44] Legesse, 1973: 43-50.
[45] Beinart & McGregor, 2003.
[46] Baxter, 1978; Helland, 1980 & 1998; Legesse, 1973; Coppock, 1994; Bassi, 2005; Oba, 1996; Kamara *et al*., 2004.
[47] English, 1968; Lightfoot, 2000; Wittfogel, 1957.
[48] For more detail see the three analytical layers of water systems by Tvedt, 2010.
[49] Calvo-Iglesias *et al.*, 2006.
[50] Ibid.
[51] Degraft-Hanson, 2005: 459.
[52] Carl O. Sauer, quoted by Ingerson, 2000.
[53] UNESCO, 2008.
[54] Farina, 2000: 313.
[55] Farina, 1998.
[56] Tvedt, 2010.
[57] Moreira *et al*., 2001: 557.
[58] Marcucci, 2000; Wood & Handley, 2001.
[59] Bassett & Crummey, 2003; Little, 2003.
[60] Antrop, 2005.
[61] McCann, 1999.
[62] Degraft-Hanson, 2005: 459*;* Kristensen *et al*., 2004.
[63] Rohr, 2003.
[64] Berkes, 2007: 284.
[65] Oliver-Smith, 1996: 303-328; Schwab *et al.*, 1998; Cannon ,1994: 13-30; Hewitt, 1998.
[66] Nel & Righarts, 2008.
[67] Dombrowsky, 1998; Oliver-Smith, 1996.
[68] Carr, 1932 quoted in Dombrowsky,1998.
[69]Cannon, 1994: 13-30; Wisner *et al*., 2004; Cutter *et al*., 2003: 242-45.
[70] Cutter *et al.*, 2003: 242-45.
[71] Berkes, 2007: 284 ; Burg, 2008: 609-630.
[72] Flint & Luloff, 2005.
[73] Fernandez-Gimenez, 2000.
[74] Olsson *et al.*, 2004: 76.
[75] Davidson-Hunt, 2006.
[76] Ibid.
[77] Legesse, 1973; Baxter, 1978; Helland, 1998.
[78] Helland, 1998.
[79] Legesse, 1973.
[80] Legesse, 1973; Kjaerland, 1977.
[81] Legesse, 1973.
[82] See Legesse, 1973 for details on the *gada* and classification systems.
[83] Legesse, 1973. See Paper I of this thesis for the detail.
[84] See Paper I of this thesis & Legesse, 1973: 184-195.
[85] Megersa & Kassam, 2005.
[86] Ibid.
[87] Legesse, 1973: 194.
[88] Legesse, 1973.

[89] Hammond, 1967: 36-43; Eadie & Oleson, 1986: 53; Lightfoot, 1996*a* & 1997; English, 1968; Lightfoot, 1997; Scarborough, 1998.
[90] Cowan, 2007.
[91] Kummu, 2009.
[92] Cowan, 2007; Lightfoot, 1997 & 2000; English, 1968.
[93] Lightfoot, 1996*a.*
[94] Ibid.
[95] Wittfogel, 1957; English, 1968.
[96] See English, 1989; Lightfoot 1996*a* for *qanats*, and this study for Borana *tula* wells.
[97] Lightfoot, 1996*b* & 2000.
[98] Kobori, 1973.
[99] English, 1968.
[100] Clark, 1944: 5-7.
[101] Oldfather, 1935, quoted in Eadie & Oleson, 1986.
[102] Allen, 1993: 22.
[103] English, 1989.
[104] Terkenli, 2001.
[105] Fleuret, 1985.
[106] Ron, 1989.
[107] See Wittfogel, 1957; Scarborough, 1998; Lightfoot, 1997; Lambton, 1989.
[108] Lightfoot, 2000.
[109] Bonine, 1989: 35-58.
[110] Lightfoot, 2000.
[111] Ron, 1989: 211-236.
[112] Hammond, 1967.
[113] Clark, 1944: 1-15.
[114] Ibid.
[115] Lightfoot, 1996*a*, 1996*b*, 1997, 2000.
[116] Lightfoot, 1996*a.*
[117] Lightfoot, 1996*a*& *b*; Beaumont, 1989: 13-32.
[118] Lightfoot, 1996*a* & *b.*
[119] Lighfoot, 1996*b.*
[120] Wittfogel, 1957; Scarborough, 2003; Scarborough, 1993; English, 1968; Erickson, 1993; Lightfoot, 1996*a*, 1997& 2000.
[121] Wittfogel, 1957.
[122] Wittfogel, 1957, 50-53.
[123] Erickson, 1993.
[124] Lightfoot, 1996*a*, 1997 & 2000.
[125] English, 1968.
[126] Scarborough, 1998 &1993.
[127] Garcia, 2007: 411-428.
[128] Tucker *et al.*, 2007; Ortloff, 1993: 327-368; Scarborough, 2003.
[129] Lightfoot, 1996*a.*
[130] Widgren & Sutton, 2004 .
[131] Erickson, 1993; Scarborough, 1993.
[132] Widgren & Sutton, 2004.

[133] Petrzelka & Bell, 2000 .
[134] Garcia, 2007.
[135] Mirumachi &VanWyk, 2010.
[136] See Östberg, 2004: 19-48 on Marakwet; Sutton, 2004 on Engaruka; Helland, 1980; Coppock, 1994; Oba, 1998; Bassi, 2005 on Borana, and Watson, 2004: 49-67 on Konso.
[137] quoted in Helland , 1980.
[138] Donaldson-Smith, 1897: 186. The ancient Egyptians used simple tools such as hand metal bars and stones for cutting rocks and breaking them when building the pyramids, see El Salam 2002, 295.
[139] Watson, 1927: 50-51.
[140] Helland, 1980; Legesse, 1973; Cossins, 1983; Leus & Salvadori, 2006.
[141] Aylmer, 1911. Some oral historians do not believe that *tula* was originally dug by Warda. However, they acknowledge that Borana displaced Warda.
[142] Maud, 1904.
[143] Buxton, 1949.
[144] This is explained by Borana as "*Waaqi looni tula-Wardeeni qote*-the God of cattle, the Warda Oromo dug the *tula* ".
[145] See Paper I in this thesis
[146] Wilding, 1985; Oba, 1996.
[147] The earlier groups included Abroji, Dawwe, Suuftu, Xaasa, Xaaya, Warda, Duubara, Arsi and Laikipia Maasai. *See* Leus & Salvadori, 2006.
[148] Wilding, 1985.
[149] *Baqassa* refers to wide passage that cuts through limestone. Animals move down to watering trough through this passage.
[150] Legesse, 1973.
[151] Legesse, 1973; Bassi, 2005.
[152] Bassi, 2005.
[153] See Paper IV in this thesis on labour organization and the need for cooperation.
[154] Lightfoot, 2000; English, 1968; Kobori, 1973; Scarborough, 1993 & 1998; Ashmore, 1984; Garcia, 2007.
[155] Garcia, 2007.
[156] Ibid.
[157] See Clark, 1944 for Nabataeans, and Hodson, 1927 for the Borana.
[158] Shaw, 1984.
[159] Lambton, 1989: 5-13.
[160] Hodson, 1927: 57.
[161] Burmil *et al*., 1999.
[162] Lightfoot, 2000; Scarborough, 1998.
[163] Hughes, 2008.
[164] Swetnam *et al*., 1999; Mosley, 2006; Steinberg, 2002; Anderson, 2002; Beinart & Coates, 1995.
[165] Beinart, 2000: 269.
[166] See Haberle & Lusty, 2000; Hughes, 2008; McCann, 1999.
[167] Hughes, 2008.
[168] Cronon, 1992.
[169] Mosley, 2006.
[170] Carruthers, 2002; Cronon, 1993.
[171] Steinberg, 2002, Mosley, 2006; Spear, 1981; Hughes, 2001; Kreike, 2004.
[172] Mosley, 2006.
[173] Pankhurst, 1985; Anderson & Johnson, 1988.

[174] Tiki & Oba, 2009.
[175] Edwards, 1998: 119-120.
[176] Short, 1984: 711.
[177] Axelrod *et al*., 1999: 32.
[178] Pickett & White, 1985; Marcucci, 2000; Wood & Handley, 2001; Bassett & Crummey, 2003; Little, 2003.
[179] See Butzer, 1971 for the details of climatic data of Ethiopia and the region for this particular period.
[180] Kjekshus, 1996; Davis, 2001; Pankhurst, 1985; Kreike, 2004; McCann, 1999.
[181] Koponen, 1996.
[182] Anderson & Johnson, 1988.
[183] For the critic, see Weiss, 1998; Spinage, 2003.
[184] Tiki and Oba, 2009
[185] Kjekshus, 1996; Giblin & Maddox, 1996; Kreike, 2004.
[186] Kjekshus, 1996; Giblin & Maddox, 1996; Kreike, 2004; Connah, 2001:269.
[187] Pankhurst, 1985; Sinclair & Griffith, 1979.
[188] Hewitt, 1998; Cannon, 1994: 13-30.
[189] Wisner *et al*., 2004.
[190] Cutter *et al*., 2003: 242-45.
[191] Eakin & Luers, 2006.
[192] Eakin & Luers, 2006; Flint & Luloff, 2005.
[193] Cutter *et al*., 2003: 242-45.
[194] Hartwing & Patterson, 1978.
[195] Berkes, 2007: 284; Burg, 2008: 609-630; Cannon, 1994: 13-30; Wisner *et al.* 2004.
[196] Colten & Sumpter, 2009.
[197] Schwab *et al*., 1998; Cannon, 1994; Hewitt, 1998; Flint & Luloff, 2005.
[198] Anderson & Johnson, 1988.
[199] Sen, 1981.
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Part B

Paper I

Reconstructing the impact of disasters on the *Tula* well cultural landscape in Southern Ethiopia, 1560–1950

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ABSTRACT

This article attempts to reconstruct the impact of disasters associated with floods, droughts, famine and epidemics, as well as social disturbances on the ancient *tula* well landscapes in Borana, southern Ethiopia. We used the *gada* timelines of the Borana Oromo to reconstruct impacts of environmental and socio-political disturbances on the cultural landscapes of the ancient *tula* wells from about 1560 to 1950. Using chronologies of *gada*, the concepts *dhaaccii* (event-repetition), *maqabas* (cyclical names), and *gogessa* (patri-class), we dialogued oral historical memories of the society on epidemics, heavy rainfall, droughts, famines, and socio-political disturbances. To corroborate the oral history of the impact of environmental and social disasters on the cultural landscape of *tula* wells, we used proxy data on Nile floods and regional climatic problems that showed positive correspondence with those events reconstructed using oral sources. The findings showed that disasters induced the collapse of the wells, pastoral economy and human demography, disrupting the social institutions that are crucial for the functioning of *tula* wells. The returns of the disturbances were correlated with the Borana oral historical returns – *maqabas*, showing clear memories of the disasters on the *tula* well landscapes that have been stored within the society for nearly five centuries. This unique system of time recall could be used for reconstructions of environmental and social changes with great reliability.

KEYWORDS: cultural landscape, environmental history, water system, climatic history, Horn of Africa

In this article our use of the term 'disasters' as drivers of environmental and social change needs to be qualified at the onset. As used in this article, we are referring to major disturbances of the environment and the society associated with floods, droughts, famine, epidemics and social conflicts, all of which disturbed the proper functioning of the environment and human survival. Blaikie and colleagues define disasters as "interactions between extreme natural events and vulnerable human population", whereas Axelord and others describe them as "…forces that disrupt the communities they strike".[1] The definitions imply that understanding the impact of disasters on environment and society requires examining the interdependence of natural and social environments, both in terms of vulnerability to hazards and responses to disasters.[2] The impact of disasters and socio-political disturbances on key ecosystems and human demography can be reconstructed using an environmental and social history approach, by relating the dynamics of historical processes to social and economic responses to disasters and socio-political disturbances.[3] The responses may be examined across space and time by integrating environmental and cultural disturbance gradients that cause disasters.[4] Disturbances vary in intensity, frequency, spatial coverage, and extent of damage to the environment and the society they strike.[5] Whites and Pickett defined disturbance as "any relatively discrete event in time that disrupts ecosystem, community or population structure and changes resources, substrate availability, or the physical environment".[6] While this definition refers to natural disturbances, in the context of this article, we have applied the definition in addition to socio-political disturbances which influenced the social system and weakened human capacity to manage the environment. The socio-political perspectives, which include human adaptive strategies and response to disturbances, assist in understanding the impact on the environment and society.[7] However, there is a dearth of research aiming to understand the impact of disasters and socio-political disturbances on human environments, such as ancient water systems on which humanity across the globe have relied for as far back as human-environmental history goes.

This is particularly relevant in arid lands where water is one of the scarcest natural resources. In this article we are interested in ancient human-managed water landscapes. The readers of environmental history are familiar with such ancient water systems as the Mayan (Amazonia), Nabataean (Middle East), *Qanat* (Arabia), *Khettara* (North Africa), *Karez* (Central Asia), Engaruka and Sonjo in East Africa, that facilitated the settlement and exploitation of arid lands during the first millennium BC. These water systems continue to interest researchers.[8] This is particularly so from the perspectives of environmental history, because these ancient water-cultural landscapes have left behind cultural and environmental

'fingerprints' that assist environmental historians to reconstruct past environmental and social changes.[9] This interest in environmental finger-printing is demonstrated by research synthesis such as that recently done by Westernberg and colleagues in the case of the Engaruka in northeastern Tanzania, where the scholars used archeological, climatic and environmental data to reconstruct environmental change from the 13th century.[10] It is, however, rare for scholars to utilize oral sources combined with proxy environmental data to reconstruct past perturbations of the environment. The work of Webster and his contributors on the East African lacustrine environmental history may be unique in this regard. We regard this work as unique because of their impressive empirical presentations of chronologies on the complex relationships between migration and droughts and the society of the interlacustrine region of Africa, clearly showing the links of the drivers of migration to the larger proxy environmental data, such as the measurements of the Nilometer.[11]

In this article, we discuss the environmental and social history related to disasters (epidemics, droughts, floods and famines) and socio-political disturbances (social disharmony, disunity, conflicts) within the cultural landscape of the ancient *tula* well clusters in southern Ethiopia. The *tula* well system, although not widely known, is very old; it has been used for providing water for people and cattle in the region for more than 500 years. The wells are unique archaeological features of pastoral land-use. There are greater concentrations of similar well clusters in southern Ethiopia, north-eastern Kenya and the Trans-Juba region of Somalia.[12] The ancient wells are products of the indigenous water-engineering technology used to exploit underground water aquifers for purposes of livestock and human use. The result is a specialized cultural landscape set within the matrices of grazing lands in the African savanna ecosystem. The construction of the ancient well system was probably an adaptive response to environmental desiccation in the Horn of Africa.[13] The *tula* wells are a key resource that influenced not only resource-use patterns in the region, but also the socio-political organization of the society, and was reciprocally influenced by socio-political systems.

The ancient *tula* well cultural landscape bears imprints of past disasters that have been etched on the memories of the inhabitants. The relationship between humans and nature within the context of the *tula* well system therefore provides the basic theoretical framework for analyzing 'recurring themes' that in turn influence the society's responses: the risks of environmental disasters, human and livestock demographic collapses, the use and disuse of wells, droughts, famines, epidemics, and social disorganizations. When epidemics and famines induced the collapse of the pastoral economy and human demography, the human

stewardship lapsed, and numbers of wells fell into disuse, while economic and demographic recovery were followed by restoration of the wells.[14] The socio-political disturbances affected social institutions that mobilized resources and labour, the crucial inputs for the functionality of the water system. In the context of *tula* wells, the Borana expect the cyclical recurrence of events (epidemics, droughts, excessive rainfall etc.), due to the presumed mythical influence of the past on the present and future course of history (see section on *gada* timeline). Understanding these historical events and their cyclical occurrences is crucial for reconstructing the historical past, as well as environmental and human population and political perturbations within the *tula* well ecosystem.

We lacked previous studies that examined the impact of environmental disasters and socio-political disturbances on the cultural landscapes of *tula* wells, human demography and livestock population. There was also very little information regarding how the society around the *tula* well system remembered and explained the impact of disasters on the *tula* wells, pastoral economy, and human demography. This was due to the absence of an appropriate methodological approach that could integrate environmental and social history in the absence of archival or archeological documentation.

Our interest in reconstructing the impact of disasters on the cultural landscape of *tula* wells was caused by a wish to know whether the society of the *tula* wells had developed memories of the past disturbances, and how they remembered them. In so doing we are seeking a methodology for recording how the society around the *tula* well system remembers and explains the impact of disasters on the *tula* wells, pastoral economy, and human demography. Reconstruction of the complex human-environmental disturbances in the *tula* well cultural landscape involves framing the research within multilayered historical analyses. This requires an interdisciplinary methodological framework that utilizes historical narratives of the society's responses to environmental risks, in order to comprehend environmental and social responses to disturbances over several centuries.[15] The risks of disasters may be local, but they must be analyzed within regional contexts so that they can be corroborated using regional environmental proxy data.[16] In this article we have used the regional rainfall and reports of Nile River floods.

We asked the following questions*:* How do the Borana remember and narrate historical events of past disasters? What time-reckoning systems do they use for measuring returns of historical environmental and socio-political disturbances? What do they remember about the ancient diggers of the *tula* wells? What major natural disasters and socio-political disturbances occurred in the *tula* well ecosystem during the last five centuries? How did the

disasters influence the dynamics of ancient *tula* wells' cattle economy and human demography? To what extent do they relate social-political disturbances to the collapse and disuse of the *tula* wells?

The article is divided into seven sections. The first section discusses a general methodological framework for reconstructing the impact of disasters on the cultural landscape and the *gada* timeline, used by the Borana to reconstruct historical events and to measure returns of similar events. Section two provides a background to the study area and methods of data collection. This is followed by discussions on the origin of the ancient engineers of *tula* wells in section three. In section four, we present *tula* wells cultural landscape dynamics. Section five discusses human and livestock population collapses. Section six presents the impact of socio-political upheaval. The last section is the conclusion. We begin with a methodological framework for reconstructing historical timelines using oral history.

FRAMEWORK FOR RECONSTRUCTING A HISTORICAL TIMELINE

The use of oral history for developing timelines of historical events is well established among African societies.[17] Oral histories serve as memory stores for the economic, social and political institutions that shape human-environment interactions and a community's worldview in general.[18] Miller suggests that oral narratives make up a 'chain of transmission' using social forums such as night-time stories, ritual performances, initiation ceremonies, and social gatherings, in addition to daily interactions.[19] Certain historical events such as famine and epidemics become reference points in time.[20] Events that have a severe impact on human demography and the wider economy are remembered more clearly than localized events. Major historical events that are socially, economically, politically and environmentally significant are recorded mentally by oral historians, and summarized and compressed into forms that enable narrators to memorize and narrate them easily.[21]

According to Goodall, oral history not only constitutes information and knowledge that enable researchers to understand the past, but also reveals the ways that society in general, and narrators in particular, represent the past.[22] Fadiman emphasizes the importance of oral historians such as old people, as sources of knowledge, likening them to 'public libraries'. He equates the death of an old man in Africa to the loss of a library to a society.[23] Despite the crucial role oral history plays in reconstructing the past, Miller cautions environmental historians to examine how oral historians construct narratives and present evidence, and to be

mindful of the procedures they follow for representing historical events, in order to minimize deliberate fabrications and biases in their own reporting.[24]

In non-literate societies in Africa, the chronologies of historical events are remembered with reference to socio-political structures such as lists of kings or chiefs, putting oral narratives into a time frame.[25] Webster notes the importance of correlating oral history using generation sets, king lists and dynasties.[26] Some historians stress the importance of sequences of events in minimizing chronological disordering when correlating events and the exact time they occurred.[27] Oral information can be corroborated by proxy data such as regional climatic data on changes in lake levels, periods of extreme wetness and drought, and other formal statistical records of famine or human and livestock epidemics. For example, records from the oldest existing environmental proxy data system, the Nilometer (which records water levels in the Nile River), are widely used to reconstruct an overall understanding of environmental history in the Nile basin region.[28] Oral historical data from the interlacustrine region of East and Central Africa has been tested for accuracy, using the Nile flood data.[29] Noting the shortcomings of each method, scholars agree that the use of a combination of techniques (oral and proxy data) is vital in reconstructing the impact of disasters in the past. As about 80% of the water in the Blue Nile comes from the Ethiopian highlands, the record of Nile River floods is important for corroborating oral records of regional wet periods (which correspond to high Nile floods) and droughts and famine (low Nile floods).[30] In this article, we have utilized the Borana Oromo time-recall system, hereafter referred to as '*gada* timeline', for reconstructing the impact of environmentally and socially induced disasters, and cross-checking the oral sources with proxy environmental data.

The gada *timeline*

The Borana *gada* timeline is based on the system of social organization and transfer of power between the five groups or patri-classes called *gogessa,* into which the society is divided. The transfer of power is based on regular fixed terms of eight years (the length of time each *gada* lasts) across the five *gogessa* (see Tables 1 and 2), each *gogessa* returning to power every 40 years, hence 8 years for each *gada* x 5 *gogessa*.[31] In case of disruptions caused by natural disasters, socio-political disturbances, or the death of the incumbent leader, the replacement leadership would be in place only for the time remaining for that specific *gada*. This meant that the incoming leader (*abba gada*, or father of *gada*) would hand over the office to the next *luba* class without deviation from the original timetable.[32] This regular power transfer makes

the *gada* timeline less susceptible to telescoping than the lists of kings used elsewhere in Africa.[33] According to Legesse, *gada* is a socio-political concept that "incorporates all history and the total cognitive framework which historical processes unfold", which suggests that *gada* serves as a societal memory of the past and it 'predicts' the future.[34] Legesse describes *gada* as a social engine that drives events in Borana by means of groups of different generation classes (*luba*).[35] Few African societies have such a structured knowledge of time as the Borana system of ordering their history, perhaps making them unique. This is what Legesse terms "the most ingenious creations of the Boran mind" that have "proven to be rich and highly systematic". He says "the techniques of time reckoning promised to be one of the most sophisticated systems devised by man". Legesse is of the opinion that the Borana system is one of the few indigenous institutions identified so far, that provide comprehensive understanding of the relationships between time and human society, which suggests that the Borana are remarkably aware of time and history, despite such history remaining largely oral.[36] Kjærland, a missionary who lived among the Borana for more than 20 years, reports: "Since they have their past in 8 years cycles and attach the story to the names of the *abba gada*, it is possible to find out when events took place". Tracing back the name and years of each *gada*, Kjærland argues that reconstructing events back to at least 1552, is possible with precision. Using oral history, he has reconstructed *gada* cycles even further back, to 1416.[37] Wilding, too, notes that *gada* is an important tool in reconstructing events using oral history.[38]

Oral historians and members of society reconstruct historical events and establish the chronology using three interconnected concepts, which they refer to as *gogessa*, *maqabas,* and *dhaaccii,* for understanding time.[39] In the context of the *gada* calendar, the Borana might interpret events roughly as follows: The *gada* timelines are similar to a clock hand counting time by means of notches at eight-year intervals. The 'jump' from one notch to another may include major environmental, social, political and economic disturbances that leave imprints on the *gada* history. These ecological and social triggers might occur during a particular *gada* or within the cycles of *gada* time (namely 8, 16, 24, 32 and 40 years). When the clock circles back to the starting point and the same *gogessa* returns to power, a return of similar events is expected (*dhaaccii*). [40]

Table 1: Schematic representation of time chronology of *maqabas* (a-g), *gogessa* (A-E) and their corresponding *gada* class (1-74 *gada* periods), modified from Legesse (1973:193).

A	B	C	D	E
74a	73b	72c	71d	70e
69f	68g	67a	66b	65c
64d	63e	62f	61g	60a
59b	58c	57d	56e	55f
54g	53a	52b	51c	50d
49e	48f	47g	46a	45b
44c	43d	42e	41f	40g
39a	38b	37c	36d	35e
34f	33g	32a	31b	30c
29d	28e	27f	26g	25a
24b	23c	22d	21e	20f
19g	18a	17b	16c	15d
14e	13f	12g	11a	10b
9c	8d	7e	6f	5g
4a	3b	2c	1d	

The lower case letters (a-g) refer to the seven *maqabas* (cyclical names) and how they repeat themselves. According to Legesse (1973), there is no first or last *maqabas*, but the order of arrangement is important. The current *abba gada* is number 70 and his corresponding *maqabas* is represented by *e* (*makula*). Based on this starting point, we can represent each letter by respective *maqabas* as a = *libasa*, b = *darara*, c = *mardida*, d = *fullasa*, e = *makula*, f = *moggasa*, and g = *sabbaqa.*

Table 1 shows the interconnectedness of the three concepts of the Borana time-recalling system. The relationship between *gogessa* and *maqabas* can best be explained by examining the schematic *gada* chronology (Table 1; see also Legesse's *Gada* Table 7-2: 193). In Table 1, the numbers at the top (71-74) represent the future or incoming *gada,* and the ones at the bottom (1-69) represent the old *gada*. The current *gada* is represented by the number 70. Columns A to E denote the five *gogessa*. The cyclical names – *maqabas* – are represented by the letters *a-g* in the columns, and the numbers they are associated with represent the time when the particular *gada* was in power.[41] The seven *maqabas* rotate among the five *gogessa* in a regular manner, 1st, 8th, 15th, 22nd, etc. This means that *maqabas* return to *gogessa* every 35th *gada,* and it is expected that what happened 280 years ago (i.e. 35*8 years) will be replicated when the same *gogessa* was in power (Table 1). For example, 35e refers to the 35th *gada,* linked to a *maqabas* called *makula*, which refers to the *gada* of Dhadacha Robale (1728–1736). That particular *maqabas* returned to the same *gogessa* 280 years later (35 * 8) when Guyo Goba (2008–2016) was inaugurated (70*e* in Table 1). The repetition of events is termed *dhaaccii* (persistent influence on the present and future).[42] The use of these three concepts assists not only to place historical occurrences into particular times, but also to narrate them chronologically. This provides a suitable methodological tool for reconstructing

the impact of disasters and the social, economic and institutional responses in the *tula* well cultural landscape within a wider time frame, in terms of frequency, intensity and socio-political ramifications. In the next section, we present a background to the *tula* well cultural landscape and discuss how the methods of the *gada* timeline were applied for collecting data for reconstructing the impact of environmental disasters and socio-political perturbations on the *tula* cultural landscape.

BACKGROUND TO THE *TULA* WELL CULTURAL LANDSCAPE

The *tula* well clusters in southern Ethiopia and their associated grazing lands cover 25,000km^2. The region is characterized by erratic and unpredictable rainfall, frequent droughts, and the absence of permanent surface water.[43] The rainfall cycle is bimodal, with a higher rainfall season occurring from March to May (60–70%), and a lower one from October to November (30–40%).[44] The rest of the months are dry. The mean annual rainfall ranges between 400 and 700mm.[45] The climatic variability, unpredictable rainfall, and the lack of permanent surface water necessitated the development of *tula* well system. The *tula* wells are found in limestone bottomlands, while the *adadi* (shallow) wells are excavated in sandy riverbeds or sunk in the bottom of volcanic craters.[46] The *tula* wells are the most reliable source of water during the long dry season.[47] *Tula* wells are the last fallback for regional human and livestock populations during severe droughts, providing over 90% of the permanent water in the region.[48]

The *tula* well cultural landscape has been the centre of important pastoral production for centuries. Donaldson-Smith, who passed through the area in the 1890s, referred to the well system as "very remarkable",[49] while Buxton states that "these wells are among the most remarkable things … to have been dug in a distant past". He continues, "We found a great cutting, apparently artificial, leading down into the ground …. At the foot of the cliff where this little ravine ended was the head of the well itself – a narrow opening in the rock. The rest of the shaft could not be seen, for these wells take many twists and turns in the ground before reaching water-level".[50] Maud is of the opinion the excavators were "civilized and energetic".[51] The ancient engineers of this water system are known for their considerable engineering acumen (see later section).[52]

The *tula* wells are not only hydrological systems in a water-scarce landscape but also significant places of human habitation, and they acquire a symbolic importance in ritual performance.[53] The wells are invoked in political debate, ritual and cultural practices, as well

as religious blessings. They are the focus of social and political organization[54] They are connected to human and livestock fertility, continuity of lineages, and the peace of Borana (*nagaa* Borana), creating a strong environmental and pastoral ideology.

The wells are essential for exploiting the surrounding grazing lands, which would otherwise be useless to the society. Therefore, as far as the Borana perception of the environment is concerned, there is no question that the grazing lands, the functionality of the *tula* wells, and the sustainability of the pastoral economy, are inextricably linked. In this respect the Borana are similar to other ancient societies that relied on the development and maintenance of the specialized water systems necessary for human subsistence in arid areas.[55] This knowledge, often recalled in the context of disasters that disrupted the functioning of *tula* wells, has enabled the Borana oral historians to narrate the dynamics of *tula* well cultural landscape. In interpreting the oral data, we critically followed the schematic of time recall developed in Table 1.

Methods of Data Collection

This research was conducted between June 2007 and August 2008. The fieldwork focused on six of the nine *tula* well clusters – Web, Erdar, Melbana, Dhas, Gayo, and Dubluq (Fig. 1). To reconstruct past environmental and social history, we used key informants' interviews and group discussions. We interviewed at least ten key informants per well cluster. All the key informants were individuals acknowledged by the society to be knowledgeable oral historians. Among them were the *abba gada*, and a renowned oral historian, Borbor Bule, who in Vasina's terms, can be considered as the societal librarian. [56] The interviews mostly took place at encampments (*olla*) and the well clusters (n = 60). All the participants were aged over 50 years. We also conducted two group discussions per cluster.

The returns of historical events during previous centuries were reconstructed with the help of these oral historians. The discussions covered major natural disasters (e.g. droughts, epidemics, famines, flooding), and socio-political disturbances (e.g. social disharmony, conflicts) that had impacts on the management of the *tula* well system and the cultural landscape. The name of the *abba gada*, the events that occurred during particular *gada* periods, and the associated *gogessa* and *maqabas* were frequently repeated to guide the discussions and check consistency. The occurrences of events (such as droughts and epidemics) were cross-referenced using *gogessa* and *maqabas,* and recorded by oral historians

as *dhaaccii* of *gada* 'X' (see section on *gada* timeline). Information from key informants that was deemed inconsistent or lacking adequate clarifications was clarified at group discussions.

Fig 1 here

In the group discussions, general questions were posed, followed by more specific questions. The interviewer might interrupt saying, "Let us return to this earlier point made by X or Y" and so on, while an informant who wanted to make additional points would say, " I am left with another word…" and he was given the floor. In cases where some of the participants did not know about time-depth, others with more information would intervene. The events remembered were both local and regional. For local events, place names, key personalities involved, and social and political events were used in the metanarratives. Using these cues, the informants covered major environmental and socio-political disturbances.

All the discussions were recorded on tape with the knowledge of the informants. We applied their terminologies to ask more questions until a comprehensive catalogue of information emerged, when we felt that we were able to answer the questions raised in this study. We were, however, flexible in the discussions, without following any strict order or questions. Rather, as already stated, we tended to be guided by the issues raised in the discussions, and allowed each to be followed up when the subject was related to the study questions. In each case, we asked participants in the group discussions to describe major environmental changes in accordance with *gada* timeline.

In certain cases we posed hypothetical questions such as "Who were the engineers of the *tula* wells?", realizing that the digging of such an extensive water system probably used rudimentary tools that left many questions unanswered the societal perception was critical. These were important areas of future research, for which our responses offered only tentative explanations. We separated the information into what might be mythology but supported by other historical sources from the ethnogenesis of the region, perhaps earlier than the 15th century.[57] Another topic was systems of labour organizations that could have realized such massive human investments of time and resources. We examined different possibilities including those used at present, as well as possible previous systems of labour for well excavations on such a large scale.

The Borana oral historians are real experts in reconstructing returns of historical events based on the schematic framework we presented in Table 1. Throughout the interviews that we conducted, we made every attempt to understand how the system worked. We tried to

determine which of the seven cycles (*maqabas*) corresponded to which major environmental and socio-political disturbances narrated by the informants. We tested the hypothesis that events repeated themselves (*dhaaccii*), as believed by oral historians, in accordance with the *gogessa* and *maqabas* of the *gada* cycles (see Table 1). From the evidence, it was possible to show that most of the natural and socio-political events listed by oral historians under the respective *maqabas* and *gogessa* appeared to replicate themselves, albeit not as regularly as suggested. We further evaluated the reliability of oral information using the repeatability of environmental and social shocks that corresponded with a *gogessa,* by considering the totals of disturbances repeating the cycles in the returns of 40, 80, 120, …260, 300. We used frequencies with which a particular historical event of major importance was reported, and by what number of informants. Using this as an index, we calculated the reliability of social memory. All the changes described were categorized in terms of the dynamics of the *tula* well cultural landscape.

For the periods of the late 19th century, we used reports from European travellers whose experiences provided valuable glimpses of the changes described by the Borana. However, where the Borana described major droughts and famine that killed human and livestock populations, we assumed that these reflected the regional status of the climate, and therefore cross-checked with proxy data in written reports and records in the region (see Table 2). In this regard, we were looking for evidences such as dropping lake levels and lowered Nile floods based on the Nilometer. We should, however, caution our readers that the Borana classification of environmental changes always came from the perspectives of pastoral production. Thus, periodic collapses of human and pastoral production resulted in dramatic environmental transformation that, according to the Borana, changed from the most desired open savannas to bushy thickets. However, by far the most elusive discussion was that on the subject of the ancient well diggers. We suspect that this is not a subject that the society in general is willing to discuss openly, but from the initial information, this could be an interesting subject for future archeological, historical and anthropological research.

THE ANCIENT WELL ENGINEERS: WHO WERE THEY?

A fundamental question that needs answers is: who were the ancient well engineers, and how did they mobilize the immense amount of labour needed to excavate such unique archaeological feats? The Borana explanations of how the ancient well diggers managed to cut wells into solid rock ranged from myth to the possible organizational capacity of a

pastoral society. However, both cases were little understood. In our interviews, we came across information which, with the limited data we have, we can only refer to as 'mythology' but that might hold a certain degree of explainable history of the *tula* well engineers. The myths have puzzled even the early European travellers who visited the Borana region in the late 19th and early 20th centuries. They also asked 'who' actually excavated the *tula* wells, and 'how' they did it. Some writers, including Haberland, suggest that the well engineers were ancient megalithic cultures.[58] One of the early travellers, Donaldson-Smith, wrote, "Although I saw no inscriptions, or relics of any kind that might lead me to suppose these wells had been made by the Egyptians,[59] their immense size and the fact of their being cut through rock immersed me with the belief that they were dug by the ancient colonists."[60] C.B.G. Watson, who visited similar wells used by the Borana in northern Kenya, noted the existence of ancient civilizations that were responsible for excavating the wells. According to Watson, the excavators built "extraordinary structures," suggesting that they must have been "immensely numerous and wealthy, clever water diviners, and cunning engineers".[61] Watson, however, expressed some doubts about the peoples with such precise knowledge, but who had "left behind them no trace[s] [of]… bones, implements, or records of any kind… save their feats as water engineers." Watson asked "Who were the people who required this immense water supply obtained by such laborious feats of engineering?"[62]

Another traveller who was puzzled by the engineering skills of the unknown ancient well diggers suggested that the wells were excavated by the Warda Oromo.[63] Other scholars were also inclined to believe that other Oromo groups before the Borana probably excavated the wells.[64] Philip Maud considered the *tula* wells as the legacy of the Warda, as did Leus & Salvadori.[65] David Buxton seems to have been convinced that the ancestors of the present-day Borana excavated the wells.[66] While archaeological investigations might in future provide more scientific evidence on the ancient hydraulic engineers or their mimesis,[67] for the moment the Borana remain evasive in their answers to the questions. Some give a more general answer, saying *itti dhalanne* – "We were born to it", making the excavation timeless and the excavators undefined.[68] Others would give a well-known folk belief about the diggers of the wells as 'the Warda' or even 'the Borana'.[69] The folklore *tula hakhaakhu Goode*, *waaqi looni tula Wardeeni qotee* – *tula* belonging to the ancestors of Goode [name of a family),the god of cattle – "*tula* was dug by the Warda", was repeated by most informants (in group discussions).[70]

The lack of agreement on who the engineers of the *tula* well system arose because of a perception created in the oral history that one ritually more powerful group of Borana,

historically referred to as *Sodom Boro* (the 30 Borana groups) led by Abay Babbo Horro (1664-1672),[71] captured the wells from the Warda Oromo. The same narrative suggests that the *Sodom Boro,* after assimilating the second group of Oromo called *Hero Abba Biya* (who were considered as the real owners of the land and wells, also called *choqorsaa*), took over the wells. The sources suggest that the *Hero Abba Biya* included the clans of the ancient well diggers who, after political assimilation, assumed new clan and social identities from the *Sodom Boro*. What was significant was that these ancient clans had among them people referred to as '*suuftu'* – the sniffers, who were the keepers of the secrets of the wells.

Information from our key informants 'who were parts of the secret society' showed that the knowledge of the ancient well diggers was more complicated. According to these sources, knowledge of the well digging and the rituals had been passed on to the present society, always through elder sons. The evidence was the elaborate rituals and myths associated with the well-digging.[72] We can confirm the existence of such knowledge based on the 'know-how technology' practised by the same society in digging new wells using the designs of the old ones.

In one of the interviews, WT had among the participants an elder to whom he was referred for 'more information'. The interviewer had actually not realized that he was "talking to a member of the secret society of the *tula* wells". But because the whole interview was on the tape, we listened to it again to fill out the scantiness of the information. The informant said, "We are the *suuftu*…we tell where water can be found… but we do not tell this information to everyone…." He evaded the next question on who these individuals were. Instead, he asked, "Did you see the other young man … who was standing nearby us when we were talking? He is my younger son. I do not tell him this hidden knowledge…the person whom I teach is at home now. He is my eldest son. He is the only one [of my sons] who should know the knowledge." WT asked several follow-up questions both in public and in private, even promising that he would turn off the tape. The informant would only add that the information was not for everyone to know.

In a digression manner, the informant continued: "Do you know about *kinisa daamu* (a type of honey bee) that makes tunnels underground to make honey? Does anyone know how they operate and where they come from and where they go? Do you know that you will lose the honey when they shift to other secret chambers when you try to dig them out? Their galleries are linked just like the springs of the *tula*…. We, like *kinisa daamu,* [can] plug them [the wells] if we wish.…" Interpreting the metaphorical language was not straightforward. The implication was that they had knowledge which was not available to others, and perhaps

to maintain their ritual relevance. The 'power to plug the tunnels' in metaphorical language might imply that without their involvement, well diggers would not find the aquifers. According to this key informant, the knowledge about the aquifers of the *tula* well system was kept with individual families, who passed them on to their progeny, always through the first-born sons. These individuals, who were referred to as *reedimeessa* and upheld as ritual performers, were the ones to help the society to locate old and disused wells, as well as knowing where water could be found in case clans planned to dig new wells.

Returning to the above story and using the symbolic language as a cue, we hypothesized that among the Borana were individuals who descended from the clans of the original well diggers, and who, after assimilation, continued to maintain their social identity through secret knowledge. But because they served as essential stores of the technical knowledge and the rituals necessary for the functioning of the *tula* wells, the Borana have continued to rely on them as advisers. Among the individuals were those of Warda ancestry who remained with the Borana, among them being the *suuftu*, who were assimilated into the clans of the Borana.[73]

It should, however, be understood that the history of the different Oromo groups in the region, before the merger of the *Sodom Boro* Borana with the clans of *Hero Abba Biya,* might have been a gradual process of assimilation rather than the appearance of a new political and social entity before the 16th century, when the Borana "shared out the *tula* wells among clans". Cyclical displacement or negotiated co-existence might have culminated in total control of the region by the Borana. From Borana oral history, the Borana drove out *sidii salan* (the nine historical enemies)[74] of whom the Warda were the last to be displaced from the *tula* region.[75] However, there is no oral information whether any of them had controlled the *tula* wells, with the exception of the Warda. The social organization that undertook the digging of such a complex water system also remains vague.

There are three possible viewpoints regarding the social organizations that mobilized labour and resources for digging the well: the organization that relied on age-sets (*hiriya*), the generation class (*luba*), and the Borana clan structure (*gosa*). There is historical evidence that 'age sets' played major roles in the overall socio-political and economic activities of Oromo society as far back as the 15th century.[76] Kalinovskaya, for instance, noted the division of the Oromo society into 'age sets', in which individuals had roles and duties specified for particular ages, as one of its organizing principles.[77] Some of our informants suggested that well-digging could have served as a rite of passage for the Borana age sets. Accordingly, age sets of earlier Oromo groups who occupied this part of the country were obliged to excavate

new wells as a rite of passage, implying that the number of wells excavated would increase steadily over time. Yet even oral sources were quite tentative about this, since the creation of the Borana age-sets which was just a another layer of institutions necessary for the defense of the society, might be a recent creation.[78] Moreover, the Borana age-set system does not have judicial powers beyond the specific cohorts, while the *luba*-generation class cross-cuts age-sets and the society at large.

The second view is that the nature and magnitude of organization corresponded with the *luba*-generation class. In this regard, the *gada* system being the centrepiece of the generation class was likely to play a key role in mobilizing labour. Indeed, it is also the *gada* that had/has the powers on the overall behaviour of young people, including issues such as the appropriate age for marriage, sexual activity, and their availability for labour. This control might have played a major role in the excavation and maintenance of *tula* wells. The *luba*-generation class and the *abba gada* in power discharged their responsibilities through enforcement organs such as *dhibba gada* (the 100 special guards under the direct command of *abba gada*) who were authorized to take measures to force people to participate. They even had the power to invoke the death penalty against 'deviants'. Besides the institutional capacity of *gada* to mobilize labour, each generation class had the obligation to provide their services to the community.

One might then ask whether *gada* was more despotic in the past than it appears to be now. There is certainly evidence that the institution was capable of implementing what was considered important and culturally acceptable, while banning other activities that were considered contrary to cultural traditions. There is oral support for the ability of *abba gada* to mobilize *dhibba gada* against anybody suspected of violating *aadaa seeraa* (customary law). A famous example is that of Jidda Seelee, who tried to introduce cultivation, in contradiction to pastoralism and the established rules of Borana. *Abba gada* mobilized *dhibba gada*, banned cultivation, and severely punished Jidda Seelee and his followers.

The third viewpoint is that well excavation is the function of clans rather than the *gada*. In Borana, clans have the sole responsibility for well management and excavations. The clans using the authority of the *gada* could enforce a contribution of labour and livestock. The Borana have specific viewpoints on different categories of *tula* well landscapes, including both those with ancient and disused wells, and those with active ones.

What physical feature distinguishes tula wells from other types of wells?

We asked the informants which of the well clusters were categorized as *tula salan* (the nine *tula* well clusters). From the field data, it emerged that oral historians disagreed on which well clusters qualified as *tula* and which did not. The disagreement resulted from two main factors. Firstly, there are many disused clusters that are dysfunctional and are not known to have ever been re-excavated. The dysfunctional clusters (referred to as *goof*) include *goof* Xuxo, *goof* Abba Rubbo, *goof* Aba Qalle, *goof* Bosaro, *goof* Walimura, *goof* Wardelle, and Dibbe Waraba.[79] The *goof tula* well system, named after either people or places, were mostly excluded from the list of the nine well clusters.[80] The well system at Dibbe Waraba might, in fact, have disappeared, as all the evidence that remains is a few hillocks which are used by hyenas as dens (the name *waraba,* from the root *warabesa,* means hyena). These rich archaeological structures still remain to be investigated.

Secondly, there are different views on which of the clusters fulfil the criteria for classification as *tula* and *adadi*. The informants listed several characteristics for identifying *tula* wells: the first criterion is that the wells have a ramp left by soil removed during excavations to reach the aquifer. This creates a winding passage of more than 100 metres, which gradually descends into the well chamber (see Fig. 2). The passage (*baqassa*) and the chamber (*madda*) are cut through solid rock, with the actual well chamber reaching down 30–40m below ground.[81] The second criterion is that the water of a *tula* well system is inexhaustible. Accordingly, the recharge of the aquifer maintains a stable water level, although the informants are also aware that in recent decades a dropping water table has caused the disuse of many *tula* wells. Third, all *tula* wells have a *gobso* (embankment). The fourth criterion is that all *tula* wells are found in limestone rocks. Some informants ignored clusters where their water tables fluctuate in response to climatic factors, while others group the nearest clusters together as one.

Figure 2 here

RECONSTUCTIONS OF *TULA* WELL CULTURAL LANDSCAPE DYNAMICS

The *Tula* wells throughout the historical period under consideration fluctuated between collapse, disuse and re-excavation in response to climatic drivers such as exceptionally wet periods and repairs delayed for lack of labour or economic capacity (Fig. 3). Periods of mass

well collapses, if followed by crashes in human demography induced by drought, famine and/or an epidemic that disrupted pastoral economy, would leave the wells in disuse, some finally turning into *goof*. Societal disorganization and political upheavals have sometimes had a negative effect on the maintenance of well systems and in turn the performance of pastoral production (see later section). How reliable was human memory in describing *tula* cultural landscape dynamics?

Figure 3 here

Reliability of human memory

Our findings suggested that the informants had less knowledge of environmental and socio-political disturbances that impacted on the *tula* well cultural landscape dynamics before the 17th century. However, from then until the present, the Borana knowledge of environmental and social disturbances was reliable. Even though most oral historians agree that there have been more environmental and social disturbances in recent years (Fig. 4a), such a trend might be partly attributable to fresh societal memory, the most recent events being remembered better than the older ones. Accordingly, environmental and socio-political disturbances reported by oral historians have shown a dramatic increase in the last 150 years (1860s to the present). This is confirmed by written sources that have shown similar trends.[82] Another important factor may be the intensity of disturbances remembered by oral historians; the most severe disasters, those that caused fundamental changes in the operation of *tula* wells, cattle economy and social systems, were universally remembered.[83] This is mainly due to the fact that change in one of them (such as collapses of the pastoral economy) affects the others (such as *tula* wells) and vice-versa.

In terms of cyclical names (*maqabas*), the findings show that *moggasa* seem to have had more natural and socio-political disturbances (Fig. 4b), followed by *mardida.* The *maqabas* of *makula* experienced fewer socio-political disturbances, while *fullasa* was associated with the least natural disturbances. Oral sources showed that each *maqabas* was associated with particular events (such as drought, epidemics, and excessive rainfall or their absences) that shaped societal memories.

Figures 4a and b

Historically, major environmental disturbances were associated with the use and disuse of the wells. The wells collapsed most often during periods of excessive rainfall. The earliest well collapse occurred in *gada* Biduu Dhuqqee (1568–1576) when there were eight years of heavy rainfall.[84] Regional climate analysis shows that this period falls roughly into what is termed, in Europe, the Little Ice Age (LIA), when the environmental conditions in the Horn of Africa were much wetter than they are today.[85] We have better knowledge of a more recent period when excessive rainfall collapsed most of the *tula* wells during *gada* Ungule Lake Sade (1800–1808). The Borana oral sources explain the event using the phrase *ganna sogaatu mo'a* meaning "the era of Soga is the winner", to refer to severe flood disaster. Oral sources show that 'Prophet Soga', who predicted the excessive rain, was taken by the flood. [86] Proxy data from the Nile shows that there was a high frequency of floods, which implies heavy rainfall in Ethiopia.[87] Another period of well collapses occurred during *gada* Doyo Jilo (1856–64). We do not have precise information on the extent of the damage done to the *tula* wells, but it was recalled that lightning killed many people. This latter incident is said to be the *dhaaccii* of the former, from the perspective of cyclical occurrence of events within *maqabas-mardida* (see Table 2).

The next heavy rain that caused well collapses occurred during the period referred to as *dhuqisa gada* Dida Bitata Mamo (1872–1880) (Fig. 5). The oral historian Borbor Bule believes that the rain during this period was the heaviest ever; causing floods that collapsed the greater majority of the *tula* wells. All the other *libasa* were predicting droughts, famine or war, but in this particular case it returned with heavy rainfall during the *gada* of Bule Dabasa (1928–1936) when floods caused wells to collapse across the *tula* clusters. Another flood disaster was that of *hagaya barba* of *gada* Madha Galma (1952–1960) when heavy rains – probably caused by El Niño – collapsed many wells.[88] The regional climatic data shows high flood levels in the Nile River and a rise in the level of Lake Turkana during these periods, indicating a link to regional climate forces, particularly in Ethiopia.[89] Records show that most of the exceptionally heavy rainfalls were preceded by droughts.[90] This was probably followed by a collapse of the pastoral economy, and delayed the rehabilitation of wells.

The last quarter of the 19th century was a period when the operation of *tula* wells was more under threat than ever. Less than 20 years later, before the Borana were able to restore productivity after the very heavy rainfall of *gada* Dida Bitata Mamo (1872–1880), another serious natural disaster occurred: the Great Rinderpest of *gada* Liban Jaldesa (1888–1896) that decimated the pastoral economy. This *maqabas-moggasa* accurately predicted severe droughts similar to other historical events that returned with this *maqabas*. The period was

followed by a collapse of the cattle economy, which meant that the wells partially rehabilitated during *gada* Guyo Boru (1880–1888) were again lost.[91] There were a number of environmental disturbances associated with heavy rains in the 20th century, such as *bisaan* (floods) of *gada* Bule Dabasa (1928–1936) which we have already mentioned.

Excessive rainfall put wells out of commission. Depending on the extent of the damage, clan-wide organization was then put into action to rehabilitate them. In most cases, only a fraction of the wells were rehabilitated, and the collapsed wells remained dysfunctional. The status of the pastoral economy and human demography were critically important for rehabilitating and maintaining human stewardship of the *tula* wells.

The collapses of wells from flooding, in most cases, were followed by outbreaks of malaria or diarrhea that greatly disturbed human populations. Malaria was a serious problem because it was responsible for huge fatalities that depopulated the region. Heavy rainfall during the *gada* Guyo Boru (1944–1952), referred to as the year of high grass (*ganna misaa*) or the year of white water (*ganna bisaan adii*), did not affect the wells too badly, but it was followed by an outbreak of hepatitis (*birte*). The indication is that disasters influenced the operation of *tula* wells either by collapsing the wells directly (flood), or denying the wells the most important inputs like labour and cattle economy. The findings show a clear relationship between the collapse of wells, the status of the cattle economy, and human demography. Despite repeated disasters and socio-political disturbances, the Borana pastoral system and the institution of *gada* have been resilient in terms of their capacity to absorb shocks and re-organize the society.[92] It is not only the community's vulnerability but also the capacity to respond to disasters that is crucial for analyzing the effects of natural disasters.[93] Human and livestock population collapses delayed re-excavation of wells that had fallen into disuse.

Figure 5 here

HUMAN AND LIVESTOCK POPULATION COLLAPSES

Periodic outbreaks of disease and epidemics, particularly during the late 19th century, decimated human and livestock populations, and disrupted stewardship of the *tula* well system. The collapse of pastoral production resulted in the deterioration of *tula* wells because of the greatly diminished human and economic capacity to maintain them. Thus, a cholera epidemic during *gada* Haro Adi (1864–1872), and the Great Rinderpest *(ciinna*) during *gada* Liban Jaldesa (1888–1896) resulted in the collapse of the pastoral economy, and the

subsequent collapse of the wells in all nine *tula* well clusters.[94] The link between the livestock economy and human demography (and therefore the labour available for operating, maintaining and re-excavating the wells) meant that economic recovery was necessary to restore human stewardship of the wells after each disaster. The responses depended on the extent of the damage caused to the pastoral economy and the status of the social institutions organizing re-excavation.

The Borana at the time of the Great Rinderpest had to plan for future recovery and protect the *tula* wells despite huge losses of livestock during the epizootic. They sealed (*kala*[95]) many active wells, leaving only a few wells per cluster for human use. The strategy of temporarily sealing wells that were often vulnerable to silting by floods, was a well-developed practice. In this particular case, economic, social and demographic conditions were different. Since it was impossible for the Borana to know how long economic recovery would take, the decision was to completely seal the wells. Tree logs were arranged across the wellhead, plastered with clay and covered with earth. The well walls were propped up to reduce cave-ins and rockfalls, while all rainwater was diverted to prevent it entering the wells. Before the *kala* of the wells had been finalized, a famine was underway. The wells that were not sealed were lost to silting. [96]

Italian travellers Vannutelli and Citerni, who visited some of the Borana wells in 1895, a few years after the cattle epizootic, wrote: "Wells were rarely utilized, others having been abandoned since most cattle had died of the contagious disease".[97] Vannutelli and Citerni reported only four wells in use at one of the well clusters, Dhas, which has more than 50 wells [including the disused wells]. Major Gywnn, at the end of 1908, noticed many disused wells. He said that "In the past it [the well] has been more utilized than at present and many old wells are choked".[98] More than 100 years after the rinderpest, despite extensive re-excavation, several of the wells studied remained disused.[99]

Structural changes to tula well cultural landscape

During the second half of the 19th century, epidemics, droughts, and famines left *tula* cultural landscapes 'empty of human and livestock populations'.[100] The collapse of herbivore populations was followed by major structural changes to the environment, because the former grazing lands were overgrown with bush.[101] Such environmental changes were followed, in most cases, by the expansion of tsetse fly habitats that forced the surviving human and livestock populations to retreat.[102] Furthermore, fewer humans meant fewer fires, and the

environment became 'wild'; the lack of fires that usually maintained the savanna in a productive state turned the ecosystem into wilderness characterized by bush encroachment.[103] The Borana oral historians refer to the changes as *laaf bineensofte* or 'land becoming wild'.[104] The environment that had been transformed into *danqaraa* (bushy thickets) lost suitability for pastoral economy. While discussing the vegetation changes over time, the oral historians stated that the advancing bush caused an additional problem in that it provided cover for carnivores which could attack people.

The strategy was to re-introduce bush fires to halt the advancing wilderness, control tsetse flies, and remove cover for the predators.[105] Widespread fires over a period of two decades transformed the landscapes into savanna parkland. The presence of a high fuel load created hot and fast-moving fires, which, according to the informants, reversed the bush encroachment. For example, during *gada* Liban Kuse (1912–1920) a fire that was started in the plains of Liban, travelled hundreds of kilometres and burned the ritual village of the *qallu* (of Karayu) at Yabelo.[106] The opening up of the bush allowed people and the regenerating livestock herds to return gradually to their former home ranges near the various well clusters.

Eyewitness accounts from a number of European travellers described the vegetation conditions in Borana after the rinderpest epidemic. Donaldson-Smith, writing in the late 19th century, reported the existence of both thick bush and open savanna grasslands. After leaving Gof (a well cluster in eastern Borana), his caravan travelled for more than nine hours through bushland towards the centre of Borana (the Gorile well clusters) where it came to open grassland. Donaldson-Smith reported patchy bushes, some dense thickets and other areas of open grassland. According to him, "Again and again we came to bushy places where there was the greatest difficulty in getting the camels ahead, and at the same time in keeping a proper compactness and guards [of the caravan] … We made our way slowly at first, over a fairly open country, in grass up to our knees, but later the bushes began to increase".[107] This was during the rainy season as he reported the rain "pouring … without stop". The high grass cover he described would suggest there was still an absence of grazing livestock some five years after the cattle epizootic. Captain French, who travelled through Borana in 1911, reported open grassland as well as scattered bush areas.[108] A decade after the rinderpest epizootic, Major John Boyes reported many abandoned grasslands and bush-encroached lands. He noted the status of bush cover as 'thick'. [109] Hodson, travelling from Mega to Moyale in 1917, reported thick bush invaded by lions and hyenas:

> During the summer of 1917, nasty experiences befall upon me on the course of my trip from Mega to Moyale. We had camped for the night about half way, and our five horses were grazing peacefully when a lion appeared and they stampeded … there was no proper track and the thick bush made it

> difficult to keep one's bearings … The bush was [so] dense and of a thorny variety, … [that] necessitated our going on foot and dragging the mules behind us.[110]

Hodson repeatedly describes dense bush and the inability to keep to his direction. He does not mention any human settlements between Mega and Moyale, which are 110km apart.

Table 2: Summary of major environmental and socio-political disturbances and proxy data sources (Column 3 is the short-hand representation of *gada* periods with their respective cyclical names from Table 1).

Gada Period	Year	Rf. Table 1	*maqabas*	Events	Primary Source	Proxy data
Arero Boru	1496-1504	6f	*moggasa*	Borana decided Sabbo-Gona moiety marriage.[111]		
Titille Dulacha	1504-1512	7e	*makula*			
Luko Jarso	1512-1520	8d	*fullasa*			
Dado Iddo	1520-1528	9c	*mardida*			
Kura Dhala	1528-1536	10b	*darara*			
Dagale Yayya	1536-1544	11a	*libasa*	Great famine.[112]		NMSA
Asosa Titille	1544-1552	12g	*sabbaqa*	Drought and famine.[113]	Oral	Degefu, Pankhurst
Borawu Lukku	1552-1560	13f	*moggasa*	Drought.[114]		Pankhurst
Abay Horoo	1560-1568	14e	*makula*	Borana started rearing camels, severe drought and famine.[115]	Oral	Schove, NMSA
Biduu Dhuqqee	1568-1576	15d	*fullasa*	Plenty of rainfall for full 8-year period, but no good livestock productivity. All *hayu* died and *abba gada* alone survived.[116]	Oral	
Oroo Dulacha	1576-1584	16c	*mardida*			
Yayya Horoo	1584-1592	17b	*darara*	Drought in East Africa.		Schove
Doyo Boru	1592-1600	18a	*libasa*	Separation of Borana from Arsi, and Guji.[117] New rules introduced.[118]	Oral	Huqqaa,
Baco Nadha	1600-1608	19g	*sabbaqa*			
Urgumessa Iggo	1608-1616	20f	*moggasa*	Famine, epidemics.[119]		NMSA
Babbo Horoo	1616-1624	21e	*makula*	Famine, epidemics.		NMSA
Babo Sibu	1624-1632	22d	*fullasa*	Famine, swarms of locusts.		Pankhurst
Idhale Doyo	1632-1640	23c	*mardida*	Famine, swarms of locusts.[120]		Pankhurst, NMSA
Accu Abayu	1640-1648	24b	*darara*			
Abu Lakku	1648-1656	25a	*libasa*	Famine.		NMSA
Abayi Babbo	1656-1664	26g	*sabbaqa*	*Sodom Boro* (Borana) conquered *tula* wells and Boranaized *hero abba biyya*[121]		
Alle Kura Yayya	1664-1672	27f	*moggasa*	Serious conflict between Borana and Arsi.[122] First attempt to introduce crop production, drought.[123]	Oral	NMSA
Wayu Huru Reelee	1672-1680	28e	*makula*	Famine.		NMSA
Morowa Abay	1680-1688	29d	*fullasa*	Period of peace.	Oral	
Gobba Alla	1688-1696	30c	*mardida*	The nine *tula* wells divided	Oral	

				among Borana clans, sub-clans and individual owners in the form of trusteeship appointed.		
Dawwe Gobbo	1696-1704	31b	*darara*	Known for promulgating strong law.[124] Famine.[125]	Oral	NMSA
Jarso Iddo	1704-1712	32a	*libasa*	Famine, war with Arsi.	Oral	Pankhurst,
Walee Waccuu	1712-1720	33g	*sabbaqa*	The first attempted coup d'etat.[126] Severe drought and famine recorded in Ethiopia.[127]	Oral	Schove, NMSA, Webster,
Sora Dhadacha	1720-1728	34f	*moggasa*	Famine and weak Nile flood.		Schove
Dhadacha Robale	1728-1736	35e	*makula*	Period of normality.	Oral	
Halake Doyo	1736-1744	36d	*fullasa*	Cursed *abba gada* for increasing the number of *hayu* from two to six.[128]	Oral	
Guyo Gedo	1744-1752	37c	*mardida*	Famine caused by locust plague.		Pankhurst
Madha Boru Dadoyi	1752-1760	38b	*darara*	Serious conflict in which council of *gada*-elect perished. Famine and drought.[129]	Oral	NMSA, Pankhurst, Webster
Dhadacha Oda	1760-1768	39a	*libasa*	Constitutes the re-established *gogessa* and *gada* council, fall in the Nile flood level.[130]		Webster, Herring
Bule Dhadacha	1768-1776	40g	*sabbaqa*	Severe drought and famine,[131] conflict with Orma.	Oral	NMSA, Pankhurst
Liban Wata	1776-1784	41f	*moggasa*	Era of prosperity, unity and consensus, and performance of all rituals. The leader was the 'wisest' man in Borana history. Famine.[132]	Oral	Herring
Wayu Raale	1784-1792	42e	*makula*	Famine all over Ethiopia, conflict.		Pankhurst
Boru Madha Boru	1792-1800	43d	*fullasa*	Famine, enforced *gada* rules.	Oral	Wood
Ungule Lake Sade	1800-1808	44c	*mardida*	Three years of drought but oral source says neither cattle nor people affected,[133]collapse of *tula.*	Oral	NMSA, Wood; Degefu
Saaqoo Dhadacha	1808-1816	45b	*darara*	The most severe drought in forty years, but similar to that of Bule.[134]	Oral	
Jilo Nencoo	1816-1824	46a	*libasa*	Drought and famine.[135]		Schove
Sokoree Anna	1824-1832	47g	*sabbaqa*	Famine, cattle epidemics, conflict.[136]	Oral	Degefu, NMSA,
Madha Boru Madha	1832-1840	48f	*moggasa*	Famine, era of misfortune and conflict.[137]	Oral	Wood, NMSA, Schove, Herring
Liban Jilo Hadhawa	1840-1848	49e	*makula*	The first irregularity in power transfer.	Oral	
Jaldesa Guyo Dabasa	1848-1856	50d	*fullasa*	Conflict.[138]	Oral	

Doyo Jilo	1856-1864	51c	*mardida*	Excessive rainfall, conflict.[139]	Oral	
Haro Adi	1864-1872	52b	*darara*	Abandoning of cultural practices, epidemics, famine, and conflict.[140]	Oral	NMSA, Schove
Dida Bitata Mamo	1872-1880	53a	*libasa*	Heavy rainfall and collapse of wells, conflict.[141]	Oral	
Guyo Boru Ungule	1880-1888	54g	*sabbaqa*	Most extreme social disorganization in Borana history.[142]	Oral	
Liban Jaldesa	1888-1896	55f	*moggasa*	Epidemics, drought, famine, conquest.[143]	Oral	Wood, Degefu, Pankhurst
Adi Doyo	1896-1904	56e	*makula*	Drought, recovery,[144]conquest.	Oral	Wood
Boru Galma	1904-1912	57d	*fullasa*	Livestock epidemic.	Oral	
Liban Kuse	1912-1920	58c	*mardida*	Conflict, drought, epidemics.[145]	Oral	Wood, Hodson
Arero Gedo	1920-1928	59b	*darara*	Bulk well re-excavation,[146]conflict.	Oral	
Bule Dabasa	1928-1936	60a	*libasa*	Heavy rainfall, drought, conflict, epidemics.[147]	Oral	Wood, NMSA, Degefu
Aga Adi	1936-1944	61g	*sabbaqa*	Severe diarrhea, Italian occupation.	Oral	
Guyo Boru	1944-1952	62f	*moggasa*	Serious drought, conflict.[148]		

The impact of drought and famine on the tula *well cultural landscape*

A number of droughts and famines are remembered in the oral history, including, among others, those during *gada* Abay Horoo (1560–1568), Alle Kura Yayya (1664–1672), Walee Waccuu (1712–1720), Madha Boru Dadoyi (1752–1760) and Dhadacha Oda Morowa (1760–1768). These droughts and famines all brought about the collapse of human and livestock populations. The most severe droughts and famines reported by oral historians occurred during *gada* Bule Dhadacha (1768–1776) and Saaqoo Dhadacha (1808–1816). These famines are remembered in an oft-repeated folklore song:

Oolaa Bulee Dhadacha	drought of *gada* Bule Dhadacha
Oolaa Saaqoo Dhadacha	drought of *gada* Saaqoo Dhadacha
Oolaan abbaa fi ilmaa	the droughts of father and sons
Gugufi tiya duuti haadhaa fi ilme	my dear stumbler, death is that of mother and offspring[149]

While showing the severity of droughts that killed both mother and offspring, the folk-song highlights the cyclical occurrence of droughts (*dhaaccii*) within the same *gogessa*. The *abba gada* Bule Dhadacha and Saaqoo Dhadacha were not biologically related but they were

'father and son' in the sense of the generations within the same *gogessa* (Table 1, Column E, numbers 40g and 45b). Degefu, Pankhurst, and Schove refer to regional famines during these periods.[150] Other sources indicate that the whole period 1760 to 1840 was characterized by drought and famine in East Africa.[151] Other *gada* periods that experienced serious famine were those of *gada* Sokoree Anna (1824–1832) and *gada* Madha Boru (1832–1840). The former is referred to as *sabdii* (famine) while the latter was known as *agaari* (voraciousness), and oral sources record that at that time 'people refused to share food' and were reportedly extraordinarily 'greedy'.[152] The famine coincided with an outbreak of lice. One oral source said "red lice covered the whole human body … [Individuals] scrubbed them off … People swelled in the face and died".[153]

The famine that occurred at the end of the 19th century was widespread and severe, partly because a situation of social disharmony existed prior to the epizootic outbreak. The Borana were not ready to cope with the disaster or mitigate its effects, and they succumbed horribly to the famine that immediately followed the loss of cattle.[154] The famine caused a major decline in human demography, and the deaths of whole families and well-owning lineages created ambiguity in well ownership, resulting in claims and counter-claims over well-property rights for generations. The transfer of wells across clans and moieties was reported, which was an anomalous and culturally undesirable practice. Some of the conflicts about well ownership in the present time are said to be the outcome of that episode.

In the 20th century *gada* Bule Dabasa (1928–1936) and Aga Adi (1936–1944) experienced severe droughts. The oral information was confirmed by drought associated with a drop in the level of Lake Rudolf and drought reported in southern Ethiopia (1932–1933).[155] The *gogessa* of Bule Dabasa (Table 1, Column E) is remembered for repeated cyclical occurrences of droughts and famines. This particular *gogessa* held office six times during the 200-year period (1768–1976), and at least four severe droughts were reported in that time. Four of the periods (40g, 50d, 55f, and 60a in Table 2) experienced at least one major drought each.

A more recent severe drought that caused high cattle mortality was reported during *gada* Guyo Boru (1944–1952). This drought was referred to as *oolaa qollajjii*. It was a period when hides and skins of cattle that died in the drought were more valuable than living cattle. The Borana sold hides and skins in the Moyale market to buy grain from the grain-producing regions of southern Ethiopia. This famine was a cyclical return (*dhaaccii*) of the earlier event (*gada* Liban Jaldesa, 1888-1896) within the same *maqabas-moggasa*. This triggered

population displacement and social unrest, and the increasing vulnerability led to a decline in the society's ability to manage *tula* wells.[156]

SOCIAL UPHEAVALS IN THE *TULA* REGION

The Borana pastoral system has had numerous social disturbances and reorganizations in history (Table 2). Even though the Borana tradition aims to maintain social harmony, oral sources recall social and political upheavals that weakened the institutional capacity for managing internal affairs and external relations. Borana peace (*nagaa Borana*) and social harmony have been tested in various historical periods. Social disharmony and institutional weakness are particularly responsible for undermining the proper functioning of *tula* wells. For the Borana oral historians, there is a clear relationship between social harmony and the stewardship of *tula* wells. Social harmony and effective indigenous institutions are crucial in mobilizing economic resources and organizing labour to re-excavate *tula* wells that have fallen into disuse. Conversely, social disharmony and weak institutions are associated with an increase in the number of disused wells.[157]

The periods most remembered for social disorganization that undermined Borana society and adversely influenced human stewardship of *tula* wells were *gada* Sokoree Anna (1824–1832) (*sabbaqa*) followed by *gada* Madha Boru Madha (1832–1840) (*moggasa*). These two *maqabas* experienced similar events, in the same chronological order, during *gada* Guyo Boru Ungule (1880–1888) (*sabbaqa*) and Liban Jaldesa (1888–1896) (*moggasa*) (Table 2). The Borana attributed the disasters that affected their ancestors during the second two *gada* to unusual human behaviour (such as non-cooperation, greediness and disobedience) that put a strain on social organization and violated cultural norms. This contrasts with other African societies that attribute disasters such as the Great Rinderpest to external causes such as colonization.[158] The perceptions might play a role in shaping human behaviour and enhancing solidarity in a society that is dependent on a fragile savanna ecosystem. Understanding societal perceptions during or prior to disasters is therefore vital for understanding human responses to disasters.[159] Natural disasters occurring concurrently with social disorganization and instability might be followed by weakened responses and delayed recovery.[160]

Mobilizing the community to respond to a disaster or mitigate its impact is difficult in the absence of effective social institutions.[161]The breakdown of social institutions weakens society's capacity to respond to disaster, and aggravates human vulnerability.[162] Social

disorganization may also result in profound social change that impact on the community's ability to control members' behaviour in solving common problems.[163] Institutional failure disrupts social relations and affects individual commitment to the norms and values of the society.[164] This, according to the informants, was caused by political disturbances.

Political disturbances

The social disharmony that is the outcome of political disturbances can rupture systems of environmental management. Political disturbances have affected the general operation of the *tula* wells at various times in the past. The oral historians remembered one of the most serious political disturbances that disturbed the whole system in the middle of the 18th century. The incumbent *abba gada* Madha Boru Dadoyi (1752–1760) ordered the incoming *gada* council and their *luba,* led by *abba gada*-elect Sora Dido Qarsa, to defend the territory against invading forces of the neighbouring tribes.[165] It was a dark moment in Borana history as the whole generation set was killed in the war. The incident is still commemorated today by a sorrowful song.[166] However, institutional flexibility and innovative leadership enabled the Borana to readjust, and ensured continuity of the system by appointing new *gada* councillors and restructuring the *gogessa* (social class) from new *luba* (generation sets). The Borana shifted their sons into different *luba* to ensure continuity and to maintain the system of *gada* rotating among the five *gogessa*.[167] The new appointees were referred to as *ilmaan jarsa* (children of the elderly) because they came from the retired generation class.[168] The *abba gada* appointed to replace the deceased Sora Dido Qarsa was Dhadacha Oda Morowa (1760–68) (Table 2). According to the oral historians, the *maqabas* cyclic events had played a part, without being overtly deterministic. The *maqabas* of *darara,* for example, accurately alternated between famine, disease and conflict, preparing the society to expect any of these events either singularly or in combination when *darara* returns to power.

Another major political disturbance happened almost a century later, when an irregularity of power transfer occurred. The transfer from Liban Jilo Hadhawa (1840–1848) to Jaldesa Guyo Dabasa (1848–1856) (Table 2) was delayed when the outgoing *gada* leader refused to hand over power to the newly elected leader.[169] The delay was a historical event known as '*ammenya gada* Liban Jilo Hadhawa', which ushered in misfortune.[170] The political turmoil continued during the subsequent *gada* period as a result of disagreement among the *gada* councillors of Jaldesa Guyo Dabasa (1848–1856). Similar attempt was made during *gada* Bule Dabasa (1928-1936). The Borana oral sources recorded this as *dhaacciii* of *gada*

Liban Jilo Hadhawa (1840-1848) within the same *gogessa*, both periods being characterized by irregularity in power transfer (see Table 1 and 2). The political disturbance weakened the Borana militarily, and a battle with their neighbours claimed the lives of all *gada* councillors except the *abba gada*. The disagreement continued into *gada* Doyo Jilo (1856–1864), which the Borana oral sources refer to as the 'fractured council'.[171]

Further serious political turmoil erupted in Borana during *gada* Dida Ditata Mamo (1872–1880). Disagreement about the election of *gada* councillors intensified internal conflict between the two Borana moieties[172], *sabbo* and *gona*, led by their respective ritual leaders, *qallu*. The internal conflict, called *xilo waraba*, violated the Borana principle of peaceful co-existence (*nagaa*) that prohibits not only physical attacks but also verbal abuse. [173] The socio-political upheavals threatened Borana social relations, thereby jeopardizing human stewardship of the *tula* wells.

The ongoing social disturbances and political turmoil had a number of effects on the operation of *tula* wells. Firstly, the social disharmony disrupted labour organization and resource mobilization for the upkeep and rehabilitation of the wells. Secondly, the death of clan leaders (*hayu*) who were mandated to organize rehabilitation, delayed re-excavation of disused wells, and the lack of proper management caused more wells to fall into disuse. Thirdly, the turmoil repeatedly displaced the population from the *tula* region, which led to the wells being neglected. Fourthly, fighting disrupted the social order that managed the natural resources. The social upheavals during the second half of the 19th century finally culminated in Borana subjugation by the invading forces of Menilik in 1897, which opened a new historical chapter.[174]

The conquering of Borana only a few years after the Great Rinderpest[175] had a negative impact on the societal institutions as well as on the management of the *tula* wells and grazing lands. The social structure that traditionally administered the Borana was dismantled and the *gada* leadership was replaced by the *qallu*, who had traditionally played only a ritual role. The Abyssinians did not take control of the ritual functions of the *gada,* but took away its political power of self-regulation.

The establishment of a colonial border between Kenya and Ethiopia disrupted the distribution of the Borana. Their lowland grazing areas became part of the British colonial administration of Kenya, whereas the wells and other grazing lands fell on the Ethiopian side of the border. Many Borana migrated to Kenya, thereby losing access to the *tula* wells. This created an ambiguity of property rights to the wells between ancestral owners and caretakers appointed by the clans.[176] Property rights to the wells were not recognized by the new colonial

masters, who reassigned ownership of wells to other ethnic groups, creating ethnic tensions that lasted for many generations.[177] The clans that lost labour and economic power failed to re-excavate their wells. The shift in clan population to Kenya affected clan resources that were essential for maintaining wells and re-excavation. Consequently, many of the wells whose owners left Ethiopia are among those that have fallen into disuse.

CONCLUSIONS

Reconstructions of the impact of environmental and social disasters on any ecosystem present a challenge to environmental historians. The challenge has been to find an appropriate methodology that is socially and environmentally amenable to empirical scrutiny. In this article we have used oral history and the *gada* timeline to reconstruct past disasters and their impact on the dynamics of the *tula* wells, the environment and the pastoral economy of the area. The time chronology was established by putting the historical events in *gada* context and showing their relationship to one another by means of event-repetition (*dhaaccii*), cyclical names (*maqabas*), and social structure (*gogessa*). Corroborating oral history with proxy data, we reconstructed the impact of disasters on the cultural landscape in terms of 'use' and 'disuse' of *tula* wells for the past 500 years.

We found a pleasing correlation of patterns between the oral and recorded environmental proxy data relating to disasters in this region of northeastern Africa and the events in the *tula* well region during the past centuries. The major indicators of disaster we considered were excessive rainfall (and its impact on the collapse of *tula* wells), epidemics, droughts, and famines. These major sources of disaster caused human and livestock demographic collapse, and disrupted the social institutions that are crucial for re-excavation, maintenance, and management of *tula* wells. Human demographic collapse interrupted human stewardship and added considerably to the number of inactive *tula* wells. The society's response to the disturbances was influenced by other factors such as the level of severity, human perceptions of disasters, institutional resilience, and human vulnerability, as well as social and political disturbances. We found that the proper functioning of the pastoral economy, stable human demography, and resilient social institutions were essential for effective human stewardship of *tula* wells. Understanding how Borana pastoralists perceived the impact of disasters was therefore crucial to reconstructing the environmental and social history of this particular critical water source.

NOTES

[1] Blaikie et al. 1994; Axelrod et al. 1999, 32
[2] Edwards 1998, 119-120
[3] Hughes 2008, 319-30; Mosley 2006; Steinberg 2002; Anderson 2002; Beinart & Coates 1995.
[4] Carruthers 2002; Cronon 1993; Hughes 2008; .Mosley 2006, 4; Gomez-Pompa & Kaus 1992; Foster *et al.* 1999.
[5] Turner et al. 1998; Paine et al. 1998
[6] Whites and Pickett 1985, 3-13
[7] Mosley 2006.
[8] Eadie & Oleson 1986, 71; Lightfoot 2000, 215-226; Lightfoot 1996, 261-273; English 1968, 170-181.
[9] Lightfoot 1997, 437. Kummu 2009, 1413.Terkenli 2001, 202, Potkanski & Adams 1998; Westerberg et al. 2010
[10] Westerberg et al. 2010.
[11] Webster 1979.
[12] Gufu Oba, Unpublished
[13] Wilding 1985.
[14]Tiki & Oba, 2009
[15] For similar experiences refer to Jacobs 2003.
[16] Nicholson 2001, 318.
[17] Vansina 1985 & 1990; Spear 1981; Fadiman 1993, Miller 1980; Giles-Vernick 1999; Sugiyama 2001
[18] Vansina 1990.
[19] Miller 1980; see also Spear 1981.
[20] Pankhurst, A. 1985.
[21] Miller 1980; Giles-Vernick 1999, 316. Oral historians refer in this document to informants or the narrators of the story.
[22] Goodall 2008.
[23] Fadiman 1993.
[24] Miller 1980.
[25] Miller 1980.
[26] Webster 1979; see also Henige 1974
[27] Miller 1980.
[28] Tvedt 2004.
[29] Herring 1979.
[30] Herring 1979.
[31] *Gada* is a socio-political institution that guides rituals, politics, and pastoral production. The office is held by one *gada* council for eight years, with no possibility of extension. See also Legesse 1973; Baxter 1978; Helland 1998; Leus & Salvadori 2006.
[32] Historically, there were a few exceptions to this rule such as when *gada* Dida Bitata Mamo (1872-1880) lasted for nine years as opposed to eight, as a result of internal conflict among the Borana. Other more recent incidents include the delay in transfer of power from Bule Dabasa (1928-1936) to Aga Adi (1936-1944) for four years during the Italian occupation of Ethiopia. When the Italians were defeated in 1941, the power transfer went ahead but Aga Adi held office only for the remaining years of his term. The events that occurred during the first four years were considered within the 'proper' time span, which was named after him and not after Bule Dabasa who preceded him.
[33] Miller 1980.
[34] Legesse 1973, 179.
[35] Legesse 1973.
[36] Legesse 1973, 12, 189.
[37] Kjærland 1977, 18.
[38] Wilding 1985.
[39] In Borana there are seven *maqabas* and five *gogessa* as detailed in Legesse, 1973. If the five *gogessa* are arranged from 1 to 5, each *gogessa* in a *gada* leadership takes one *maqabas*, and the last two go to the sons of the first and second leaders. The first and the third persons call each other *qadaddu* (allies), having certain socio-cultural ties to one another. They have mutual rituals (e.g. *gubisa*, naming of sons). When this *maqabas* repeats for the third time, the events of the first are expected to repeat themselves (both good and bad). For instance, *Xiloo waraba* took place during *gada* Dida Bitata, 1872-1880 (*libasa*), and the next *libasa* period was during *gada* Bule Dabasa (1928-36). The next was during *gada* Boru Guyo (1976-1984) which had similar internal conflict to *gada* Dida Bitata, 1872-1880 (although this time it was controlled by government

intervention). The *gada* of Liban Jaldesa (2000-2008) was the 3rd repetition of *ciinna* (a disaster of the 1890s) within the same *gogessa*. Borana were expecting similar events to those of the 1890s in this *gada* period. However, they are also aware of differences between the past and the present. At present, natural disasters are dealt with by international communities. Two *maqabas* of major concern are that repeats every 3rd and that returns to the same *gogessa* every 35th. For instance, the social disorganization and famine of *gada* Guyo Boru Ungule (1880-1888) repeated itself during *gada* Boru Madha (1992-2000). The other expectation of event repetition is within a *gogessa* (like Saaqoo Dhadacha and Bule Dhadacha) from genealogical ancestors to their descendants.

[40] Gufu Oba unpublished

[41] The seven *maqabas* names (*libasa*, *darara*, *mardida*, *fullasa*, *makula, moggisa* and *sabbaqa*) correspond with ritual cycles each representing a day of the week, not dissimilar in function to the Islamic seven days of the week.

[42] Leus and Salvadori 2006.

[43] Oba and Kotile 2001; Coppock 1994.

[44] Oba and Kotile 2001; Oba 1998.

[45] Coppock 1994.

[46] Oba 1998; Cossins 1983.

[47] Coppock 1994.

[48] Ibid.

[49] Donaldson-Smith 1897, 185.

[50] Buxton 1949, 101.

[51] Maud 1904, 564.

[52] Almyer 1911.

[53] Dahl and Megersa 1990; Helland 1982; Legesse 1973, 87, and also see Burmil *et al.* 1999 for symbolic meanings of water.

[54] Helland 1980; Dahl & Megersa 1990; Cossins & Upton 1987; Maud 1904.

[55] Ramos & Aguilơ 1988; Scarborough 2003.

[56] Vansina 1990.

[57] Oba 1996.

[58] Haberland 1963 quoted in Helland 1980

[59] The ancient Egyptians used simple tools such as hand metal bars and stones for cutting rocks and breaking them when building the pyramids, El Salam 2002, 295

[60] Donaldson-Smith 1897, 186

[61] Watson 1927, 50.

[62] Watson 1927, 50-51

[63] Aylmer 1911

[64] Some oral historians do not believe that *tula* was originally dug by Warda. However, they acknowledge that Borana displaced Warda. The excavation is a mystery in the absence of any improved tools. For more of the divergent views, see Helland 1980; Legese 1973; Cossins 1983

[65] Maud 1904; Leus & Salvadori 2006

[66] Buxton 1949

[67] More discussion of this topic is found in the forthcoming book by GO

[68] See Webster 1980 on how people of interlacustrine lake regions explained the past for which they could not state the time, similar to the Borana

[69] The folklore is a subject of watering song sang by water men and women.

[70] In Borana world view, the tula is is a god to cattle as God is to a man.

[71] There is no consensus as to whether *sodom boro* constituted 30 people or 30 groups of people

[72] Waktole Tiki & Gufu Oba unpublished data.

[73] Wilding 1985; Oba 1996

[74] The earlier groups included Abroji, Dawwe, Sufftu, Xaasa, Xaaya, Warda, Duubara, Arsi and Laikipia Maasai. The Laikipia Maasai and Arsi invaded the region and drove the Borana out of the *tula*. Both groups were routed by the Borana cavalry. According to the oral sources, the other groups were part of the clans of Heero Abba Biya (which means the multitudes that were begotten from others)

[75] Leus & Salvadori 2006; Legesse 1973

[76] Hassen 1990; Pankhurst 1997; Kalinovskaya,1988.

[77] Kalinovskaya, 1988.

[78] The Borana memory of the past age sets are poor. The furthest they could recall is *Luugo* that probably corresponded with events in the early nineteenth century. After this period the age sets are known but their use in recalling of environmental and social events falls outside the function of age sets. Rather, it it within the

realms of *gada luba*-generation sets that close connections with events are related, as we have shown in this article.

[79] *Goof* refers to either disused wells in a cluster, or to a cluster in which there is no operating well.

[80] The goof well clusters are geographically located from the nine *tula* well clusters but within the same geological systems. *Goof Wardelle* implies that the old cluster was from the Warda periods of occupation, while *goof* Walmura refers to a geographical locality by the same name Walmura. Others were associated with the well owners such as Bosaro, known to be of the ancestry of the prophets among the Borana.

[81] Donaldson-Smith 1897.

[82] Nicholson 2001, 325; Webster 1979; Miller 1980.

[83] For similar discussion see Miller 1982, 19.

[84] Borbor Bule, Peronal communication

[85] Kiage & Liu 2006

[86] According to oral sources, there were three years of extended drought when heavy rainfall was predicted by the Borana prophet Sogaa who advised people to move to the hills to escape the coming flood. Accordingly people migrated to the hills. At some point, the prophet himself returned to settlement in the valley to collect some items he had left behind. Before he could return to the hills, the rain started and continued for seven days. The heavy flooding collapsed all *tula* wells and killed the prophet himself. (Borbor Bule interviewed by by WT).

[87] Fraedrich *et al*. 1997, 1303.

[88] *Barba* is the accumulation of water not originating from the well, or a flood, in a well.

[89] Nicholson 1979, 43.

[90] Dias 1981; Indeje *et al*. 2000.

[91] Tiki & Oba, 2009

[92] Berkes 2007, 284; see also Gardner & Dekens 2007, 319.

[93] Flint & Luloff 2005, 399-412; see also Edwards 1998, 123.

[94] Key informants and group discussions held at each well cluster provided similar information.

[95] Temporary closure or sealing of wells with wooden material to protect cave-ins.

[96] Borbor Bule, personal communication.

[97] Vannutelli & Citerni 1899, 158.

[98] Gwynn 1911, 120.

[99] See Tiki *et al*, In press , for the current status of *tula* wells

[100] Livestock were decimated by the rinderpest epizootic whereas the human population declined as a result of famine, attacks by wild animals and epidemics like smallpox, see Richards 1983, 21.

[101] Kjekshus 1996, 166; Jacobs 2003.

[102] Ford 1971, 193; Kjekshus 1996, 166; Boyes 1906.

[103] Oba 1998.

[104] See Kreike 2004 for similar discussions on human managed land and abandoned ones, which he described as changes from *Oshlingo* to *Ofuka*

[105] Oba & Kotile 2001.

[106] Oba 1998.

[107] Donaldson-Smith 1897, 195-203.

[108] French 1913.

[109] Boyes 1906.

[110] Hodson 1927, 161-163.

[111] This tied Borana within marriage to reduce conflict and facilitate resource sharing.

[112] The Ethiopian meteorological service reported severe famine that forced a change of food habits – people survived by eating the roots of trees.

[113] Great drought and famine in Ethiopia, see Degefu 1987; Pankhurst, R. 1985.

[114] Absence of rain for three consecutive years, see Pankhurst,R. 1985; NMSA 1996.

[115] Borbor Bule, oral historian; Schove 1977; NMSA 1996.

[116] It was believed that there was some power in the eyes of *abba gada* himself – when he looked angrily at people, they died. His lineage has never come to power again since then.

[117] This separation is assumed to be the cause of conflict over resources among these groups, Huqqaa 1996.

[118] Rules governing husband-wife relations were promulgated. They state that a husband and wife should not stay apart for more than 30 days. If this does happen, the wife can be 'inherited' by others. It was termed *nyapha Doyo Boro* (enmity of Doyo Boro). Huqqaa 1996. (Group discussions at well clusters confirmed this).

[119] The Amharic term *manin tita* meaning 'whom did it spare' was used to describe the epidemic, see NMSA 1996.

[120] The locust invasion and consequent famine forced the Emperor to change his seat of government, see Pankhurst, R. 1985; NMSA 1996.

[121] The rule of adoption or the rule that enables a person to acquire Borana citizenship was announced. This might have been designed to assimilate the population the Borana conquered.

[122] In this period the Arsi conquered almost all Borana and many people were killed. It was called *warana malkaa hallu*, meaning 'the way Arsi left Boranaland'. The war lasted three months.

[123] Increment of grain price reported, see NMSA 1996.

[124] He proposed that women contend for *hayu* positions, but women did not participate in the meeting and the proposal failed. According to the promulgated rule, husbands should be held responsible for the transgressions of their wives whereas unmarried girls should be dealt with like males if found guilty. This era also generated detailed family laws, human rights, and the accountability of *abba gada* to the community.

[125] Severe starvation was reported particularly in northern Ethiopia, see NMSA 1996.

[126] His followers envied his braveness and turned against him, planning to kill him. The Borana admitted their mistake and asked *abba gada* for pardon. The ritual of reconciliation was then performed and he simply said "Rain", and it rained and prosperity returned.

[127] For drought records see Schove 1977; NMSA 1996; for the fall in Nile flood levels, see Webster 1979.

[128] On Gumi Gayo of Guyo Gedo, an old man called Waticha Guyo (who became *hayu* (councilor) twice in his lifetime because of his extraordinary ability) asked the participants "*Halake Doyo waagafadha*" (let me ask Halake Doyo a question). When he was allowed to speak, he stood up (unusually) and listed what he considered to be irregularities (including the increment in the number of *gada* councilors) introduced by Halake Doyo, and requested the assembly to curse him, saying: "*Gumi Gayo Halake Doyyo wanni Borana sibirati hinhafne jedha*" means Halake Doyo has nothing to do with Borana. This amounts to total isolation, in the society where cooperation is not an option, but necessary condition for survival. Increasing the number of *hayu* increases obligations – cattle contributions, mules and other additional costs. They are also expected to maintain *hayu* wherever they are by slaughtering animals. According to oral sources, Halake Doyo fell sick on the spot and died after two days.

[129] NMSA 1996; Pankhurst,R. 1985; for the fall in Nile flood levels, see Webster 1979.

[130] Webster 1979; Herring 1979.

[131] The drought killed almost all animals and people. Famine was recorded all over Ethiopia. The Amharic term *qacine,* meaning 'my thinness', was used to convey its serious impact; see NMSA 1996; Pankhurst,R. 1985.

[132] It was reported as the worst famine of the century. A fall in Nile flood levels from Ethiopia was also recorded, Schove 1977; Herring 1979.

[133] Drought was followed by excessive rain that collapsed all the *tula* wells. This was termed *ganna sogaa.* For more information on drought and famine see NMSA 1996; Wood 1977; Degefu 1987.

[134] Known for the migration to cultural sites crossing enemy forces. After that the cultural centre changed from Madda Walabu to Liban.

[135] Famine that affected many parts of the world, including Ethiopia was reported, see Schove 1977.

[136] The famine was known as *sabdii gada* Sokoree (1824–1832), when 'people ate but were not satisfied'. Degefu (1987) reported drought and famine all over Ethiopia, and NMSA (1996) reported international famine, drought in most African countries, and failure of crops and death of cattle in Ethiopia.

[137] The famine was known as *agarii gada* Madha (1832–1840). Drought and famine were reported in central Ethiopia and low Nile flood levels, see Wood 1977; NMSA 1996; Schove 1977; Herring 1979.

[138] The disagreement among the leadership led to their defeat on the war front. The *gada* council was re-established three times (all killed during the war except *abba gada*). It was known as *duula cirrate,* meaning the battle of *cirrate.*

[139] It was known as the 'era of thunder'. Three branches of *gada* established at three separate places (no agreement among *gada* councilors).

[140] *Rada maraa, dulacha dhugoo,* and *dulacha anadu* (cultural practices performed to repel evil and ensure prosperity) were abandoned. Consequently prophets lost their powers of 'future-telling'. There was a severe cholera outbreak on the eastern side and ownerless cattle dispersed into the bush (Group discussion led by by WT). Famine and lowering of Nile flood levels were reported in the northern part of Ethiopia, see NMSA 1996; Schove 1977.

[141] Serious internal conflict between the Borana moieties. See endnote 161

[142] It was known as *kaayoo dhabuu* (misfortune). Many cattle were lost to competing tribes as there was no defence force.

[143] Considered as the worst natural disaster both by oral history sources and written documents: rinderpest epizootic, famine, smallpox, cholera, and severe drought, see Wood 1977; Degefu 1987; Pankhurst, R.1985.

[144] Oral history tells of good rainfall and pleasant life. Wood (1977) acknowledges the absence of recorded drought but records falls in the level of Lake Rudolf because of low discharge from rivers in Ethiopia, and lower Nile flood levels.
[145] This period is remembered for the first urbanization in Borana. On drought, see Wood 1977, and on the influenza outbreak, see Hodson 1927.
[146] This indicates the full recovery of the cattle economy.
[147] Drought and a fall in the level of Lake Rudolf were documented, see Wood 1977; NMSA 1996; Degefu 1987. Severe malaria outbreak also reported by oral historians. Oral sources also show irregularity in power transfer that has been due to Italian invation and also reluctance of the incumbent leader to hand over power.
[148] Severe drought occurred and the Borana started selling hides and skins for the first time. The remaining period characterized by heavy rainfall and a malaria outbreak. Conflict was widespread when one of the two *qallus* (Oditu) was killed by neighbouring tribes. The conflict also caused the execution of an army chief for allegedly siding with Borana.
[149] The old lady sang when taking her drought weakend cow and her weaker calf.
[150] Degefu 1987, 23-36; Pankhurst,R. 1985.
[151] Holmgren & Öberg 2006, 191; Webster 1980.
[152] Oba 1996.
[153] Archival interview collection of Oba Sarite Kura, interviewed by GO in Marsabit, 1992 (Borana historical archival collections).
[154] Oba 1998.
[155] NMSA 1996.
[156] Ibid.
[157] Oral historians explain the impact of social disharmony by referring to different historical periods.
[158] Van Onselen 1972, 481.
[159] Eakin & Luers 2006, 369.
[160] Holmgren & Öberg 2006, 193.
[161] King 2007, 657; Berry *et al*. 1977, 83-92.
[162] Raynaut 2001,15.
[163] Batterbury & Warren 2001, 3; Vincentnathan & Vincentnathan 2008, 566.
[164] Thorlindsson & Bernburg 2009, 234.
[165] Oba 1996.
[166] For the song, see Oba 1996.
[167] For details of *gada* and *gogessa*, see Legesse 1973.
[168] *Ilmaan jarsa* by itself implies children that were not born in the appropriate time period to occupy leadership. It does not necessarily imply being older than others, but it shows the prematurity of individuals for leadership positions in a system that requires the birth of children at particular periods, considering not only the age of individuals but correlating with the required generation set. For more detail, see Legesse 1973.
[169] Conflict among Borana about positions started during the 49th *gada* and continued into the 50th. This disagreement continued to Doyo Jilo's period when the councillors for Guyo Boru Ungule (1880-1888) were announced. Liban Jilo sided with Karayu, while Jaldesa Guyo Dabbasa sided with the Oditu clan. This time there was no physical clash, but much disagreement.
[170] Informant Borbor Bule.
[171] *Yaa'i Doyo Jilo fuula sadii qubate,* means Doyo Jilo's *gada* council fractured and settled at three different ritual sites.
[172] For details of Borana clan and moiety organization, see Bassi 2005
[173] Doyo Jilo was the 51st *abba gada*. While he was the leader, the *ya'a* promised to make his son *abba gada* in the future. But competitors such as Atu Kotte and Godana Moye were planning to make their sons *abba gada*. This conflict started during the second year of Doyo's era (on the appointment of his *gada* councilors), when Doyo was reluctant to include the competitors in his council for fear they would challenge his son in the future. However, Doyo Jilo had special respect for Galgalu Atu (the wife of Atu Kotte), and she promised that the *gada* position of his son would be ensured, but requested her husband's *hayu* position be approved. Doyo Jilo agreed and approved Atu Kotte's *hayu* position. Atu Kotte had a son called Gedo and Godana Moye had one called Adii. Unfortunately, Doyo Jilo died without having a son of his own. He was 'given' one (Adii Doyo Jilo, locally known as *Ilme Xuxi*) by immediate family, who was entitled to every position his own son would have been entitled to. The appointment of this *luba* was to take place during the 3rd year of *gada* Dida Bitata, about 29 years before he was to assume power. A web of complex relationships between different categories complicated matters. Atu Kotte and Godana Moye had a relationship called *jalaa* and they supported one another. As a result, Godana Moye supported Gedo Atu to be *abba gada* and his son Adii Godana to be his deputy. It was at this stage that Galgalu Atu discovered she could not keep her promise to

Doyo Jilo, and she committed suicide. On her burial, the two men (Atu Kotte and Godana Moye) joked that she was going to tell Doyo Jilo what they were doing. After the burial they announced Gedo Atu *abba gada* and Adii Godana as his deputy. They were supported by *qallu* Oditu (Anna Boru), whereas *qallu* Karayu opposed the announcement and supported Adii Doyo Jilo to be *abba gada*. The pretext used by Atu and Godana to appoint their sons instead of Adii Doyo was that Adii was not the biological son of the previous *abba gada.* However, there was no cultural or legal reason to prevent Adii Doyo occupying such a prestigious position in the community. This caused serious fighting between the two moieties. Atu Kotte, Gedo Atu, Godana Moye, and Adii Godana were all killed. Anna Boru was captured and had his hair shaved contrary to cultural norms and the positions of *abba gada* and councilors were re-announced. Adii Doyo Jilo became *abba gada.* See Baxter 1965 for details of nagaa Borana

[174] Oba 1996.

[175] Oba 1996; Lugard 1968; Hickey 1984; Hodson 1927.

[176] Hickey 1984.

[177] Tache & Oba, in press

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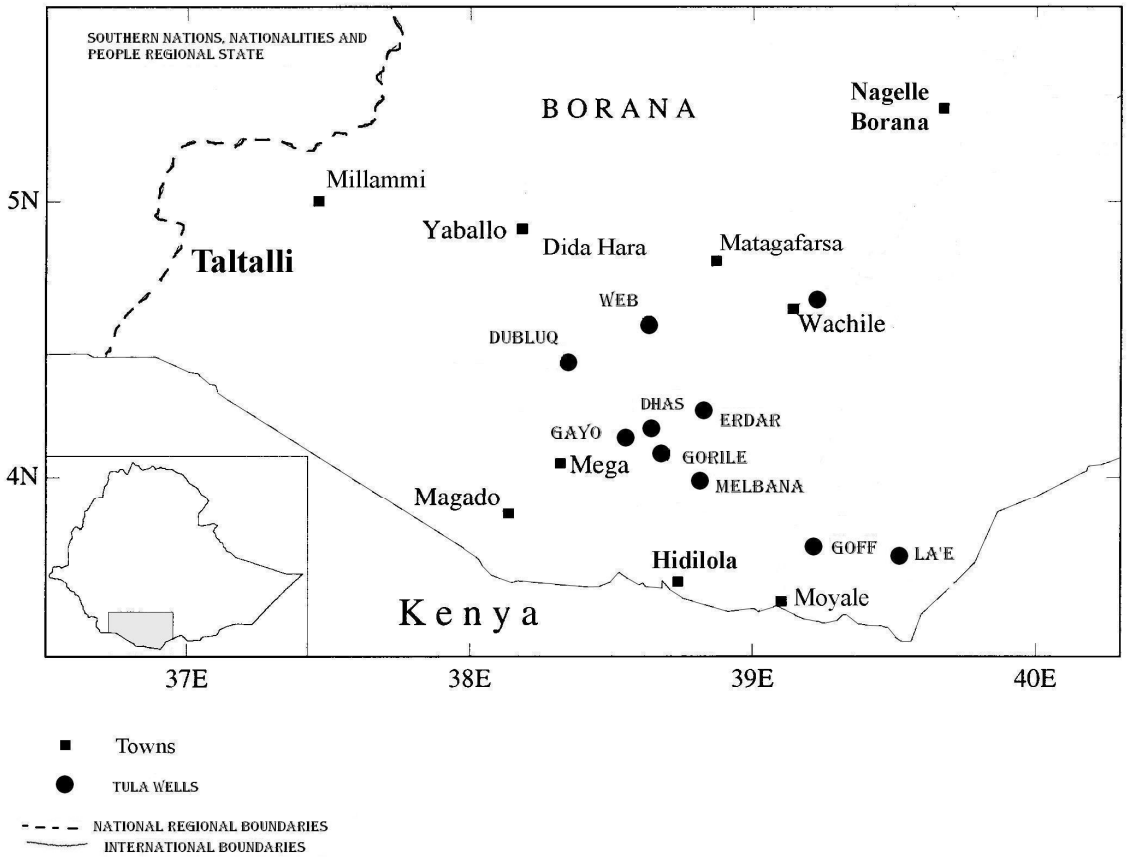
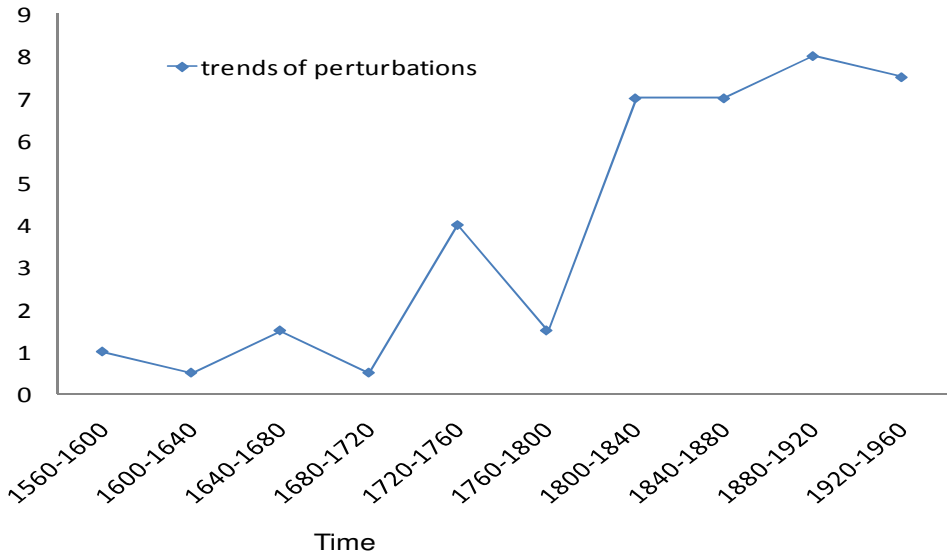

SOUTHERN NATIONS, NATIONALITIES AND PEOPLE REGIONAL STATE
BORANA
Nagelle Borana
Millammi
5N
Yaballo
Dida Hara
Matagafarsa
Taltalli
WEB
Wachile
DUBLUQ
DHAS
ERDAR
GAYO
GORILE
Mega
4N
MELBANA
Magado
GOFF
LA'E
Hidilola
Moyale
Kenya
37E
38E
39E
40E
Towns
TULA WELLS
NATIONAL REGIONAL BOUNDARIES
INTERNATIONAL BOUNDARIES

Fig. 1

Fig. 2

Fig. 3


9
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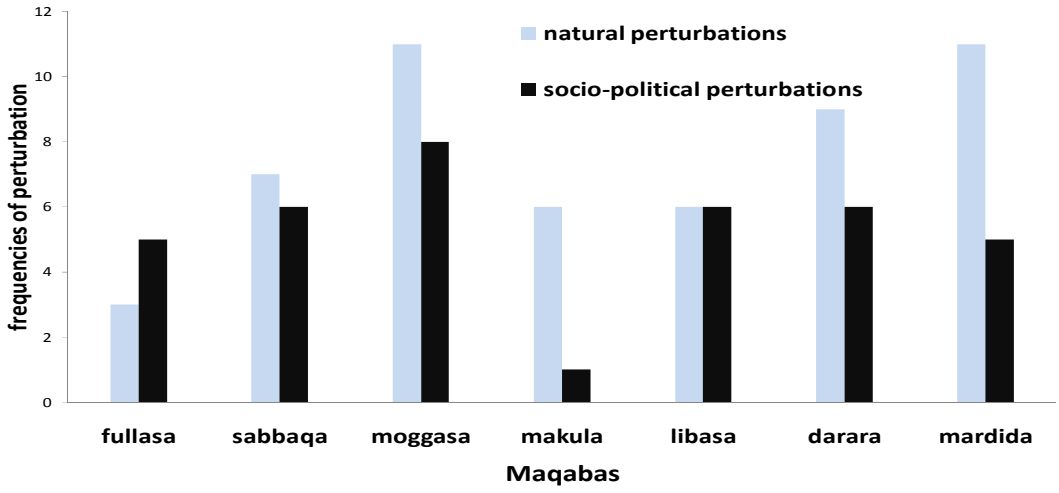
trends of perturbations
1560-1600
1600-1640
1640-1680
1680-1720
1720-1760
1760-1800
1800-1840
1840-1880
1880-1920
1920-1960
Time

Fig. 4a


12
10
8
6
4
2
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frequencies of perturbation
natural perturbations
socio-political perturbations
fullasa
sabbaqa
moggasa
makula
libasa
darara
mardida
Maqabas

Fig. 4b

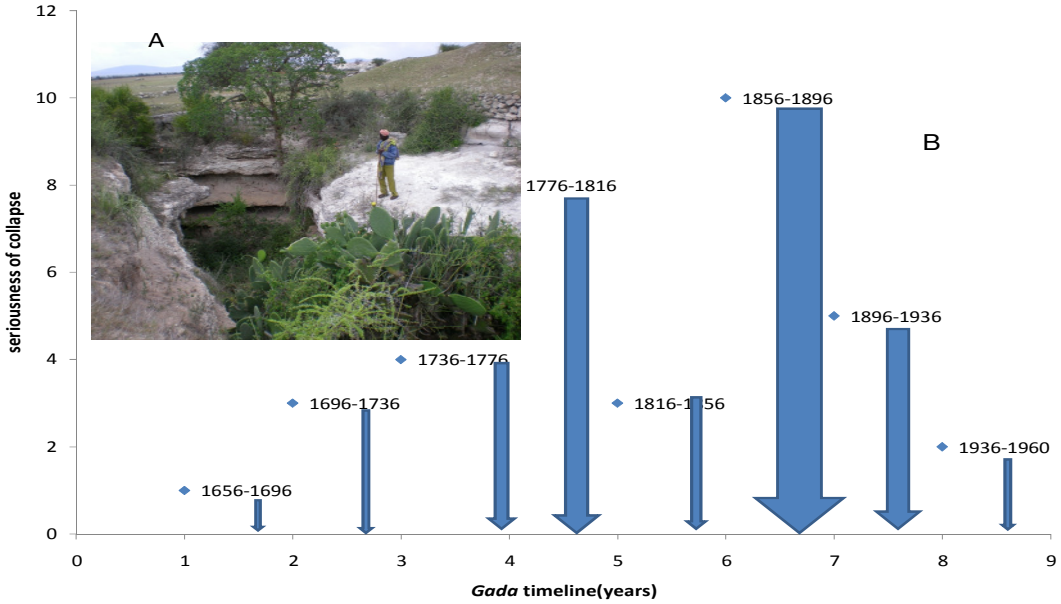
A
B
12
10
8
6
4
2
0
seriousness of collapse
0
1
2
3
4
5
6
7
8
9
Gada timeline(years)
1656-1696
1696-1736
1736-1776
1776-1816
1816-1856
1856-1896
1896-1936
1936-1960

Fig. 5

Paper II

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Ciinna – the Borana Oromo narration of the 1890s Great Rinderpest epizootic in North Eastern Africa

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During the last quarter of the nineteenth century, consecutive natural calamities occurred in North Eastern Africa that collapsed pastoral economies and forced human adaptations. A rinderpest epizootic and devastating famine characterized the period. Using oral narrations of the Borana Oromo of Southern Ethiopia, this paper discusses the impact of the Great Rinderpest of the 1890s on cattle, as well as the subsequent famine, and the beginning of predation by carnivores on humans. Societal memory is utilized to reconstruct that particular historical period, referred to by the Borana as *ciinna tiittee guracha* – the "extermination of cattle whose corpses were covered by swarms of black flies". The pastoral economy and human population collapse that occurred left imprints on historical traditions. The impact of the pandemic was explored in this study by discussing family traditions of the unusual danger of man-eating carnivores, the practice of pawning children, the dispersal of populations, the wiping-out of entire families and, most critically, the crisis of social identity. We examine societal responses and the revival of those social institutions that coordinated recovery and the redistribution of resources. We attempt to understand the process of recovery: the importance of head counting the survivors, the social and ritual re-organization of the *gada*, and the revival of social institutions that re-created social harmony and promoted pastoral economic recovery.

Keywords: demographic collapse; epidemics; oral history; rinderpest; Southern Ethiopia

During the last quarter of the nineteenth century, consecutive natural calamities occurred in East Africa and the Horn of Africa that led to the collapse of human populations. A series of disasters – a rinderpest epizootic, smallpox epidemics, social disorganization and devastating famine – characterized the period. This paper records the oral historical narrative of the Great Rinderpest of 1891. Rinderpest is a viral disease that affects ruminants and is known for spreading rapidly across wide geographical regions. It affects cattle and other ungulates and can result in 100% morbidity and up to 90% mortality of the infected animals.[1] The impact of the Great Rinderpest was described in chilling terms in contemporary accounts. One of the eye-witnesses reports: "We first saw [August 1891] terrible evidence of the great rinderpest epidemic ... The buffalo were chiefly affected and they came down the Tana River in thousands to die ... it was a tragic sight to see all these great creatures dead and dying."[2] The same source continues: "the stench was nauseating and one could not have believed that there were so many carrion birds in Africa as were collected for the feast ... all was desolation ... desiccated remains of tens of thousands of

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beasts were piled up in the form of a wall".[3] The fatality of the disease is described as "acute ... [it] does not attack the same animal more than once in its life".[4] Helge Kjekshus describes the Great Rinderpest as "the event that led to the collapse of a man-controlled environmental system ... which broke the economic backbone of many of the most prosperous communities, undermining established authority and social structure".[5] James McCann states that in Ethiopia, "culture was dying and a life was coming to an end".[6] Richard Waller refers to the pandemic as the "disease that struck Maasai without warning and overwhelmed them by its rapidity and virulence".[7] Lord Lugard, one of the eye witnesses in the British East African colony formerly known as Tanganyika, writes that "never in the memory of man, or by the voice of tradition have the cattle died in such number; never before has the wild game suffered as such".[8] Even as far away as South Africa the epidemic "caused incalculable suffering and material losses".[9]

Historically, rinderpest was not known in Africa before at least the 1840s, when outbreaks in Egypt were recorded.[10] An isolated case of cattle disease, suspected to be Bovine plero-pneumonia, was reported by Joseph Thomson in 1883, when he witnessed great cattle devastation in Maasai land.[11] Many scholars agree that the 1890s rinderpest epizootic was introduced to the Horn of Africa around 1888 by infected cattle from Asia brought by the Italian army when it occupied Eritrea.[12] Richard Pankhurst, referring to eyewitness accounts, states that:

> Hamasen (Eritrea) was the first to be affected ... within three days all the cattle in the province were paralyzed, refused to graze and died. The epidemic then spread to Tigre ... swept across all the Northern Province travelling by way of Tigre, Begemder and Lasta to Gojjam ... then spread to Shewa.[13]

The rinderpest spread "like wild fire"[14] over the whole of East Africa, "from sea to sea".[15] Many individuals who were rich before the outbreak became destitute.[16] Bahru Zewde citing the biographer of Menelik II captures the picture of economic and social destruction "a nomad owning a thousand head of cattle before the famine, ... was left with only one or two".[17] Herds of a thousand or more cattle were reduced to a few survivors that were not in good condition.[18] Richard Pankhurst puts cattle losses at 10,000 to 12,000 head among the richest families of Oromo.[19] Pankhurst and Johnson estimate the general loss of cattle among the Oromo to be one-half to four-fifths.[20] However, which specific Oromo group or groups in the south are being referred to, is not clear.

The Great Rinderpest is remembered by local communities as one of the many epidemics such as typhus, cholera, dysentery, and influenza that occurred at the end of the nineteenth century.[21] Furthermore, since the numbers of natural preys were drastically reduced as a result of the epidemics, wild carnivores began to attack humans. The people also suffered a smallpox outbreak. [22] The first appearance of smallpox in Africa was reported to be around 1600,[23] while its first appearance in the Oromo land in Ethiopia was around 1690s.[24] Since then it was known for causing serious infant mortality despite its beneficial impacts of immunizing the surviving population against later outbreaks of the disease.[25] Smallpox epidemics of the 1890s, however, attacked all social categories indiscriminately. The demographic and economic collapse put the pastoralists' adaptive and survival strategies to their greatest test.

However, the reported accounts have met with criticism. Spinage, for example, criticizes the language used to describe the disaster as "exaggerated". What Spinage disagrees with is the assumption that Africa had previously had long periods of ecological and social stability. Holger Weiss (discussing the impact of rinderpest in Western Sudan in the 1890s) further hypothesizes that these communities had historically experienced worse disasters,

but that those were underreported before the arrival of Europeans.[26] Understanding the impact of an epidemic on an economy, its demographic consequences and the societal response to it, requires analysis of historical human disaster responses using collective social memory.[27] Such collective memories are a feature of many African societies.[28] In the words of Gregory Maddox "they have developed a collective explanation for both the causes and the effects ... the collective metaphors, to which the *mtunya* [famine] has given life and especially the image of social disorder and dislocation, flow from individual memories of the famine".[29] Thomas Spear suggests that oral traditions present the main lessons from the past in a summarized manner by compressing them into a single elegant message for the present.[30] Jan Vansina, Joseph C. Miller, and Jeffrey Fadiman also emphasize the role of oral tradition in reconstructing the past.[31] To the best of our knowledge, only a few historical investigations attempted to use oral sources to reconstruct the devastation of rinderpest and societal responses. Thus, the existence of different opinions as to the extent of the devastation caused by the rinderpest epizootic, severity, and the impacts of man-eating beasts on the society, remain untested. The exceptions are the landmark studies by Richard Waller, James Giblin, Helge Kjekshus, and Richard Pankhurst.[32] It remains unclear from these sources whether the communities they described had previously been exposed to far greater disasters.

In the case of the Borana, oral sources suggested that they had experienced nine great devastations (*Boranni sagal ciite*) including the 1890s rinderpest.[33] However, eight of the devastations were encapsulated in timeless historical traditions and their impacts on the society and environment remained unexplained. It is only the 1890s rinderpest epizootic that is vividly remembered and narrated by oral historians. The Borana social memories of the 1890s rinderpest provide us with detailed explanations of the devastation of the cattle economy, the impacts of man-eating beasts, human responses to the disaster, society's determination to prevail, and institutional resilience that ensured fast recovery. Yet, no research has captured the details of the societal memories of this disaster. Furthermore, how the society responded to the disaster, the revival of social institutions, measures taken by the society to reorganize the dispersed population, and the speed of pastoral recovery have not been examined.

In this paper we use indigenous knowledge and social memories of the Borana Oromo of Southern Ethiopia to reconstruct the impact of the Great Rinderpest of the 1890s on the cattle economy, and the resulting collapse that led to famine and attacks by man-eating beasts. The event left historical imprints on human memories in terms of changes in livestock and human demography that were summed up as the "termination of the pastoral economy" (*ciinna*). In the phrase *ciinna tiittee guracha*, "termination" has a broad meaning. It refers to the termination of social, economic, political and cultural structures. *Ciinna* means the complete discontinuity of pastoral life that created social disorientation and disharmony. The complete termination (*ciinna*) of the cattle economy caused the disruption and discontinuity of survival strategies.[34] The Maasai have a comparable term that Richard Waller records as *emutai*.[35] This refers to the damage to the capacity of indigenous institutions to mitigate the impacts of the multiple disasters that occurred simultaneously. The impacts of the pandemic were examined by discussing individual memories of a family's suffering, the unusual danger posed by man-eating carnivores, the practice of pawning children, the dispersal of populations, the wiping-out of entire families, and the disappearance of whole clans, resulting in crises of social identity. We examine the pandemic within the context of societal responses and the revival of those social institutions that coordinated recovery and the redistribution of resources.

The effort of recovery necessitated assessment of the demographic condition through head counting and reorganizing the clans and sub-clan to create a viable social system. We further examined: a) the oral narration of the 1890s rinderpest epizootic and its impact on the pastoral economy; b) the impacts of famine, man-eating beasts, and smallpox pandemic on human demography; and c) societal responses to the disaster by re-building the "broken" families, the revival of social institutions, and roles played by clan social security system in rebuilding the pastoral economy. We attempt to understand how the revival of social institutions and the importance of symbolic representations and performances of the *gada* rituals were used to create social harmony and promote pastoral recovery. The resilience of the system is apparent from the magnitude of the economic and social suffering the Borana pastoral production endured towards the end of the nineteenth century. An important aspect of this paper is the link it provides between the studies on the Maasai in East Africa by Richard Waller and the research on the Ethiopian highlands by Richard Pankhurst.

The first section describes the data collection methods used in this study. The second section presents the oral narratives of the rinderpest outbreak and its impact on the pastoral economy. In the third section, the impact of famine and the effects of man-eating carnivores on human demography are described. The fourth section highlights the impacts of smallpox and the fifth section examines the human responses to *ciinna*, while the sixth section considers the impacts of the disasters on human demography. The seventh section presents the society-wide measures of head-counting (1892) and evaluations of families by clans, the dispersed and scattered populations, the moralities of pawning children, as well as methods of negotiating social conflict. In the eighth section, a brief summary of family rebuilding and the gathering of lost children are presented. The ninth section investigates the revival of the *gada* institution followed by discussion of clan social security system: *busa gonofa*.

Data collection

The study was conducted in the Borana zone of the Oromia Regional State of Ethiopia among the communities around the six *tula* well clusters.[36] The well clusters have been sources of water for several centuries, centres of social memory for historical events in the past, and remain so in the present and are, therefore, the focal point of Borana social organization and pastoral land use. The wells, being sources of water in this semi-arid region, are the cause of human and livestock population concentrations.[37] Dependence on the *tula* wells for water during the dry season results in congregations of tens of thousands of animals from the different grazing zones that surround the wells (Figure 1). The *tula* wells are also meeting places for social interaction and the performing of the *gada* rituals.[38]

We interviewed oral historians and elders selected from six *tula* well clusters: Web, Dhas, Gayo, Dubluq, Melbana and Erdar. The knowledgeable individuals selected were well known for their competence in oral history. One particular individual, Borbor Bule, known for his encyclopaedic historical knowledge, was valuable in helping us to identify other oral historians. Group discussions were conducted at each of the well clusters for us to understand the collective memories and clarify facts. The discussions, as well as the interviews, were recorded with the agreement of the participants. In some cases, Borbor Bule was asked to conduct the interviews and his competent approach resulted in the detailed recall of events and names of people and places, as well as vivid descriptions of the disaster. The majority of the informants were elderly, aged over 60 years. The elders in most cases had been closer to people whose parents lived through the epidemic. Some cited the

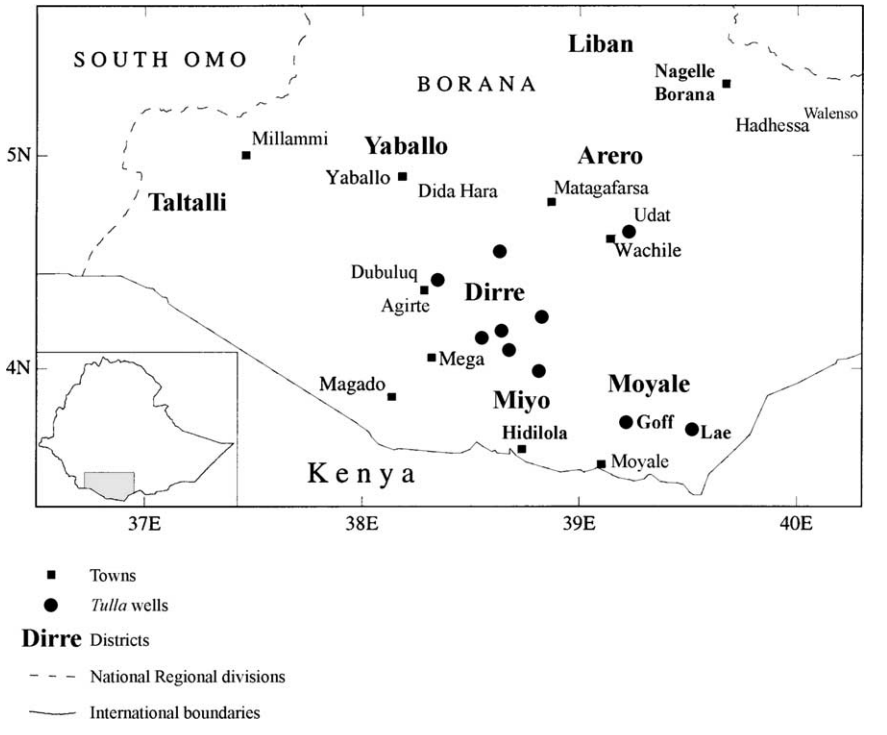

Figure 1. Map of southern Ethiopia showing locations of the nine *tula* wells.

names of renowned oral historians (now deceased) as the authorities on whom they relied. Others described the event as part of family history. It was common for the narrators to refer to their sources ("this information was described [passed on] to me by X or Y") or to state that their fathers had told them.

Our interviews turned into social gatherings that became part of historical dialogue for the younger generations and, as such, are an example of how historical events are registered in social memory in the present. Stories of the pandemic must have been repeated in the past at such social gatherings many times. All that is required is a social forum. The discussions for this study were conducted in the traditional form of social interaction, where participants make contributions without hindrance.[39] Our aim was to understand the narrations of *ciinna* as a social memory.

The informants described geographical variations in the devastation, intra-community differences in the effects of the pandemic, successful as well as failed strategies that were employed by various families, and how the community ultimately survived. From individual and collective memories of the 1890s rinderpest epizootic, it became apparent that the Borana have a well-established system of recalling the past. A surprising amount of detail enables the society to create oral traditions, myths, and legends as a means of storing memory.[40] We used the resulting social memory of *ciinna* to understand its impact on three interconnected systems: the cattle economy, traditional *tula* wells, and human demography. Some oral historians narrated the events with such details of the impact and the societal responses to cope with the devastation, as if they had only occurred a few decades ago. The oral sources told of deaths in their families, related either to famine or attacks by man-eating beasts, as well as the disruption of the cattle economy and collapse of the human population. The Borana oral narratives referred to sequences of events

before and after the rinderpest outbreak. Cattle are the economic base and the source of political power of the Borana. They are the means of performing the *gada* rituals and getting married. They support the social security networks of sharing, called *busa gonofa*.[41] Livestock is distributed from the wealthy to the poor and is a means of building friendship networks.

The oral narratives of the rinderpest outbreak

Rinderpest destroyed the Borana pastoral economy and caused massive starvation. Water points were the main sources of contamination and this resulted in the abandonment of the *tula* wells and the surrounding grazing lands.[42] Swarms of black flies were graphic evidence of the disease. Informants remembered which herd had been the first to be affected. The oral sources reported that the outbreak occurred in 1891, the third year of the *gada* of Liban Jaldesa (1888–96). There were two viewpoints on how the disease first appeared. Some elders recalled that traders conveyed reports of the epidemic in the north (the direction of the Ethiopian highlands). There was evidence of dead wildlife species such as buffalo, giraffe, Grant's gazelle (*hiddii*), and gerenuk (*gugufto*), as well as some dead cattle in the area of Gomole in northern Borana.[43] The carcasses of great kudu *(gadamsa*) and other ungulate species were found in the forests before the flies arrived in the region of the *tula* wells.

The other viewpoint suggests that the Borana unintentionally facilitated the contamination after hunters found a dead buffalo, covered in swarms of black flies, in the bush. The hunters initially did not agree on what to do with the carcass. Some wanted to share the meat, while others were suspicious of the cause of death of the buffalo because of the unusual presence of swarms of flies. Finally, they agreed to skin the animal and share the meat, which they carried to their respective homes. According to the oral informants, the hunters were followed by swarms of flies that then invaded the healthy cattle and spread the disease.[44]

> Black flies invaded animals, and then the feeding habits and physical appearance of cattle changed. They refused to graze and drink [water], and then died . . . [The] black flies entered through oral orifices [and formed black masses on the ribs of the carcasses]. The vibrating sounds of the "army" *tuuta* of flies [can be] heard all over . . . all domestic animals and wildlife became victims.

The rapid infection and subsequent death of the cattle convinced some of the Borana that the flies were the means by which the disease was transmitted. There is, however, no scientific evidence to support this. The black flies were the type that feed on carcasses. They entered the orifices of live and dead cattle, feeding on the flesh and depositing their eggs. The fly pupae then also used the carcasses as a source of food. People thought that the virus was spread by the flies from wildlife to cattle.

Another viewpoint suggested that the disease spread from pools of water in which carrion birds such as marabou stork (*Leptoteros crumeniferus*) gathered. It was quite possible, according to the informants that the birds had fed on the carcasses of infected beasts. The storks (*babbo loona*) came from an unknown direction and landed in the water. The informants claimed that "the legs of the birds were red with blood [and that] the storks washed the disease into water".[45] They recalled that the first herd to be infected belonged to a man called Mataa Kitaanaa. His herd was struck at a pond and died in large numbers soon afterwards. Mataa Kitaanaa, not being able to skin the entire herds of cattle himself, asked the communities nearby to help themselves to the meat, while the surplus carcasses were left to be eaten by hyenas and vultures. This was what Hobley termed the "feasts of

birds".[46] The oral sources suggested that each of these activities facilitated the spread of contamination and the disease spread "like wildfire". This was the starting point of the rinderpest outbreak. According to the informants, the incubation period of the disease was short and the possibility existed that the water points were the source of contamination. Most frightening to the population was that many people who ate the meat died of diarrhoea, probably as a result of the unsanitary condition of the meat.[47] In the *tula* wells region, an oral historian recalled that "if black flies were seen among a given herd, there was no hope of finding survivors". There were cases where people, having seen the black flies among their herds, started slaughtering and storing the meat.[48] Others who heard the rumours about the spreading disease tried to move to the highlands. Only a few managed to escape – most lost their herds.[49]

The people in the east of the *tula* region (towards Somalia) were among those who escaped unscathed by the disease. The communities far from the contamination points moved away as soon as they heard the rumours about the pandemic, quarantined all cattle, and minimized their contacts with others.[50] The oral sources were unanimous that the cattle in the eastern rangelands (towards Somalia), the hot lowlands in present day Kenya, as well as pockets of the highlands (*baddaa sadeen*) in central Borana, were spared from the epidemic.[51] The regions that were devastated by the rinderpest epizootic were the *tula* well zones where livestock from the surrounding regions concentrated during the dry season. In the words of one oral historian, "no head of cattle survived" in the *tula* region. The *tula* wells were the only source of water during the dry season and thus created perfect conditions for the spread of the rinderpest virus. Historically, the role of water points in facilitating disease transmission is well documented.[52]

Some of our oral sources reported that the pandemic devastated cattle populations in the *tula* region within 18 days, while others suggested that the pastoral economy collapsed within 30 days. In Eritrea, all the cattle in the Hamasen province were reported to have died in three days, while the loss of all cattle in Bulga (central Ethiopia) occurred in eight days.[53] The devastation of the cattle economy exposed the social fabric of the Borana to unprecedented pressure. Although we lack documentation about cattle losses we can make inferences from reports by European travellers. Donaldson-Smith, who passed through the *tula* region in 1895, reports:

> I saw a single track of buffalo, but none of the animals themselves. The cattle disease that swept through this country five years [in 1891] ago spared scarcely one of those fine animals out of the herds of thousands that used to roam about, as is shown by the quantities of skulls lying about ... every side.[54]

The Italian travellers, Vannutelli and Citerni travelling with Buttego when crossing Boranaland in 1895, reported evidence of a cattle epidemic. They saw footprints of buffalo, but found no actual animals, which was "now very rare after the last epidemic that destroyed all the cattle".[55] Another eyewitness, who travelled through Boranaland a few years after the epidemic, reported that the Borana had not recovered fully from the rinderpest epizootic. He states that the "rinderpest had been particularly bad on Borana".[56] Fitzgerald, who travelled through northern Kenya in 1892, summarizes the overall impact of the epidemic:

> [T]he Galla [referring to the Oromo of the Tana River] whom we met reported that in the country to the north [referring to Borana in Ethiopia or northern Kenya] there were numerous topi and a few rhinoceroses, elephants, and ostriches, but that giraffes had suffered from the disease which had played such havoc among the ... buffalos ... at a period the wa-Galla (*Oromo*) used to feed their cattle here, but now they appear to possess none ... I was informed

> that in the year 1889, the wa-Galla owned from 200 to 3000 head of cattle [per family] ... but all the cattle were destroyed by the disease.[57]

Richard Pankhurst reports how the oral sources described the "great havoc" the disease caused to the Borana pastoral economy.[58] The devastating impact of rinderpest on cattle and other ungulates was also reported for the Maasai in Laikipia. Elsewhere, in western Sudan, Holger Weiss reports that the rinderpest decimated the cattle of the Fulani, stating that: "some [Fulani] were said to have gone mad, going to the bush screaming ... leaving their families and wandering naked in the bush, eating dust".[59] In all areas the loss of cattle produced famine. The most common memories to be retold were those involving predators that after losing the natural prey developed the unusual habit of feeding on human flesh. As shall be shown, the unusual predations of humans by such animals as hyenas and lions were both real and symbolic of the disaster.

The famine and man-eating beasts (*gorjam*)

Three factors contributed to the dramatic changes in human demography. First, the mass mortalities of livestock within a few days left the entire society without food. The community skinned many dead animals to dry and store the meat,[60] but this was insignificant in preventing long-term famine.[61] After the dried meat was finished, people ate dried skin and hides and tried other means of survival including dispersing into the bush to hunt wildlife and gather wild plants. Waaqoo Halake reports the breakdown of food sources:

> [T]he community skinned up animal carcasses and stored both meat and the hides.[62] After the epizootic, people survived for some time on dried meat that was stored. After the stored meat was exhausted, people resorted to eating dry skins and hides. When skins [had been] eaten they had no option [but to suffer famine] ... people tried to hunt game and gather wild fruits.[63]

For the pastoral Borana who lacked a diversified means of survival and depended mostly on cattle, the impact was serious. Traditionally, the Borana co-habited with the Waata hunter-gatherers who occupied a social category that played a crucial role in ritual, but who were nonetheless despised because of their habit of not practising food taboos. The turn of events forced the Borana to become hunter-gatherers and change their food habits. Traditionally, the Borana hunted "clean" wildlife – gerenuk (*gugufto*), oryx (*saala*) and giraffe (*sattawwa*). They hunted in bands with the help of horses and dogs.[64] The difference between the hunter-gathers (Waata) and the pastoral herders had disappeared. This was evident in the breakdown of food taboos, when, like the Waata, the Borana began eating the meat of donkeys, horses, elephants and warthogs, as well as scavenging carrion. Indeed, the oral sources suggested that the survivors were those who took refuge with the Waata and adopted their food habits.[65] This was also observed among other pastoralists who suffered pestilence in eastern and north east Africa.[66] Pankhurst and Johnson refer to "impure foods" that included putrefied animal corpses.[67] The breakdown of food taboos, the abandonment of children, voluntary enslavement, suicide, murder and cannibalism were common.[68] Having no food to eat, the community was exposed to famine, the worst in living memory. The Borana experience was captured in the narratives of Godana Ajaa, told to one of us several years ago:

> *Ciinna* was the end of everything as the Borana knew it ... families disappeared, clans disappeared, *raba gada* disappeared, the land was left empty ... our fathers have no recall of such a calamity [before then].[69]

The real impact of the rinderpest was far reaching, with ecological disturbance and changes to the predator food chain. Lions, hyenas and other carnivores that habitually preyed on wild and domestic animals resorted to eating people who were weakened by famine and, later, by smallpox (see below). Uncoordinated individual strategies and institutional failure have been suggested as factors contributing to people being exposed to wildlife attacks. Since there was no organized defence, they became the victims of *gorjam*[70] (man-eating beasts). Hyenas and lions attacked famine weakened people easily. Hyenas were more vicious than lions in attacking humans. The problem of *gorjam* occurred mostly during the night but the dispersion of people into the bush in search of food during the day also exposed them to the attack. Waaqoo Halake narrates the impact of *gorjam*:

> While going into the bush in search of food, some people died of hunger, and hyenas ate human flesh, this was followed by countless numbers of people taken alive. [In general], it was the worst time in Borana history, which we do not want to be reminded [of] ... but also which we cannot ... forget [because of the imprint it has left on the societal memory].[71]

The oral historians suggested that previously, hyenas and lions eating human flesh had been unusual, but during the famine the predators ignored domestic animals such as goats, dogs, donkeys and horses that had survived, and began to attack humans. There were two important reasons for this behaviour of wild carnivores in regard to humans. The most likely explanation was that the famine-weakened human population was defenceless against the man-eating predators, and was therefore an easier target than domestic animals and wildlife.[72] This was why the local community referred to these extraordinary predators as *gorjam*. A natural predator feeding on wild game and domestic animals would be called *koote* (the paw). The second reason why humans were at risk from predators was because of competition between people and hyenas over carcasses. Given that both were scavenging, the hyenas' behaviour might be interpreted as fighting for survival in competition with humans. Alternatively, the relative increase in references to man-eating beasts might actually have referred, not to animals, but to people practicing cannibalism on famine-weakened or dead people, thereby assuming the food habits of *gorjam*. The *gorjam* was therefore real as well as metaphorical because of the belief at the time that some individuals by eating some specific fruits and playing rituals could be turned into beasts. This is not dissimilar from mythical stories told to children about the *gorjam* that took away the naughty ones. Yet, this was widespread as also reported by others about man-eating beasts in the aftermath of the pandemic.[73] What was not in doubt was that both the *gorjam* and the famine killed many people.

James Harrison, who crossed the western side of the Borana region in 1899, came across many dead people, with the few survivors feeding on plant roots. This might have been the second famine in a decade, before a full recovery from the rinderpest began:

> We passed hours after hours through silent cities of dead, counting six to eight corpses laid together, while inside the kraal you could see the whole family just as they had perished, the last having crawled and dropped almost on the embers of the fire. The few living people were crawling about eating the young shoots of a certain weed and digging up grass roots ... they dug up these sieve roots and ground them up, eating them instead of meal.[74]

Such scenes were widespread. Several scholars described the interconnectedness of different natural calamities and their social, economic and environmental impact.[75] The lack of material reserves and the failure of social systems exposed the society to famine.[76] It was a period when all food taboos were violated to the extent that cannibalism was practised. Alula Pankhurst describes the famine as the "removal of social garments and

revealing the savage animals beneath".[77] This shameful and dehumanising famine in northern Ethiopia was heart wrenching. James McCann reports that:

> [A] culture is dying .... A complete way of life, virtually unassailed for 3000 years, is coming to an end ... rapidly turning to dust, merging wearily into the barren and stony deserts that surround it. As it does so, the human populations that it supported for so long are blowing away having slaughtered their draught oxen and eaten their seed grains, the people are leaving for ever their eroded field and terraces.[78]

The story is the same among other communities during the rinderpest outbreak of the 1890s.[79] Many families lost members to *gorjam* or hunger. Few families survived intact, while some died out completely, creating social discontinuity. The impact of the disaster was different for the various social categories. The Borana oral sources reported that children, weak and sick people, women and the elderly were the most vulnerable social groups.[80] The stronger individuals were too preoccupied with their own survival to help others. Young men and women survived by hunting, gathering and by climbing into trees during the night to escape *gorjam*.[81] After their parents had died, children became victims. They could not protect themselves against the *gorjam* by living in trees as adults did, and they were not strong enough to gather wild foods or hunt.

Among the Maasai, the most vulnerable social categories, such as the elderly and children, suffered from the famine much more than the young warriors did. The latter were more exposed to smallpox while hunting and raiding.[82] The "warriors somehow managed to survive by hunting and petty thieving ... women, children and old people suffered the full measure of the tragedy".[83] Incidents of hyenas preying on people were a major problem in northern Ethiopia during the period 1888 to 1892. The Amharic term "*wesedegn*" meaning "took me away" was particularly apt throughout the famine period when hyenas carried away helpless and weak people.[84] Graham Hancock, for instance, quotes written sources: "to increase our affliction, the hyenas, having devoured the carcasses, and finding no other food, fell upon the living, their natural fierceness being so increased by hunger that they dragged children out of the houses".[85] Smallpox followed in the wake of the famine and the *gorjam* to finish off what had been left.[86]

The impact of smallpox

Smallpox, one of the most horrid human diseases arrived on the footsteps of the rinderpest, the famine and the *gorjam* problem, summed up the concept of *ciinna* as understood by the Borana. According to oral sources, this disease was introduced from eastern direction, *ill boru*, where animals survived rinderpest. Unfortunately, this region attracted many people from rinderpest affected regions who were moving around to get clan assistance: *busa gonofa*. Oral sources report that this facilitated the rapid transmission to the *tula* region that already suffered the rinderpest disaster. The most remembered event was that the smallpox was responsible for the death of the *Abba gada* (Liban Jaldesa), while the *gada* was in the progress of visiting the ritual sites in Liban in the East (see Figure 1).

The smallpox epidemic is widely reported in historical literature for coinciding with the rinderpest epizootic of 1890s.[87] It contributed to the disorganization of communities who tried to maintain their intactness despite the devastation of the famine. People who escaped death abandoned the areas and migrated to other places, where such human mobility created opportunity for further disease transmission. Many victims of smallpox and famine presented themselves (and in some cases their families) for adoption to neighbours

who escaped the devastation.[88] Smallpox weakened the military power, claimed productive forces, and exposed the weak to attacks by *gorjam*.[89]

The smallpox outbreak in Borana occurred a year after the rinderpest. Sources show that the smallpox of 1890s was the most serious epidemic ever remembered in Borana oral history. Oral sources suggest that the Borana had tried to inoculate the healthy population in order to reduce the severity of the disease. Inoculants from mild forms of the virus were obtained and transferred to the healthy individuals. The procedure of inoculation involved both medical and ritual aspects. Healers vaccinated people, convincing them that illness would not follow vaccination, and that, if it did, it would not be as serious as that of the person who provided the virus. The oral sources recite the poetic expressions used by healthy people for begging the infected for the virus. The vaccinations of the inoculants were done through the nose. The process went as follows:

Bagaa naakeni – Give me smallpox (repeated three times)
Hinkennu – I will not give you (repeated three times)
Ta kiya hingeene fudhu – Take that which is milder than mine

Another preventive method for smallpox was isolating suspects from others by constructing separate huts and providing necessary services in isolation to control the spread. Despite the efforts and measures taken by the communities, deaths of whole family members were reported making burial difficult. The Borana oral historians remembered the situation when huts were collapsed on all the household members, with society incapable of burying the dead (because of famine, disease, and demographic decline). The Borana, in their suffering, sought strategies for responding to the pandemic.

Responses to *ciinna* and smallpox

The only animals that survived in *tula* well zones were equines (horses and donkeys) and small stock. The saying "a few goats are better than a thousand cattle" became common.[90] However, the Borana, being a predominantly cattle-owning people, had fewer small stock than neighbouring pastoral groups such as the Somali and the Gabra, who, with their camel-dominated economy, were relatively unaffected by the pandemic. The households that relied entirely on cattle were the most severely affected.[91]

The oral sources suggested that the community had little time to quarantine sick cattle. The few individuals who attempted quarantine by taking themselves and their animals out of contact with the "hot spots" of the pandemic, saved their herds. Inquiries had already established that the cool highlands in the central plateau and the eastern grazing lands towards Somalia were safe from the pandemic. Some people had, even at an early stage, attempted to inoculate their cattle, but to no avail as the virus had already spread.

The Borana utilized their surviving equines and dogs to start the recovery process in a number of ways. The horses were used for hunting. The domestic dog, traditionally viewed as the "property" of the Waata, was, with the change in fortune, used to assist in the hunting of wildlife for food. Recovery was facilitated through the revival of social networks, which were used for sharing or loaning donkeys. A common phrase of the period was "you have been assisted by them (the equines) to survive the disaster period, also help us to do so" (*isiin ya malkaa dabartanii, nullee malkaa dabarsaa*). The community collected salt and soda ash (*magadi*) from the local mines (*booqee*). Donkeys were then used as pack animals to carry the salt and *magadi* from the mines in Borana to be exchanged for grains from the highlands of Konso and Gedeo. During this time, the long distance caravan trade (*buunaaqa*) with the coast of Somalia, through the markets of Luuqi, Bardheer and Boru

Hache, was utilized by the Borana.[92] Along these routes the Borana exported salt, coffee berries, leopard skins and elephant tusks, and imported cattle, as well as clothes and other manufactured goods that they bartered for grains.[93] Oral historians suggest that one elephant tusk was exchanged for up to 30 head of cattle in Somalia.[94] Thomas Spear confirms the existence of the ivory trade from Southern Ethiopia to the Somali coast during the nineteenth and early twentieth centuries, while Gunnar Kjaerland emphasizes the importance of ivory in restocking Borana pastoralists after the cattle epidemic.[95]

Although there were local variations, similar survival strategies were employed across East Africa.[96] Richard Waller lists the following strategies used by Maasai pastoralists: "skilful management of resources, control of human reproduction, construction of exchange networks and reciprocity with communities across ecological boundaries, dispersal of herds, and pawning".[97] The refugees who moved into neighbouring communities were not harmed as a result of being outsiders.[98] The communities used the situation to fulfil social obligations that they too had benefited from when suffering disasters at various times in the past.[99] We heard no evidence from the oral sources of incidents of looting, raiding and counter raiding as reported among other African societies, although there were cases of common theft.[100] Nura Dulacha, one of our sources, reported that a man was robbed of his goats.[101] Another informant, Waaqoo Halake, spoke of an old man who kept his cow tied to his leg as he slept at night. Nevertheless, thieves cut the rope without disturbing the man and took away the cow. This type of incident is perhaps what Alula Pankhurst was alluding to when referring to a deepening crisis that led to a decrease in voluntary sharing and an increase in robbery and theft due to unusually great social tension.[102]

The Borana who dispersed among neighbouring communities such as the Konso, Gujii and Gedeo agriculturalists, provided herding labour in exchange for food. A greater number dispersed among the camel-owning Gabra and the Garre. The Borana had had strong relationships with the Gabra before the pandemic. They shared grazing and water resources, as well as ritual items, had clan alliances, and practised inter-marriage. These very strong social and economic links accounted for Gabra willingness to restock herds and provide relief for Borana families. The relationship of the two communities has been peaceful and reciprocal.[103] The relationship with the Garre was based on the long-distance caravan trade, in which they (the Garre) played an intermediary role. The Garre, rather than providing temporary support to the destitute, absorbed the "lost families" into their community.[104] The change in identity might suggest a shift in power balance between Borana and neighbouring camel pastoralists, who were less affected by the pandemic.[105] The collapse of the Borana human and livestock population left much of their traditional grazing lands under utilised. Soon after this period attacks on the Borana by the Somali clan families in the eastern part of Borana increased.[106] Slavery, albeit uncommon, was reported by the oral sources although they were not specific about the details. The use of the word *tiise* (pl. *tisoota*), meaning "slaves", implied that the practice existed, even though there was no evidence that the Borana conducted slave raiding. On the contrary, the Somalis raided the Borana on the eastern periphery for slaves.[107]

The practice of pawning children was common between neighbouring communities. However, the children's status became a major issue as recovery progressed and the surviving clans "head counted" their members (see section on head counting and recovery). What was rather peculiar when compared to other East African pastoralists, who were also subjected to the pandemic, was the Borana's choice of returning to pastoralism. Unlike the Borana, it was reported that many victims of rinderpest in east Africa shifted from pastoralism to either hunting and gathering or agriculture.[108] The

return to pastoralism implied that the Borana as part of later recovery had safeguarded the key resources such as the *tula* wells, obligatory to revive the pastoral economy.[109] As we discuss the reasons for this in a more comprehensive manner elsewhere, it should suffice here to say that the revival of political and social institutions was the greatest challenge to recovery after the human demographic collapse and the emptying of the grazing lands.

Impacts on human demography

The impact of the pandemic was indiscriminate, affecting all social and wealth categories – families disappeared, children were orphaned, the elderly were abandoned, and women married into other tribes or clans other than the clan of their former husbands. The long term demographic impact of the loss of children and women remained unclear. However, oral sources suggested that it impacted on human demographic recovery. Asmarom Legesse reported that the Borana experienced long term low population growth rates that could be the result of loss of cohorts of younger and reproductive populations in addition to social mechanisms for controlling population growth.[110] For these reasons, social processes towards recovery required major re-organization – the rehabilitation of broken families, and the gathering up of dispersed clan members that had customarily been responsible for the welfare of their members. The process was intended to build more viable groups where necessary, rather than just reconstituting the pre-disaster ones.

The impact of the collapse as a result of *ciinna* was, however, more than just the demographic reduction that disrupted the biological reproduction of the society[111] and changed family structure and roles. The most evident result of all was the social and political reduction of family economic capacity. The situation demanded societal reorganization in order to conduct a large-scale evaluation of the survivors, to determine the resources available to the clans and the wider community, and to "repair the damage". This was what the oral historians called the "head counting of the survivors", in essence a census of the families and clans that had survived the multiple disasters.

Head counting and recovery (1892)

The deliberations and evaluations were conducted by the *gada* leaders and *qallu* (ritual leaders) who gathered survivors to the assembly called *Gumi Qonye*.[112] The aim of the assembly was to carry out a census of the survivors and reorganize the society. This assembly created the basis for social and economy recovery. The primary purpose of the assembly was to re-organize the dispersed community and prepare for recovery of the pastoral system. Several decisions were passed at this assembly, one of which was the establishment of large settlements into which all the survivors were to be gathered. This occurred in the second year after the pandemic. The settlements came to be known as *olla magallata*[113] and were intended to protect people from *gorjam*, assist weak and sick people and bury the dead,[114] and coordinate hunting, gathering and later trade.[115] The previously dispersed form of survival had made people vulnerable to man-eating beasts and therefore the settlements were used for protection and information gathering. Alarms were raised by blowing kudu-horn pipes (*magallata*).[116] The *olla magallata* each comprised 120–200 households. In every well cluster, at least two such *olla* were established, whereas during the normal period before the famine, many smaller settlements had been common with varying population sizes.[117]

From an environmental perspective the organizers tried to spread the settlements to tackle encroaching bushland (*danqara*), a situation that had arisen as a result of the dramatic decline in human and livestock populations. Some oral sources suggested that

people were advised to use wells on a rotational basis to prevent them falling into disuse. The strategy was idiomatically expressed as *akka hartii hingoone, akka raachi hindone* ("so that the ponds do not dry, to save the frogs").[118] Preventing wilderness encroachment and wells falling into disuse were therefore priorities that emphasized the absolute necessity of viable social systems and economic recovery.[119] The advantage of the Borana social system was that it had a proven capacity to absorb shocks and recover without fundamental alteration to its mode of operation. The *gada* council and *qallu* institution were instrumental in re-establishing the social order and facilitating resource sharing. These decisions were taken to contrast to the earlier disorganization.[120]

The immediate task was to assess the impact of the disaster on human demography by head counting. This involved counting the surviving heads of households and their families. The evaluation of ponds and wells was also part of the census.[121] The counting was done at lineage and clan levels in accordance with the rulings of the general assembly of *Gumi Qonye*.[122] First, the census quantified the status of individual clans in terms of their populations and their reproductive potential. Second, the process of reclaiming individuals who had migrated to neighbouring peoples began. Third, plans to re-establish pastoralism were put in place as part of the recovery process. One of our informants relayed the history of his family:

> My grandfather survived in Konso (the highland farmers) [where he] was pawned to herd goats. He was the only person who survived in the family .... After *ciinna*, when everything was back to normal, and after head counting by clan, the rumour was heard that a man from Borana was herding for Konso. The clan did not waste time but sent people to ... claim him back. By that time he spoke in Konso language .... He returned, married and fathered many children from whom we are descended.[123]

The census established that the disaster had reduced the social and economic viability of many clans and lineages, but the fast recovery after the epizootic appeared to attract many people to return. The decision of the Assembly of *Gumi Qonye* was therefore to create a different social structure by merging clans and sub-clans that had lost viability, thus creating functional social networks. In some cases, where the lineages were sufficiently intact, they could start with the process of distribution of *busa gonofa* (clan-based social security) at lineage level. In other cases, where clans and lineages had lost great numbers of their members and the resources were inadequate, the decision was to merge the proximate sub-clans to make them more economically viable.

The Alchaya clan, for example, was joined with the Maliyu for *busa gonofa* after *ciinna*, and the Limmu sub-clan became too small and was merged with the Saaroo lineage.[124] There is a vernacular joke that the Alchaya clan lacks its own identity: "*Jida-Maliyu jennaan Alchayan ofiin yaatee*." This means that the Alchaya clan (having lost its own identity) responds whenever the two cooperating clans, Warra Jidda and Maliyu, are mentioned by name. The impact of demographic decline was felt first at family level, since those families that had strong people who survived coped better and recovered faster. Economic inequality had created social inequality as well. This was amply demonstrated by those few families with livestock who were able to absorb stock-less people as herding labourers. Such control of labour is also widely reported among other African communities following the pandemic of the 1890s.[125]

The wealthy people, who partially or fully escaped the epizootic, had many orphans under their control whom they collectively named *arganne* ("we pawned him/her"). This situation was discussed at a clan head-counting meeting. Jilo Boru, a *hayu* (*gada* councillor) who arrived late at one of the clan meetings implementing the decisions of *Gumi Qonye,*

raised the issue of child pawning. In accordance with the Borana custom, latecomers to meetings were not prevented from delivering an address. Jilo Boru therefore asked the convener of the meeting for permission to speak, but the participants were furious and considered his intervention an interruption to the important proceedings. Jilo Boru, being a wise man, was patient but insistent. When he got the chance to speak he delivered his speech in a symbolically loaded message:

Dhuguma dubbii irraa laturee – Yes, I was late for the palaver
Daallee timaa – Only fools are hasty
Qaroof kuufamaa – For the wise this is accumulation [of knowledge]
Najalaa qabaa – Give me your hearing.

Expressing himself in this symbolic and poetic way, he was allowed to speak. Addressing his question to the *qallu*, the ritual head of the moiety who was the convener of the meeting, he continued:

Rindiltichi Waannoo galee – The Rendille was adopted from Waannoo[126]
Arsichi Dallo galee – The Arsi was adopted from Dallo
Safartichi Luuqii gale – The Somali was adopted from Luuqii
Jamjamtichi Girjaa galee –The Jamjam (Guji) was adopted from Girjaa
Arganneen kuuni nama essaa galee? – Where was this *arganne* from?

Yes, all the others adopted were from the communities mentioned, but how could the current position of the *arganne*, being Borana, be explained *vis-à-vis* customary law?[127] In Borana customary law, there is no provision for adopting another Borana by holding them captive or giving them a new clan identity. This could only be possible with non-Borana who must undergo the ritual of being made Borana.[128] This was the inconsistency Jilo Boru wanted to the meeting to address.[129] The decision taken was to force the families that adopted orphans to return them to their clans and sub-clans. Other forms of relationships such as caring for the orphaned children, and the arrangement of helping with herding, were to be made with the full knowledge of the families if they were still living, or of their clans if they could be identified.

Richard Pankhurst quotes early Italian travellers such as Captain Bottego who wrote that starving parents either sold or gave away their children to avoid them dying of hunger.[130] There was evidence that the Borana practised the pawning of children with the Gabra, and our sources suggested that some Borana families might have pawned their children in exchange for camel meat. According to one oral source, meat from a single camel was exchanged for six children.[131] This might have encouraged the kidnapping of children to exchange for food, which did happen during the crisis, and which was discussed at the assembly of *Gumi Qonye*. Returning children to their rightful clans therefore became problematic when their parents and close relatives did not survive.

Borana children are taught about social identities in terms of family name, lineage, and clan from an early age. This is one way of ensuring lineage continuity, by transmitting basic knowledge of clan and lineage identities.[132] Children who lost parents and other close relatives during the pandemic were taken in and brought up by other families. Oral historians told of cases when orphans who were very young could not recall any of their social identity markers. This was one of the issues raised by Jilo Boru. Since being a clan member was a pre-requisite for survival, the community had to develop a mechanism for assigning the orphans to clans "using random allocation" without violating customary laws. It worked as follows:

> A meeting was held and the cultural food, *buna qalaa* was prepared.[133] The clan representatives were gathered in a circular sitting ... and a cup containing *buna qalaa* was given to the orphan and he was told to give it to "his father". The orphan looked around and gave it to one of the old men. Without creating anomalies and contradictions, the boy was assigned to that man's clan with full privileges and obligations as a son. The "adopter" took the boy with the obligation of treating him in the same way with his biological sons.[134]

The above example illustrates why reviving social institutions was necessary after *ciinna*. Social reconstruction, consensus building, coordination, and the revival of cultural values were initiated, carefully crafted by the incumbent *gada* leaders. The rationale was that as the disaster destroyed the society's ability to function, the need for adjusting and formulating ways of rehabilitating the social system became a major preoccupation.[135] It became necessary to establish new rules that guided relationships among the community by overlooking the violation of food taboos, cultural traditions, and norms that had taken place during the disaster periods. During the pandemic, to protect themselves from *gorjam*, for example, many women and girls took refuge with men. This resulted in a number of sexual transgressions which were customarily regarded by the Borana as polluting. In particular, a man having sex with an unmarried girl was a social taboo. However, many unmarried girls conceived and gave birth to children, which the Borana referred to as *cabana*,[136] children born out of wedlock. Learning from the crisis, the Borana utilized all the opportunities and knowledge systems they had in order to reorganize and strengthen social institutions. The community decided that punishing the wrongs committed during the disaster period would not solve the problems. They had two strategies for social engineering: to forgive all past violations of customs, and to put in place stricter social regulations.[137]

At the assembly of *Gumi Qonye*, all people were pronounced *qulqullo* (clean), whether they had violated sexual norms, food taboos or committed any other cultural malpractices. Those who had joined the Waata[138] and ate animals that did not constitute Borana food (such as equines), and even those who practised cannibalism were pronounced "clean".[139] The rules included harsh punishment for people who ostracized others because of what they had done during the disaster.[140] *Hama-mudammuddi* (the death penalty) was re-introduced to put the system on a firm foundation. The rules called for harsh punishment for deviant members who might want to continue with the socially unacceptable behaviour they had exhibited during the disaster period. The *gada* exerted pressure on the members by defining acceptable boundaries of individual behaviour.

Rebuilding families

In this period of social discontinuity that followed human demographic collapse caused by the mortality, many survivors had dispersed.[141] In such a chaotic situation, the continuity of families and lineages depended on the survival of one or more of three important categories of people: husbands, wives, and sons. Girls do not contribute to the continuity of the natal family line, since the Borana are a patriarchal society. There is no need to debate how the male members ensured continuity of family in a patriarchal society; however, how wives ensured family continuity is worth mentioning. According to customary Borana family law, regardless of who the biological father is, children legally belong to the clan of the woman's first husband. Widows remain the legal wives of their first husband (even after their deaths), and their children are named after the first husband, even when they have a different biological father. There is no transfer of families from the clan of one husband to another.[142] Therefore, women who lost their husbands during the disaster returned with their children to the clans of their deceased husbands when the society was re-organized.

The law was mindful of the contribution made by individuals who had cared for the wives during hard times and ensured continuity of the clan. In most cases the "care-taking" individual was allowed to "retain" one male child as a "gratuity" (*galata*) for his contribution to the continuity of the family (*daaraa baduu dhowwe,* meaning "preventing the dying-out of family ashes"). After the head-counting process had taken place, many women returned to the clans of their former husbands. Their children were named after the deceased "social" fathers, not the "new" biological fathers. From the oral history of several families and lineages, we were informed that their continuity came about through such cases. For example, the wife of a man from the Digalu clan who had lost her husband during *ciinna,* took refuge with another man from the Karayu clan and he sired seven children with her. After a long period, the Digalu clan claimed the women and the children, leaving one son for the Karayu man as a gratuity.[143] Thus, the children may have belonged biologically to the Karayu father, but socially they belonged to the Digalu father. The same thing happened across many of the seventeen Borana clans.

Another example was the story told to us by one of our sources, a member of the Nonitu clan, whose grandfather had been a victim of *gorjam*. His grandmother took refuge with a man from the Warra Jidda clan and continued living with him. She gave birth to several children. However, during the head counting after *ciinna*, this case was discovered and the Nonitu clan claimed the women together with her children. However, she refused to leave her new husband. Several decades after the pandemic, she came up against a cultural obstacle to the performance of the retirement ceremony (*gadamoj*) during the *gada* of Arero Gedo (1920–28). The clan of her second husband (the Warra Jidda) refused to recognize her as the legal and senior wife, and denied her the right to settle at the ritual site (*arda jila*) with her husband. She then decided to re-join the Nonitu clan of her former husband, with her 12 children, grandchildren and cattle,[144] leaving one of her sons with the Warra Jidda father. The situation described above put brothers in different social categories, with different expectations and roles in society. The changes implied that the sons in the Nonitu clan would have marriage partners, political alliances, use of wells, social security systems, and other clan obligations and privileges different from the brother left with the "adopted" clan. The descendants of the children belonged biologically to the Warra Jidda father, but socially they were categorized as Nonitu and shared that clan's social obligations. The complex social relationships of this family, with both Nonitu and Warra Jidda fathers, have continued for many generations. Even today, they are addressed as Warra Jidda even though their ancestors had returned to the Nonitu. Such practices created persistent social ambiguities. The most important decision made by the assembly of *Gumi Qonye* was the revival of the *gada* rituals and *busa gonofa* necessary for revival of the pastoral economy through reconstruction of families that dispersed or lost.

Revival of *gada* rituals and institutions

Recovery required social engineering as well as the revival of *gada* rituals, without which social harmony could not be restored. The democratic and participatory reorganization of the Borana was said to have contributed to the fast recovery of the system, by bringing people together and enabling cooperative action. This cooperative action helped in pooling resources to overcome the socio-economic problems. By establishing social reconstruction, people were helped to regroup and resist further natural disasters. The reorganization needed a holistic approach to a process of recovery which assured human survival and into which cultural and ritual practices could be incorporated. Oral historians narrated the role of cultural practices and rituals in bringing people together to rebuild the peace of Borana.

The determination of the society to revive cultural practices can be understood from the symbolic reactivation of the *gada* rituals that ensured the revival of *aadaa* (culture). Water was substituted for milk in the ritual where milk was traditionally used for libation. The water was referred to as the "milk of the black cow" (*annan sa'a guracha*). The symbolic "slaughter" of the fruit of Solanum species (*hiddii*) provided substitutes where cattle sacrifices were required.[145] The Borana collected the fruit of Solanum species in cattle enclosures and used them to symbolize cattle when performing *gada* rituals of sacrifice. *Hiddii* were slaughtered as religious offerings in ceremonies that would have required the slaughtering of bulls or cows. Their philosophy was: *Aadaan babbaddaa hinjibbitu, hanquu jibbiti malee*, which literally means: "the custom would accept even the 'polluted' (normally unacceptable) but not the 'absence' of symbolically important rituals". The *Hiddii* fruits were also slaughtered as *rakko* (in the marriage ceremony) for legalizing marriages, which would have demanded the slaughtering of bulls or rams. The lack of cattle would have postponed important ceremonies such as marriages (*fuudha*) and naming of new-born boys (*gubbisa*) if the old tradition of cattle sacrifice had been strictly adhered to. The symbolic representation of ritual objects was essential for the revival of important cultural functions.[146] The determination to uphold cultural traditions was acknowledged by the saying "during *ciinna*, Borana suffered but did not abandon *aadaa*" (*Bara ciinnallee boranni hindhiphate malee aadaa hinlakkimne*).[147]

Even though the oral sources emphasize the institutional breakdown, it appears that the Borana did not encounter total institutional collapse, despite the economic and demographic collapses. The *gada* system and *qallu* institutions were capable of reorganizing the society and facilitating recovery. They were also capable of maintaining peace and security, at least within the community, contrary to devastating wars and raids reported, for instance, among the different sections of the Maasai.[148] The institutional differences of the two communities might provide some explanations for the differences in the ways they responded to the disaster. The Borana system based on *gada* system ensured continuity from one generation to the other that had the functions of political, administrative, and rituals, while the hereditary *qallu* institutions is responsible for religious and ritual activities. The Maasai institutions depend on age set systems. The devastation of the warrior age group by smallpox was reported as a major setback to the Maasai system that probably led to institutional collapse.[149] In the case of the Borana, the *gada* and the *qallu* institutions remained active for reorganizing the society and managing key resources such as the wells. This shows that the socio-environmental crises of 1890s had both institutional and economic dimensions. The indigenous institutions of the *gada* and the *qallu*, despite the economic collapses, had remained functional and had the capacity to modify the system, leading to economic recovery through institutional revival.

Revival of *busa gonofa*

The institutional flexibility of the Borana to accommodate past deviations, and the introduction of stringent rules to guide future actions, were timely responses that facilitated recovery. To achieve recovery, the revival of the traditional resource-sharing system (*busa gonofa*) was vital for re-establishing pastoral production. The system was responsible for restocking, which, combined with diverse strategies of resource redistribution, was essential for a functional pastoral life. The system has social as well as administrative and ritual roles to play. Under traditional customary rules, female and male cattle could be transferred to those in need. After the pandemic there wasn't enough livestock left to restock the poor,[150] and therefore the restocking rules were modified. At

first, the clan level of distribution was allowed to continue. Where clan members had died out or they had inadequate resources, the distribution used the concept referred to as *ballitti* (broad based), until the historic meeting of *Gumi Qonye*, after which head counting helped to determine the economic capacity of all the clans and clan alliances. This is what Alula Pankhurst described as the "suspension of normal reciprocal relationships in favor of pooling resources for the duration of emergency".[151] However, in the absence of obligatory clan assistance, the enforcement of entitlements according to *ballitti* was less effective, as the system was based on voluntary giving, and individuals did not always feel the obligation to do so. For this reason, the Borana preferred the more assertive system of clan-based redistribution, *busa gonofa*. The clan-based system of *busa gonofa* is obligatory and involved the use of force if necessary. This system required the clans to have representative administrators at various levels.[152]

The *hayu* councillors[153] travelled throughout Boranaland to ascertain how much clan cattle survived and to redistribute it among the victims of the disaster. They were acting on the orders of the Assembly of *Gumi Qonye*. It was not only the number of cattle that survived, but also the willingness of people to redistribute, and the capacity of the clan-based institution to implement the entitlements, that were crucial for the success of the system. As Amartya Sen argues, the most important factor during scarcity is not the aggregate availability, but the distribution, or what he calls "realization of entitlement".[154]

The problem for the Borana in the 1890s was not only the failure of entitlement, but also the failure of aggregate availability. How to revive the social security system of *busa gonofa* was particularly challenging when there was so little to share, with the population being so impoverished. The number of animals that an individual received during the first phase of recovery was contingent on many factors, such as the number of clan members whose herds survived, the number of destitute people, the fairness of the *hayu*, and the capacity of individuals to move around and appeal to other clan members.[155] It was the first time in Borana history that the arrangement of restocking by means of "future offspring" was used to create social debts. The oral sources reported cases where three or more people were in line to receive, in turn, the offspring of a single cow.[156] A heifer or a cow was given to a family and put under the control of the eldest male member of the family. The milk was shared, and the younger brothers and next of kin were promised possession of the offspring of the cow. This system of resource sharing might seem unfair to the younger family members. However, its role in minimizing conflict over scarce resources by accommodating all social categories in the system was vital for social stability.

In regions that were less affected by the rinderpest there were a few families left with some vestigial cattle, but they had no capacity to resist "clan raids" by large numbers of people from the *tula* region who had lost their cattle to the disease. In the Borana worldview, clans had "two opposite sides" in carrying out their social responsibilities – one harsh, and one benevolent. On the one side, individuals were forced to share their few remaining livestock. They had no choice but to accept their fate, as a clan is like a "spear that pierces" (*gositi warana*). Symbolically, the clan was like a common enemy that would treat deviant members harshly.[157] Cases were reported when livestock owners who resisted sharing their livestock with their fellow clan members were forced to give up all their cattle for distribution. On the other side, for those who benefited from the actions of the clan, the clan was "like God" (*gositi waaqaa*). They accepted that it was impossible to live without the help of the clan. These two sides of the clan's role are illustrated in the following proverbs:

Nama gaarri itti jigee gosatu irraa kaasaa – The clan rescues those on whom hills have fallen
Nama gositi itti jidee eenutu irraa kaasa? – Who will rescue those on whom the clan has fallen?

What differentiated the social safety nets of the recovery period from those of earlier times was that large proportions of the community were in need of help, while few people had the capacity to help. At first, the epizootic concentrated what little wealth remained in the hands of a few people, creating wealth differences.[158] But eventually everyone was reduced to the same level – while many lost thousands of their cattle to the epizootic, others whose animals survived lost their herds through redistribution. In Borana, the rinderpest was said to have played an equalizing role by reducing the rich to desperately needy. The period after the rinderpest was considered by the Borana as one of the most "equitable" periods in history, when wealth differentiation was minimal, but poverty was pervasive. Similar equalizing effects of the rinderpest were recorded in the central and northern parts of Ethiopia[159] while in South Africa the term *masilangane* ("let us be equal") is a consequence of the indiscriminately levelling effect of the rinderpest.[160]

The change from wealth to destitution, and the importance of cooperation among people through social networks, is stressed by the Borana saying *kaa udaan loonii nyaate ciite*, *ka udaan namaa nyaate baaye*, which suggests that those who relied on their cattle and isolated themselves perished, whereas those who relied on broader social networks (literally eating human faeces – but metaphorically reliant on problematic social relations) survived.[161] For this reason the emphasis was on social networks and social capital being more valuable than the wealth individuals had before the scourge. The beneficiaries of cattle redistribution expressed their appreciation of the social networks. The gift cattle were given the names of the places from which they were obtained, such as Batalu.[162] The evidence helped oral historians to recall which places had been spared by the rinderpest. For example *Gobeesa* refers to the flood plains of the Dawa and Ganale Rivers (now in the Oddo region of the Ogaden). One of the informant's grandfathers, a *hayu* councillor, received ten cows from this area and named them *gobeesa.*[163] This naming of cattle after the areas where the animals acquired was common.[164]

Our sources confirmed that the recovery of the society was rapid. Neuman writing about communities around Lake Rudolf confirmed the rapid recovery by stating that the effects of the rinderpest were "things of the past" by 1893. He attributed the fast recovery partly to large-scale raids, and partly to the regrouping of communities who gathered their remaining stock together.[165] Writing about his travels in Borana in 1896, H.S.H. Cavendish did not mention the effects of the disease, but instead referred to the abundance of milk and the gift of 30 oxen he received from the Borana ritual leader (*Qallu*).[166] This suggests that that particular clan either recovered fast, partially escaped the effects of the disaster, or a combination of both. Cavendish described the Borana as "the richest race" of people he had seen.[167] The oral historians in this study agreed that the Karayu clan survived the scourge better than others. This was attributed partly to their migration to the Mega and Arero highlands, and partly to their occupation of the highland region prior to the pandemic. Cavendish visited two villages of people he called the Aseba clan (which probably refers to the Karayu sibu sub-clan) and was presented with milk and honey. Arkell-Hardwick noted that in 1899 the Borana possessed large numbers of cattle, despite the outbreak of disease "many years ago".[168] The huge number of cattle captured in punitive expeditions of Menelik's army at the end of 1890s and in the early 1900s was a sign of rapid recovery.[169] Donaldson-Smith, who visited the Borana five years after the epizootic, referred to the fast recovery.[170] Towards *tulluu leenca* of Tertale (the far west of the Borana region), Donaldson-Smith found about 20 villages, comprising about 2000 huts.

He described the number of livestock as follows: "I saw larger herds of cattle here than I have seen anywhere outside Texas. They must have numbered over ten thousand."[171]

During 1903, while travelling through the *tula* region, Philip Maud recorded the concentration of high numbers of people and animals around the nine *tula* wells, without referring to any remaining impact of *ciinna*.[172] Borana cattle wealth, camel and horses impressed Major John Boyes when he crossed Boranaland in 1906, and he noted that the villages he visited subsisted entirely on milk.[173] Travelling through Boranaland in 1911, Captain C.N. French confirmed the full recovery of the Borana society from the effects of the rinderpest within two decades. He wrote "here we found ourselves in Borana country ... we saw thousands of their stocks – cattle, sheep and goats – brought down to water".[174] Donaldson-Smith travelled from village to village and was served milk, in exchange for which the Borana refused to take gifts. This might be attributed either to their having an abundant supply or to cultural customs that prohibited the selling of milk. Even though there was no oral evidence in support of great raids for restocking, Cavendish witnessed impoverished Dasenech tribes on the western side of Borana. James Harrison also noted a similar situation in Hammer, where the people were said to have lost their cattle to the rinderpest as well as repeated Borana raids.[175] However, there were no violent intra-clan raids among the Borana as opposed to the Maasai. Richard Waller, records predatory raids among the Maasai sub-clans. The Borana responses to the rinderpest induced both internal institutional processes and external social networks to hasten recovery.

A fast recovery was also reported elsewhere by European travellers in the late 1890s and early 1900s. Among other communities in East Africa such as the Maasai, the livestock economy was said to have begun to recover around the mid-1890s (four to five years after the disaster) and a decade later, general stocking rates were reported to have approached pre-epizootic levels.[176] Contrary to Borana recovery that depended on clan social security system, Richard Waller attributes the fast recovery of the Maasai herds to remittances and income from the ivory trade. The Borana oral sources stressed the fast recovery with their use of the popular phrase "*jireena gada* Adi Doyo" (1896–1904), describing the time of prosperity that followed the crisis of the *gada* period of Liban Jaldesa (1888–96). This was the period when re-excavation of the disused wells began. Perhaps, it was because of the rapid recovery that Clive A. Spinage, writing in 2003, is sceptical and argues that either the devastation was not as complete as records indicate or the recovery was, indeed, extremely rapid.[177] The latter seemed to have been the case in Borana.

The impact of the Great Rinderpest of the 1890s on the *tula* wells was twofold. First, it led to the collapse of the cattle economy and changed human demography, causing the disruption of human stewardship of the *tula* well systems. Second, it resulted in the destruction of many families and lineages that had owned the wells. This created ambiguity of well ownership. Consequently, ownership conflicts increased among family members who claimed to be next of kin. Such claims and counter claims are said to have discouraged clan members from investing resources to reclaim wells that had been disused during the epizootic. The long-term implication of social and demographic collapse on the "property rights of the *tula* wells" in the aftermath of the rinderpest pandemic is an important subject of historical research addressed elsewhere.

Conclusions

In concluding this study, we have shown that the collapse of the pastoral economy resulting from the rinderpest epizootic of the 1890s caused extensive human demographic changes due to famine and predation on humans. The social memories of the incidents were clearly

recalled by Borana oral sources who participated in this study. These vivid memories were not only about the speed with which the disease wiped out the cattle population in the region, but also about the social disorders and the breakdown of cultural traditions that resulted from the collapse of the pastoral economy. The oral sources told of deaths in families related either to famine or attacks by man-eating beasts, the collapse of the cattle economy, the drastic reduction of the human population, and the temporary abandonment or total collapse of the *tula* wells. The events were related as they occurred chronologically, namely the infection of cattle, the consequent deaths of animals, followed by strategies to resist famine such as hunting and gathering, and the dispersion of the people into the bush where they became victims of man-eating beasts. The unusual behaviour of wild beasts was characterized by the Borana term *gorjam*, or "man-eaters". The overall impact was termed *ciinna*, meaning the "termination of everything" related to pastoral production. The social memory of the oral historians examined the devastation that occurred and its possible causes. *Ciinna* was understood not only by its negative consequences, but also in terms of the related effects that forced the society to introduce strong rules that guided action and facilitated recovery. Meanings and explanations of events that interpreted human behaviour contextually played a role in reorganizing the society and coordinating responses to the disaster. The Borana social memory of the rinderpest and its consequent impact clearly underline the importance of social organization, unity, solidarity and respect for cultural traditions in tackling environmental vagaries and reconstructing socio-economic life. The reorganization paved the way for reinstating a clan-based social security system that enabled many of the victims of the rinderpest to re-establish their herds and restore their pastoral lifestyle. Notwithstanding that significant progress, perhaps the longest lasting effects of the pandemic on the population are discontinuities and conflicts over disused wells where owners perished and disputes about ownership and property rights persist.

Notes

1. Barrett, Pastoret, and Taylor, *Rinderpest*, 87; Jacobs, "Colonial Ecological Revolution," 29.
2. Hobley, *Kenya*, 42–53.
3. Ibid.
4. Spinage, *Cattle Plague*, 1.
5. Kjekshus, *Ecology Control*, 126–32.
6. McCann, *People of the Plow*, 4.
7. Waller, "*Emutai*," 76.
8. Lugard, *Rise of East African Empire*, 527.
9. Ofcansky, "The 1889–97 Rinderpest Epidemics," 31.
10. Barrett, Pastoret, and Taylor, *Rinderpest*, 87; Spinage, *Cattle Plague*, 497–8; Mack, "Great African Cattle Plague," 210.
11. Thomson, *Through Masai Land*.
12. Pankhurst, *History of Famine and Epidemics*, 59; Jacobs, *Environment, Power and Injustice*, 101; Kjekshus, *Ecology Control*, 126; Kreike, *Recreating Eden*, 36; Ranger, "Plagues of Beasts and Men," 246–7; Van Onselen, "Reactions to Rinderpest," 473; Phoofolo, "Epidemic and Revolution," 112–43. The date of 1887 for the infection entering Eritrea is reported as 1887 – Zewde "A Historical Outline of Famine," p. 54.
13. Pankhurst, *History of Famine and Epidemics*, 61.
14. Kjekshus, *Ecology Control*, 126.
15. Lugard, *Rise of East African Empire*, 527–32.
16. Kjekshus, *Ecology Control*, 127.
17. Zewde, "A Historical Outline of Famine", 52–58.
18. Davis, *Late Victorian Holocaust*, 128–31.
19. Pankhurst, *History of Famine and Epidemics*.
20. Pankhurst and Johnson, "Great Drought and Famine," 42–72.

21. Ibid.
22. Anderson, *Eroding Commons*, 37; Kjekshus, *Ecology Control*, 126–32; Waller, "*Emutai*," 101.
23. Watts, *Epidemics and History.*
24. Pankhurst, *History of Famine and Epidemics.*
25. Kjekshus, *Ecology Control.*
26. Weiss, "Dying Cattle," 174.
27. Hartwig and Patterson, *Disease in African History*, 19.
28. Maddox, "*Mtunya*," 188; Fadiman, *When We Began*; Spear, *Kenya's Past*; Vansina, *Oral Tradition*.
29. Maddox, "*Mtunya*," 188–90.
30. Spear, *Kenya's Past*, xviii.
31. Vansina, *Oral Tradition*; Miller, "Listening for the African Past"; Fadiman, *When We Began.*
32. Richard Waller details the impact on the Maasai, while Helge Kjekshus deals with the impact on East Africa. Pankhurst focuses on north and central Ethiopia and James L. Giblin, *The Politics of Environmental Control*, on north-eastern Tanzania.
33. Megerssa and Kassam, "The Round of Time."
34. Van Onselen, "Reactions to Rinderpest," 484.
35. Waller, "*Emutai*," 73.
36. There are nine *tula* well clusters that Borana have managed for centuries.
37. Oba, "Assessment of Indigenous Range Management Knowledge."
38. Legesse, *Gada*.
39. Bassi, *Decisions in the Shade.*
40. Pankhurst, "Social Consequences of Drought and Famine," 10.
41. Tache, "Pastoralism under Stress."
42. Oba, "Shifting Identities," 128; Pankhurst, *History of Famine and Epidemics*, 66–80.
43. Waaqoo Adii Liban Dikale, 80, is the descendent of a brave *hayu* who is remembered by all Borana for playing a major role in organizing not only his clan but also the Borana in general. According to Waaqoo, *ciinna* started in the north where the Borana found dead buffalo and rhino that they skinned. They then shared the meat.
44. Borbor Bule, age 59, interviewed at Dubluq.
45. It is usual for the marabou stork to have a pink colour on the legs, which the Borana mistook for blood. One cannot discount, however, that the birds carried the virus without being infected by it.
46. Hobley, *Kenya*, 42.
47. Group discussion at Melbana.
48. Group discussion at Dhas.
49. See Pankhurst and Johnson, "Great Drought and Famine," for a similar situation in northern Ethiopia.
50. Tadhi Did Sarbo, Borbor's informant was 90 years old in 1961. Tadhi was an eye witness who was in his late 20s during the epidemic. He migrated with his goats to the Gabra area but his brother remained behind and was eaten by a hyena.
51. The families of Waree Mogorree and Diimaa Teqee were in the same *olla* around Mega. The family of Diimaa Teqee migrated to the Mega highland and survived whereas Waree Mogorree's family were not in agreement and were affected because they did not migrate. This was confirmed by oral historians citing what Waree said after *ciinna*. He said, "*warri kiyya ciinnaaf rukkise ciinni fuula keessa dhufee gurraan tolfate*" meaning his family was in "disagreement and impoverishment and all their misfortunes were predestined". According to Gurro Dida Diimaa Teqee, age 82, 12 family heads, women and children from Waree Mogorree's family died or were taken by *gorjam*. Only three family heads survived and were taken care of by Diimaa Teqee. The surviving members were restocked by Diimaa's family. Waree's family disorganization and chaos in every aspect of life was a reflection of the situation of Borana society in general, while Diimaa's family was a typical example of a family and society created after the incident. It was a good benchmark for what unity can do in a chaotic situation.
52. This is relevant in examining the role of water points in disease transmission. See Weiss, "Dying Cattle"; Goodall, "Riding the Tide."
53. Pankhurst, *History of Famine and Epidemics*, 61.
54. Donaldson-Smith, *Through Unknown African Countries*, 238.
55. Vannutelli and Citerni, *Seconda Spedizione Bottego*, 136.

56. Gwynn, "Journey in Southern Abyssinia," 138.
57. Fitzgerald, *Travels in the Coastlands of British East Africa*, 347–49.
58. Pankhurst, *History of Famine and Epidemic*, 65.
59. Weiss, "Dying Cattle," 184.
60. Balanbal Fayo, aged 102, talks of extreme cases of boiling dried bones and sniffing the evaporating water that had some odour of meat, and even of people fighting for the chance of sniffing, let alone over something to eat: *Danfa lafee ulatanii deeffatan*. Eating skin and licking the poles supporting the house (*utuba*) where, during times of plenty, people wiped their hands. The less wise people who did not store meat probably died earlier.
61. Gwynn, "Journey in Southern Abyssinia," 122.
62. *Nama horii dhaberra nama qalbii dhabetu bade* means that "being wise is far more important than being rich, because wise people can easily design strategies to solve problems, whereas cattle can easily be lost".
63. Interview with informant Waaqo Halake by Waktole Tiki in Borana in 2007.
64. Baxter, "Repetition in Certain Borana Ceremonies"; Hodson, *Seven Years in Southern Abyssinia*; Donaldson-Smith, *Through Unknown African Countries*.
65. The Waata group was in a better position not only because of their food habits, but also because of the survival strategy that they had been following. The weapons (poisoned arrows) they used in hunting enabled them to easily fight off hyena and lion (*gorjam*). That is why Borana who joined the Waata survived better than others.
66. Pankhurst, "Social Consequences of Drought and Famine," 12.
67. Pankhurst and Johnson, "Great Drought and Famine."
68. Waller, "*Emutai*"; Dias, "Famine and Disease."
69. Godana Ajaa interview by G. Oba in 1978, translated from personal recorded archives.
70. *Gorjam* is a term describing habitual changes in food of normal predators that are described differently from predators that depended on natural preys. The Borana Oromo term for predators is *koote* referring to animals with paws.
71. Informant Waaqoo Halake, aged 72, Melbana.
72. Informants Dida Waaqoo, aged 80, Doyo Waaqoo, aged 82 at Dhas.
73. Ford, *Role of Trypanosomiases*; Sinclair and Norton-Griffith, *Serengeti*, 5.
74. Harrison, "Journey from Zeila," 270–1.
75. Spinage, *Cattle Plague*, 498; Pankhurst, *History of Famine and Epidemics*.
76. Pankhurst, *History of Famine and Epidemics*, 61–80.
77. Pankhurst, "Social Consequences of Drought and Famine," 15.
78. McCann, *People of the Plow*.
79. Kreike, *Recreating Eden*; Kjekshus, *Ecology Control*; Waller, "*Emutai*"; Sinclair and Norton-Griffith, *Serengeti*, 5; Pankhurst, *History of Famine and Epidemics*, 88.
80. According to Balanbal Fayo, the young people of the *Wokor Mallu* age group escaped the most pressing problems (both *gorjam* and famine). They slept in trees to escape *gorjam* and hunted and gathered to obtain food. This was the social group that could do a lot, considering their social category.
81. Oral historians (Dida Waaqoo, aged 80, Doyo Waaqoo , aged 82, and Sora, aged 75) showed me (WT) a tree in which the *Wokor Mallu* age group slept to escape *gorjam*. It was called *qalqalcha Wokor Mallu*. It was a big, old tree with flat branches that could be used to sleep on. There were cases when people were taken by hyena after falling from trees or after coming down to hunt, gather food or collect water.
82. Kjekshus, *Ecology Control*, 127–31; Waller, "*Emutai*," 96–8.
83. Kjekshus, *Ecology Control*, 130.
84. Pankhurst, *History of Famine and Epidemics*, 89.
85. Hancock, *Ethiopia*, 64.
86. Waller, "*Emutai*," 92; Kjekshus, *Ecology Control*, 132; Maddox, "*Mtunya*," 181–96.
87. Anderson, *Eroding Commons*, 37; Kjekshus, *Ecology Control*, 132; Waller, "*Emutai*," 79; Ford, *Role of Trypanosomiases*.
88. Fadiman, *When We Began*, 108; Pankhurst, *History of Famine and Epidemics*,
89. Waller, "*Emutai*," 92; Kjekshus, *Ecology Control*, 132; Maddox, "*Mtunya*."
90. Gosa Wariyo, *hayu* of the Konitu clan, aged 88.
91. Weiss, "Dying Cattle," 185.
92. Mordechai, "Southern Ethiopia."

93. Halake Huqana, 90 years old, interviewed by GO in Moyale in 1993. Personal recorded archives.
94. Group discussion and informants like Gosa Wariyo and Borbor Bule.
95. Spear, *Kenya's Past*; Kjaerland, "Culture Change Among the Nomadic Borana," 60.
96. Strategies such as hunting, gathering and migration were reported across eastern and southern Africa. For details see Kjekshus, *Ecology Control*; Waller, "*Emutai*"; Jacobs, *Environment, Power and Injustice*.
97. Waller, "*Emutai*," 85–101.
98. Group discussion, Dhas.
99. Ibid.
100. Kjekshus, *Ecology Control*; Waller, "*Emutai*," 77; Maddox, "*Mtunya*," 181–97.
101. As evidence, Nura Dulacha had seen scratches and wounds on the faces of members of the *Wokor Mallu* age group who were injured while keeping goats during *ciinna*.
102. Pankhurst, "Social Consequences of Drought and Famine," 13; Hartwig, "Social Consequences of Epidemic Diseases," 36.
103. Kassam, "The People of the Five 'Drums'," 187.
104. Pankhurst, "Social Consequences of Drought and Famine," 13; Halake Guyo Huqana 90 years old, interviewed in 1993 in Moyale by Gufu Oba.
105. Schlee, *Identities on the Move*.
106. Oba, "Ethnic Conflicts."
107. Luling, *Somali Sultanates*.
108. Kjaerland, "Culture Change Among the Nomadic Borana."
109. See Weiss, "Dying Cattle" on the Fulani in Sudan; and Van Onselen, "Reactions to Rinderpest," on South Africa.
110. Legesse, *Gada*.
111. Jacobs, "Colonial Ecological Revolution," 28.
112. Water points were the major places where the proposed *Gumi Qonye* to gather dispersed people was announced.
113. A *magallata* is a musical instrument made from the horn of the Great Kudu. It is used to awaken or to call people together for announcements, and to provide an early warning of approaching danger. An *olla magallata* was a settlement where people used this instrument to sound a warning or to call people together.
114. After the onset of the rinderpest, the burying of dead bodies was temporarily suspended, at first because of dispersion and disorganization and later because of the lack of manpower.
115. *Qorii Bara ciinna* was food made of wild fruit. People gathered the fruit and cooked it in a pot. It was then shared among many people. See also Dias, "Famine and Disease," Waller, "*Emutai*"; Pankhurst, *History of Famine and Epidemics*.
116. Fadiman, *When We Began*, 108.
117. Group discussion at Dubluq.
118. Borbor Bule, oral historian, aged 59.
119. The importance of social organization in dealing with environmental vagaries is detailed in Kreike, *Re-creating Eden*; Jacobs, "Colonial Ecological Revolution," 28–32; McCann, *Green-land*.
120. Boru Afato, aged 98, Gosa Wariyo, aged 85, interviewed at Lafto.
121. This was to determine which owners of individual wells and ponds had survived so that the property rights of these resources would not be violated.
122. Borbor Bule, oral historian, aged 59, Nura Dulacha, aged 90, interviewed at Dubluq.
123. Malicha Golo Qoncorro, aged 65.
124. The Alchaya clan has now grown and is requesting independence from the Maliyu clan, as the 18th Borana clan.
125. Maddox, "*Mtunya*," 181–97; Kjekshus, *Ecology Control*, 131.
126. This is the Borana name for Gudas in the present day Marsabit District of northern Kenya. The incident refers to the capturing and adoption of the Rendille children during the war. Waanno, Dallo, Luuqii, and Girja were known places to all Borana from which Rindille, Arsi, Somali, and Jamjam or Guji tribes respectively adopted.
127. According to oral sources, one of the most appreciated measures of this period was the returning of wives and children to their former clans.

128. Different terms such as *ni Oromomsaan* (made an Oromo) or *hin oromsaan* (given property) are used after which the adopted person assumes the name of the family that adopted him. From then on he breaks with the past and his identity in terms of tribe and clan changes.
129. Oral historians and participants in group discussions explained the contribution of this brilliant man to the continuity of the Borana system. However, his family line later lost its leadership position because of his challenging the *qallu* who was authorized to approve the election of *Hayu.* Family members of Jilo Boru are now reported to have become Muslims.
130. Pankhurst , *History of Famine and Epidemics*, 84.
131. Bilalo Dimala, aged 80.
132. Giles-Vernick, "*Doli*," 373–94.
133. It is a cultural food prepared by roasting coffee beans in butter. It is used in every ritual, ceremony and blessing.
134. Borbor Bule, oral historian, aged 59.
135. Oliver-Smith, "Anthropological Research," 304–5.
136. This is a serious violation of family law and sexual norms and it has serious consequence for both the girl and the man.
137. Maddox, "*Mtunya*," 189.
138. The Waata, who depend on hunting and gathering, are a despised social group in Borana.
139. Borbor Bule, oral historian, aged 59; Nura Dulacha, aged 90.
140. Whoever tried to ostracize others because of the *aadaa* they violated during *ciinna* faced the death penalty (*hama mudammuddi*) as punishment.
141. Group discussion at Dubluq.
142. For similar situations elsewhere, see Henige, "Oral Tradition."
143. The children's biological father was from the Karayu clan whereas they were socially categorized as Digalu.
144. The two remained together even after the woman returned to her previous clan, but the second husband maintained his clan identity.
145. Borana children traditionally used the fruits of *Solanum* as their "cattle" in child herding games. Parents take them home from herding as gifts and their children use them as toy cows. Thus, the sacrifice of the *Solanum* fruits was merely an extension of an already existing cultural practice.
146. Krieke, *Recreating Eden*.
147. Borbor Bule, aged 59
148. Waller, "*Emutai*."
149. Ibid.
150. Biiqaa Boru Anna Fayo Dhaka, aged 78. Anna Fayo Dhaka was a clan leader who confiscated about 200 cattle from surviving clan members and divided them among the community. He took a ritualized cow (*fitiko*) that lost its calf, for ritual purposes. The owner of the cow requested that Anna Fayo Dhaka leave the cow for him, but Anna Fayo refused and took it anyway. Then the old man cursed Anna Fayo. On arrival back at home, Anna started using the milk of that cow, but he choked and died.
151. Pankhurst, "Social Consequences of Drought and Famine," 10.
152. This involved *jaarsa* (community elders), *jalaaba* (elders appointed by the *Hayu* councillors, the most senior, working in the *gada* in power), who had the final authority and *Qa'e* (the grand elder) who coordinated the activities of the clan at a geographical level.
153. According to Balambal Fayo, aged 102, the *hayu* used to spray salt on their clothes and enter the cattle kraals. When the cattle licked their clothes, which is believed to be a sign that the animals like a person, the *hayu* would request that the owners make them a gift of the cattle as the animals already liked them. Balanbal Fayo's father migrated further east to avoid clan raids.
154. Sen, *Hunger and Entitlement*.
155. While searching for honey, a group of people found cow dung, which was unusual by then. They brought it home and showed *qallu* Oditu. A group of men led by Amaro Arero (the informant Sora's grandfather) killed the man from *jamjam* and captured and shared the herd.
156. Brothers who were given a cow divided the milk udders. Each individual milked his side of the udder. When there was good pasture, a family could survive on milk from a single udder supplemented by wild fruits and hunting.
157. Nura Dulacha, aged 90.
158. Kjekshus, *Ecology Control*, 127; Hartwig, "Social Consequences of Epidemic Diseases," 37.

159. Pankhurst , *History of Famine and Epidemics*; Hancock, *Ethiopia*.
160. Van Onselen, "Reactions to Rinderpest," 483.
161. Nura Dulacha, aged 90, Boru Afato, aged 98.
162. The grandfather of Bilalo Dimala was a *hayu.* He got cattle from Buna Batalo but was attacked by an enemy on the way home and stabbed with a spear. He stitched the wound in his stomach back together with traditional surgery to prevent the intestines falling out and returned home with the cow.
163. Nura Dulacha, aged 90.
164. In the family of Karayu Gababo, aged 78, only one family member survived. This person recalled when Borana went to Somali to obtain cattle for re-stocking. They did not have a mutual assistance agreement or the obligation of *busa gonofa,* but the Borana had no option but to try all possibilities. These people were the Borana's enemy (*sidii*), but they discussed the situation and gave one cow each, just to avoid further complications in their relationship. This place was far from the *tula* region, and it was reported that many people died of hunger while driving home the cows they had obtained either from clan obligation or from *sidii*. Some people were also lost in attacks by unknown clans. The cows were taken by colleagues or people who were nearby. One family member of this informant went to *Luuqi* and returned with a heifer. He then requested the giver to assist his safe passage by giving him a camel for transport; otherwise he would die on the way either from hunger on the long journey or from fighting off robbers. The camel was used to transport water and the person himself. He named the cow *gaalaa*, which means camel. He used the young camel to establish a herd. The two animals were the basis for re-establishing herds for Gababo and his lineage. His brothers, for whom they were arranged, waited patiently. A man went to a Somali area called *luqume* to look for cattle. He was from *Oda Olale*, a place known for its cattle. A Somali man asked him where he came from. The Boran replied "*Oda Olale*," and the Somali said "*loon odaan olale siihinargin odaan luqumee siif hinargitu deemi*," which means "you can not find cattle here that you did not at *Oda Olale*."
165. Neumann, *Elephant Hunting in East Equatorial Africa*; Spinage, *Cattle Plague*, 521–2.
166. Cavendish, "Through Somaliland," 375.
167. Ibid.
168. Arkell-Hardwick, *An Ivory Trader*, quoted by Spinage, *Cattle Plague*, 522.
169. Spinage, *Cattle Plague.*
170. Donaldson-Smith, *Through Unknown African Countries*, 206.
171. From Donaldson-Smith's account it seems more likely that he visited villages that were spared the rinderpest. He refers to the impact of the rinderpest on wild ungulates, but says nothing about cattle. Donaldson-Smith, *Through Unknown African Countries,* 243.
172. Maud, "Exploration in the Southern Rangelands."
173. Boyes, *My Abyssinian Journey,* 43–46.
174. French, "Journey from the River Juba," 433.
175. Harrison, "Journey from Zeila," 270.
176. Waller, "*Emutai*," 94.
177. Spinage, *Cattle Plague*, 1.

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Paper III

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

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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

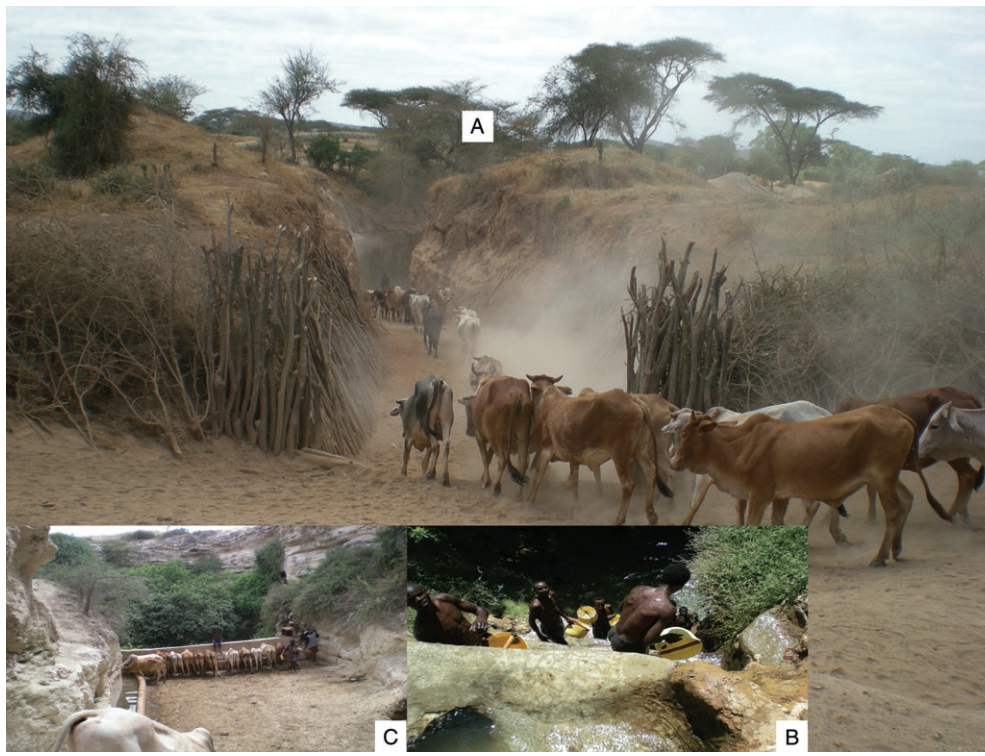

Figure 1 (A) Cattle walking into well through well ramp. (B) Insert showing men lifting water from 15 m depth of the well to the trough. (C) Cattle drinking at the troughs

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,

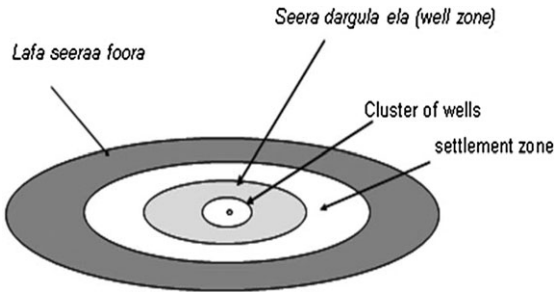

Figure 2 Land use zonation around *tula* wells. The *tula* well cluster is found at the centre while different land use zonation is fixed in reference to the wells

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

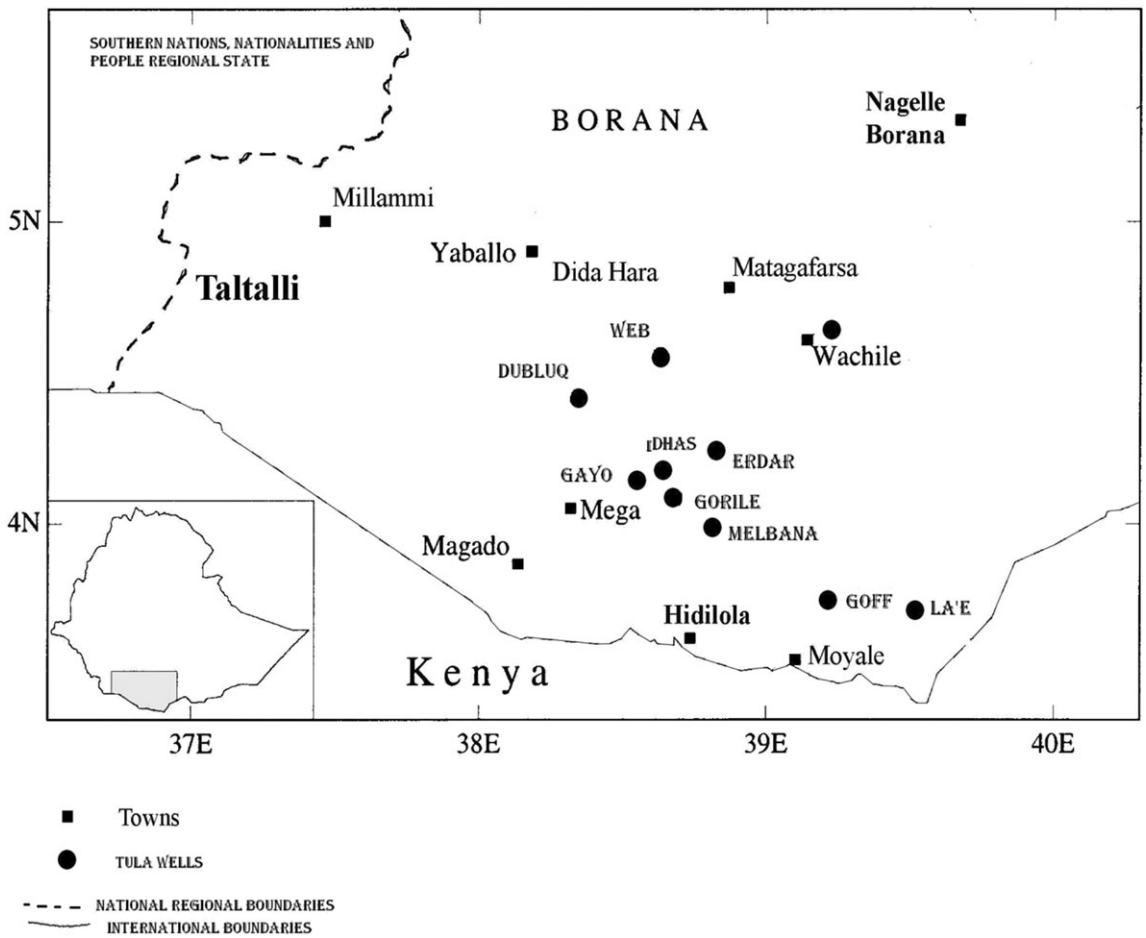

Figure 3 The distribution of *tula* wells in southern Ethiopia

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

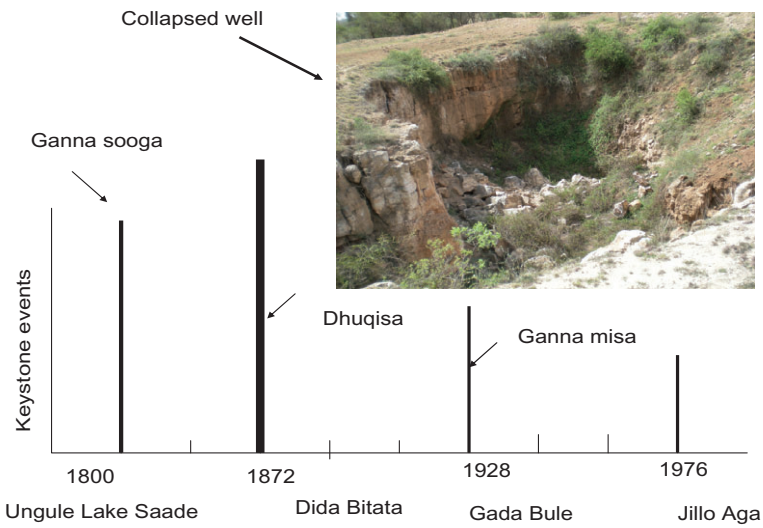

Figure 4 Disused *tula* wells showing timeline of well collapses. The disused well in the insert collapsed in the early 1960s and has not been rehabilitated. The longer the well stays in a disused state, the more it is filled with rocks and soil, demanding huge labour and capital investments to bring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

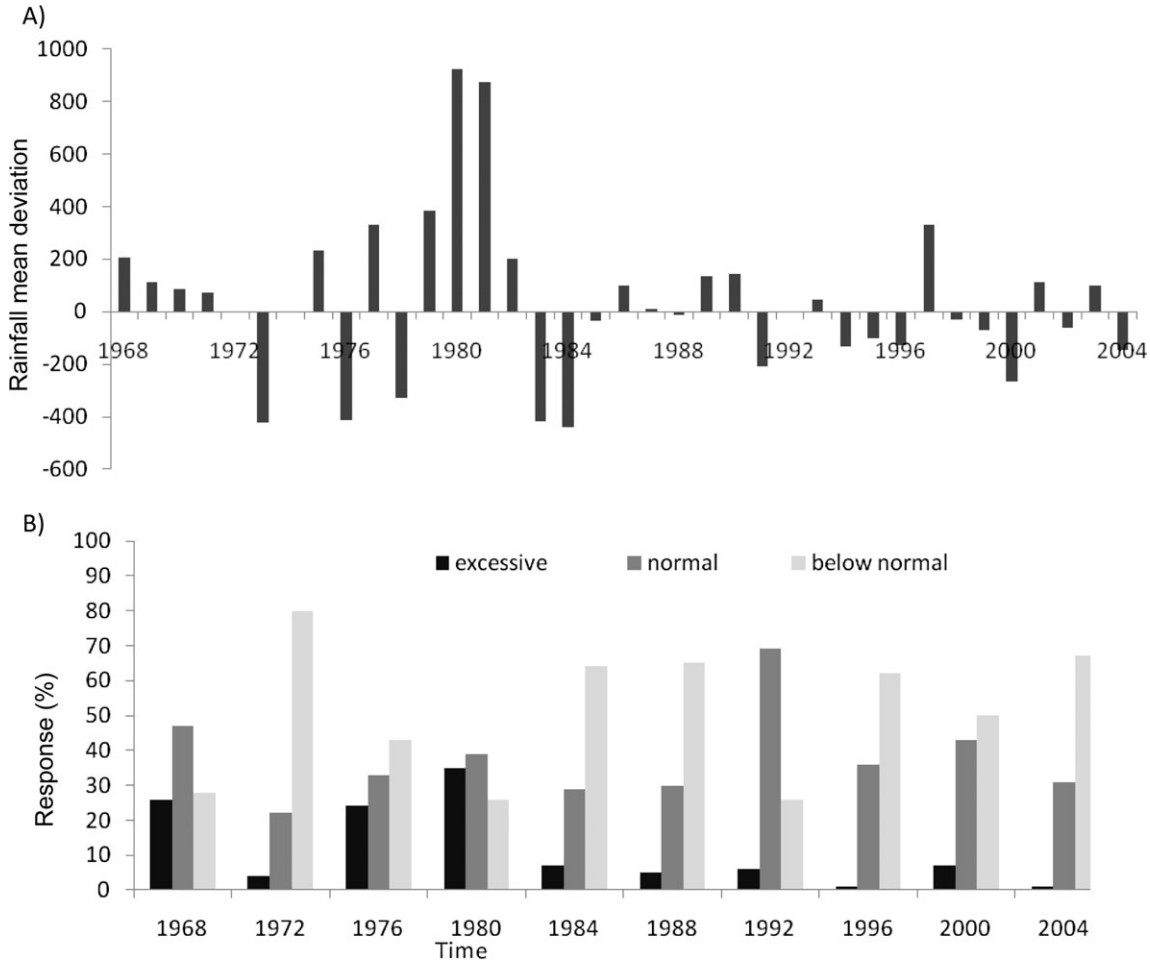

Figure 5 (A) Rainfall mean deviation. (B) Perceptions of rainfall conditions. Despite the correspondence between informants' perceptions and regional meteorological data, there was a difference particularly for the mid 1970s, which may be attributed to memory of informants or local variation in rainfall

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.

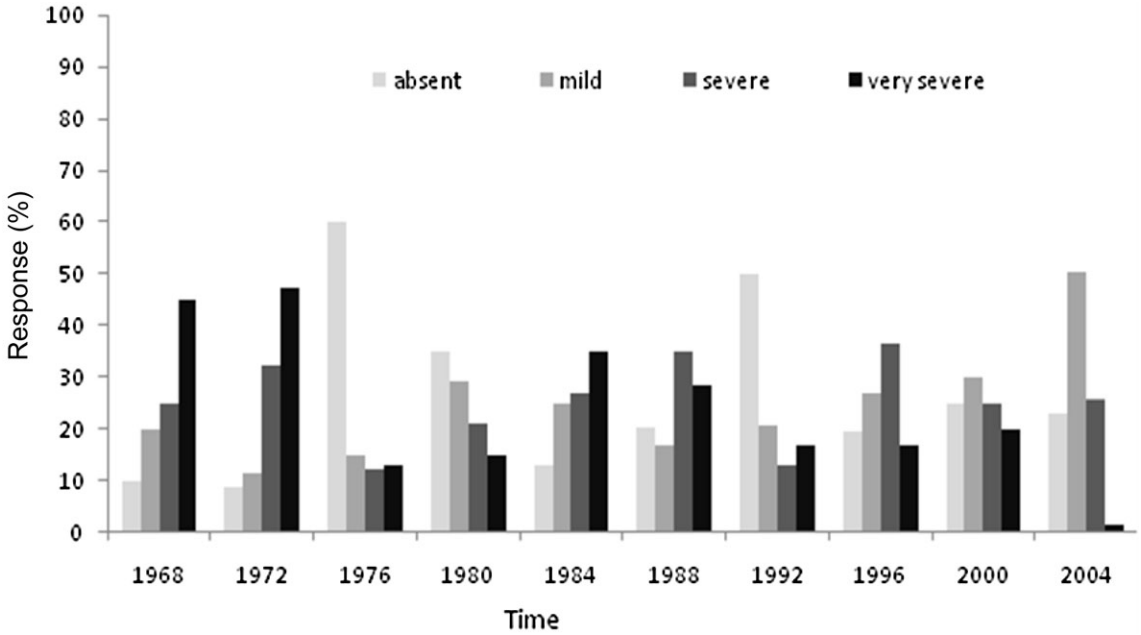

Figure 6 Perception of drought severity. The periods from the early 1970s to the mid 1990s show severe drought. In recent years, pastoralists perceived droughts to be more frequent

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

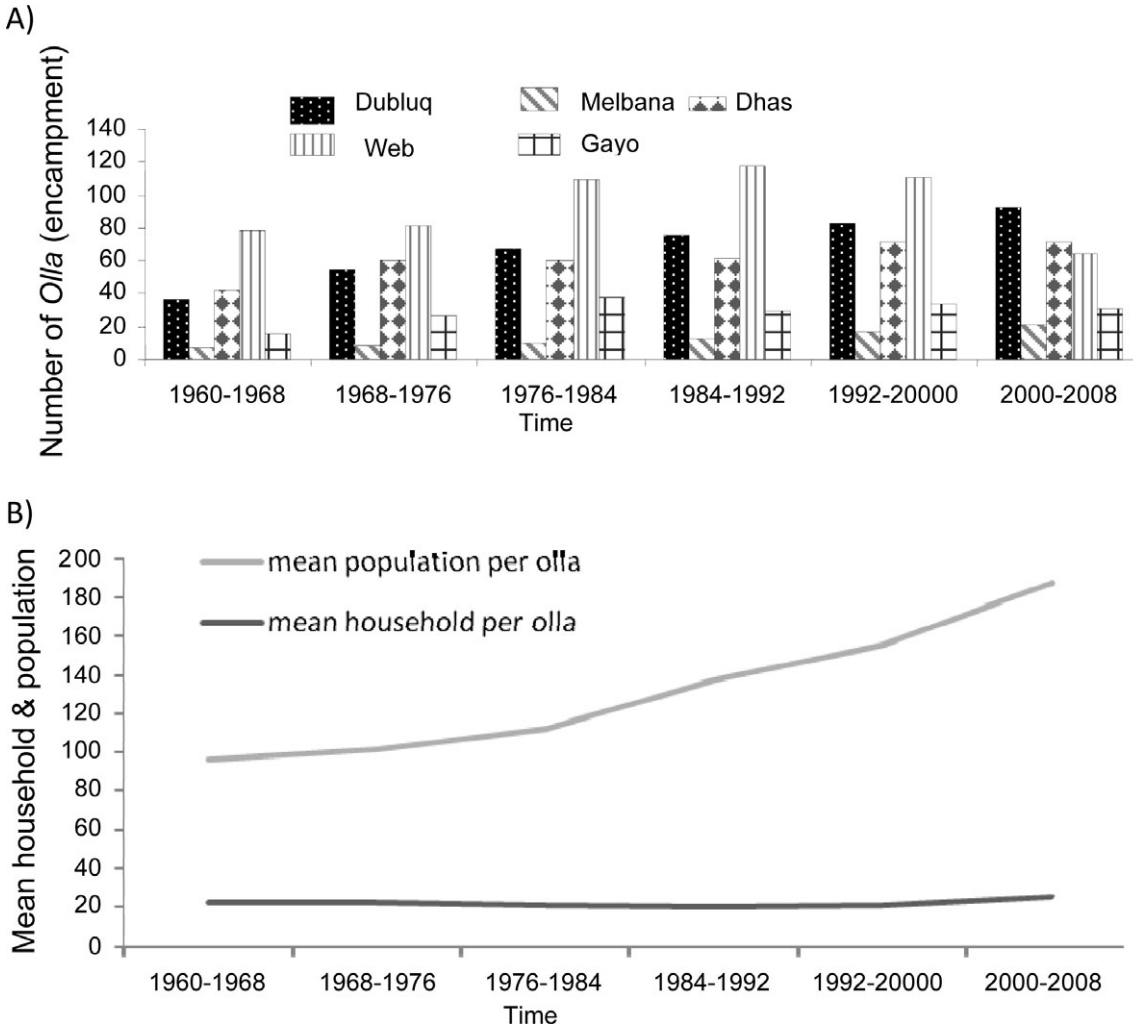

Figure 7 (A) Perception of change in size of *olla* over time. (B) Changes in mean number of households and size of human population per *olla* over time. The size of *olla* has not shown much change, while human populations have increased over time

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.

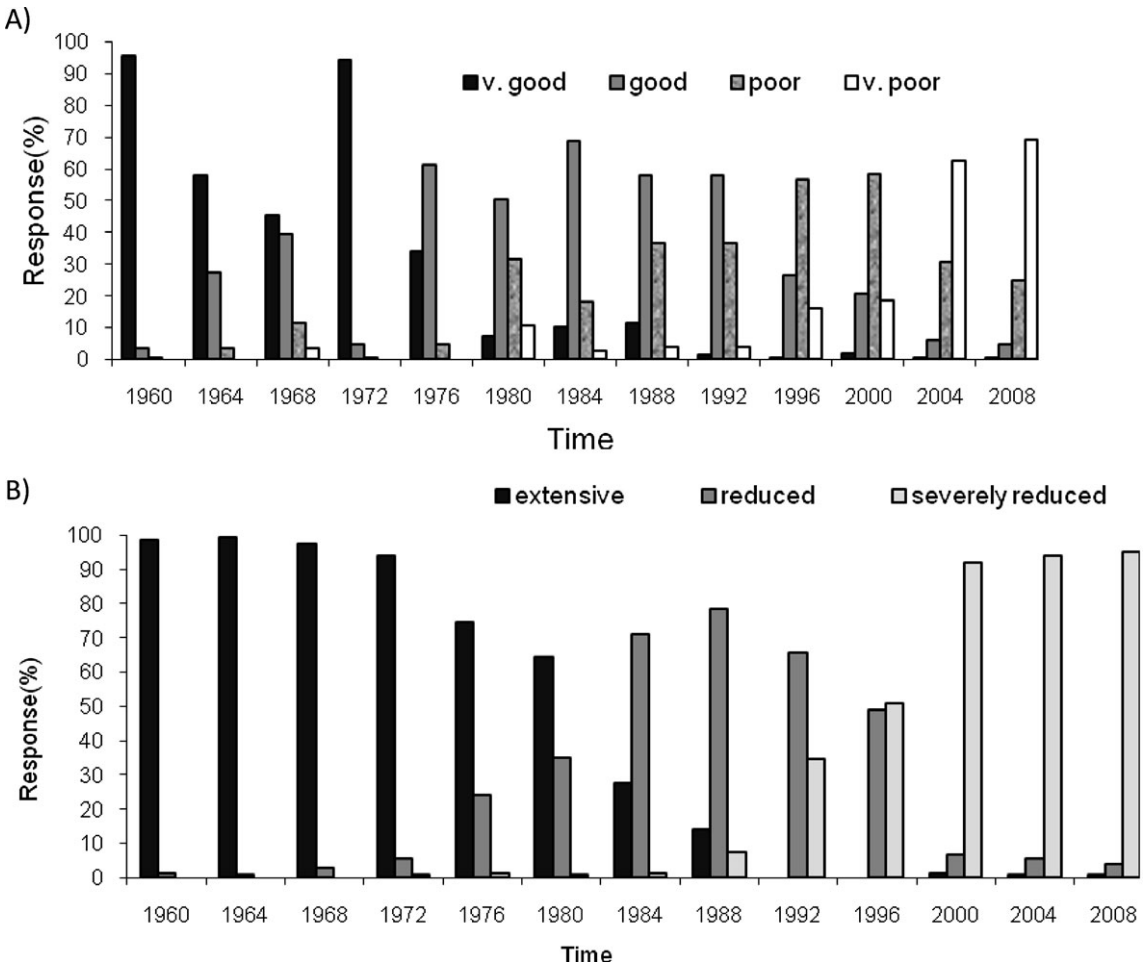

Figure 8 (A) Perception of pasture status over time. (B) Perception of changes in the size of home range grazing land. Informants perceived that the status of pasture availability changed from 'very good' in the 1960s to 'very poor' in recent years, the middle periods being characterised as 'good' and '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.

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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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Paper IV

Labour and technological transformation in utilising ancient water systems in southern Ethiopia

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Abstract

Improvements of water technology are rarely discussed from the perspective of indigenous systems of water management in arid and semi-arid areas where these systems of water management for pastoral land use have been developed over millennia. This article presents an analysis of the labour and technological transformations for utilising the ancient *tula* wells by Borana pastoralists in southern Ethiopia. Traditional utilisation of the deep *tula* wells was by means of human chains lifting water using *okole* (leather bucket) technology, while rudimentary tools and clan labour organisation were used for excavations of wells. This article shows how the *okole* (leather buckets) made from giraffe skins were replaced with plastic jerry cans and how clan labour organisation was replaced by hired labour, while traditional tools for well digging were substituted by improved hand tools or heavy earth-moving machinery. The article evaluates the transformation of technology and the effects of well modifications on well structures, watering efficiency, and saving labour. The Borana consider these transformations to be beneficial as they increase water yield and promote labour efficiency. It is, however, possible that in future the community may use diesel engines for pumping water.

Keywords: Borana, labour organisation, *tula* wells, water management, technological transformation

1. Introduction

In arid and semi-arid regions of the world where ancient water management systems and technologies of water harvesting have generated much historical and scholarly investigation (e.g. Scarborough 2003; LightFoot 1996, 1997 & 2000; Erickson 1993; English 1968; Wittfogel 1957); however, discussions of human adaptation through technological transformation remain limited. Labour organisation, resource mobilisation, and new technology have always been used to solve problems of water scarcity (Cowan 2007; Lightfoot 1997; English 1968) for irrigation, animal husbandry and settlement (Wittfogel 1957), but discussion has seldom focused on how societies that managed ancient water systems evolved technologies and transformed labour. This required changes in the management and utilisation of the water systems through technological, labour and institutional transformation (e.g. Scarborough 1993 & 2003). To understand the need for transforming labour, technology, and water management institutions, one needs to answer some basic questions. Why do societies transform the labour and technology for water harvesting? What are the social and economic drivers, and how does a society cope with changes in the management of water systems? This study uses the Borana of southern Ethiopia as a case study. This is a society well known for its use of indigenous water technology to manage the ancient *tula* wells: for hundreds of years human chains have lifted water from wells using the *okole* (leather bucket) technology and clan labour.

The success of the Borana's pastoral system in the dry savannah ecosystem in southern Ethiopia has been attributed to the capacity of their indigenous institutions and, in particular, to the customary laws (*aadaa seeraa*) that govern the mobilisation of clan labour and resources for the sustainable use of *tula* wells (Legesse 2006; Watson 2003; Helland 1998). These institutions have had the capacity to solve problems regarding cooperation, to promote regularised interaction, and to manage scarce resources (Kjaerland, 1977; Helland, 1998). Labour organisation and the use of indigenous technology for well excavation and for lifting water from deep wells were the main methods of water extraction. This often involved a chain of about 12 men and women passing water buckets from the spring to the watering trough, thereby maintaining a continuous flow of water. However, research has rarely focused on the internal dynamics of this society or on the external drivers of labour and technological transformation.

The purpose of this article is to understand what forced the Borana to transform the organisation of labour for the digging, re-excavation, rehabilitation, and maintenance of wells, as well as the traditional technology, using the *okole* (a leather bucket made from giraffe and buffalo hide), for harvesting water from ancient *tula* wells. The traditional technology required high levels of human labour organisation and was economically demanding (Watson 2003). The Borana transformed the technology of lifting water from wells (the *okole* gave way to plastic jerrycans) while methods of excavation changed: simple hand tools were replaced by improved metallic tools or heavy earth-moving machinery. The organisation of labour also changed, from clan-based labour to the use of hired labour. Diverse drivers may have acted as catalysts for these transformations. As a result of water scarcity, the Borana were forced to adopt new technologies of well digging and to use the plastic jerry can for water harvesting (Hodgson 1990), they also began to employ paid labour. Cattle were no longer seen as the sole source of livelihood, and the introduction of a cash economy enabled the Borana to use paid labour for well digging. This was an important driver of change. Development intervention was another driving force for labour and technological transformation. The article examines these transformations within the context of Borana water culture and technology of water management.

1.1. The Borana Water Management

The Borana pastoralists occupy arid and semi-arid rangelands in southern Ethiopia. They rely on the nine *tula* well clusters (*tula salan*) for water supplies for livestock and human use. The *tula* wells are dug in fractured Precambrian (gypsum and granite) rock (Coppock 1994). The ancient engineering skills of well diggers attracted the attention of early travellers who crossed the region. This is discussed elsewhere (Tiki et al., in press). Arnold Hodson records that "…[the wells] have been made by a race endowed with considerable engineering skill … The sides of the pit are roughly hewn out, so that the natives may sit on the protruding rocks and pass the water up from one to another" (Hodson 1927: 58). Donaldson-Smith (1897: 185-186) describes the wells as "very remarkable, being approached by a widening passage a hundred yards long, which descends gradually to the bottom of a large round chamber … cut through solid rocks. Rough ladders made of sticks [*hirri*], and whipped together by leather thongs, lead down to the water".

The sustainable management of *tula* wells required skilful water-engineering systems that evolved over centuries. During the dry season, a considerable proportion of people's time and energy is spent working on well rehabilitation, on (re)excavation, or on lifting water (Helland 1980; Wilding 1985; Hodgson 1990). Over the centuries, the Borana relied on the organisation of clan labour and *okole* for drawing water from varying depths (Buxton 1949; Hodgson 1990; Helland 1980). Lifting water is the work of young men and women that require collaboration. Regardless of the number of cattle a herder owns, he/she cannot water his/her herd alone (Helland 1980). The absence of one worker in a chain of people lifting water may be equated with breaking an assembly line in a factory, resulting in delay or stoppage: if one person is removed from a line of 10 people, water lifting stops immediately. If this happens, either households with an excess of labour must provide a replacement labourer, or the users have to leave the well and look for an alternative source of water. This encourages every user to cooperate. However, no study has so far investigated the transformation of labour and technology with regard to the use, management and (re)excavation of *tula* wells. This paper examines the internally driven need for labour and technological transformation as well as external development interventions.

1.2. Role of Water Development Intervention

In the early 1980s when the improvement of pastoral livelihoods was high on the agenda of development organisations, the Borana pastoralists had serious water problems. The water table of the traditional wells had dropped and herders were forced to wait for hours until the wells refilled. Wastage of water due to physical (structural) problems and lack of *okole* were other major concerns (Hodgson 1990; Cossins 1983). As a result, water development intervention in Borana targeted the structural modification of the operating wells, re-excavation of disused ones (Fig. 1), and substituting the traditional okole with easily accessible material. Different development organizations funded the work and provided technical advice. Southern Range Development Unit (SORDU), mandated with the transformation of pastoral livelihoods, introduced the technology of cementing *facana* (hereafter 'reservoirs') and *naniga* (hereafter 'troughs') (Hodgson 1990). SORDU also provided sample plastic jerry cans to demonstrate their potential to replace the traditional *okole* (Hodgson 1990), and introduced earth-moving

machines for well re-excavations. On the other hand, the collapse of the pastoral economy in the 1983/1984 drought meant that the rehabilitation of wells was beyond a clan's capacity. Thus, for first time ever, (i.e. after 1983) the Borana sought assistance from aid agencies to re-excavate collapsed wells. The 'Food for Work' program was part of this aid and introduced paid labour into well re-excavations. This program was organised through Peasant Associations (PAs) as opposed to the clans that had traditionally been responsible for the rehabilitation of wells. This was the turning point with regard to labour organisation and the economics of Borana well re-excavation and rehabilitation. The 'Food for Work' program mobilised the wider public as opposed to the clan, which had supplied labour previously, and the Pastoral Associations took over the role the indigenous institutions had played in the past.

Figure 1 here

In general, governmental and non-governmental organizations that have operated in Borana since the 1970s have in some way played a role in transformation of the *tula* wells in terms of their structure, technology, institutional functioning and the organisation of labour. The Borana have responded positively to these transformations, but, as discussed elsewhere, these external interventions came with a price in the form of environmental degradation (Tiki *et al*. in press). The transformation of labour and technology is discussed in terms of: a) the physical characteristics of the *tula* wells; b) the implications of the transformation of labour organisation; c) the *okole* technology for harvesting water; e) the livestock demands and f) the technological transformation of well re-excavation and the implications of this.

2. Methods

2.1. Data Collection

To address each of these objectives, we systematically conducted measurements of sample wells in five clusters, interviewed key informants, and held group discussions at six well clusters, namely Dubluq, Web, Dhas, Melbana, Gayo and Erdar (see Figure 2). Measurements of various well structures, including well depth (measured from well watering trough to water level),

diameter of shaft, ramp length and height, were taken at each sample well. The well structures were assessed for both labour efficiency and the effects of technology in modifying the structure. Key informants also provided information on how the Borana organise labour. Informants were asked to explain the roles of different social categories (for instance male, female, old, young) in watering animals, and the factors that affected labour organisation. A census of the labour available for watering animals was taken at sample wells.

The reasons for the Borana's abandoning of the traditional *okole* (leather buckets) and their adoption of new technology for lifting water from deep wells were examined. Livestock censuses were conducted at sample wells over two or three watering days in 2007/2008 to estimate the numbers of livestock that individual wells supported. Through the use of key informants and group discussions, the role played by the pastoral economy in the re-excavation of wells was investigated. For each sample well, an investigation was made of the ways in which structural modifications using paid labour and heavy earth-moving machinery improved water harvesting efficiency. The use of machinery reduced the demand for labour. Representatives of development organisations were interviewed to gain an understanding of their roles in the technological and structural transformation of the wells.

Figure 2 here

2.2. Data Analyses

A statistical package for social sciences (SPSS) was used to analyse the quantitative data. We used correlation analysis to examine the association between different well structures. Data obtained from labour and livestock censuses were analysed using simple frequencies. The results are presented using tables in the section below.

3. Results and Discussions

3.1. Well Physical Structure

The width and slope of the ramp are most important in facilitating easy access to a well. The slope varies from well to well, but it always increases as one approaches the well-head. The bottom of the well is called *madda ela* (the source). The main working party forms a line in the well shaft and lifts water from the source to reservoir (Figure 3a). The capacity of a reservoir differs from well to well, but always amounts to thousands of litres (Cossins 1983). At most wells, two or three people form a line between the reservoir and the trough to lift water (Figure 3b). Troughs have different lengths and depths at which the animals drink (Figure 3c). Workers stand on *hirri* (ladder) and pass full buckets of water up and empty buckets down in a process not dissimilar from moving conveyer belt.

Figures 3a, b & c here

Every position of a *hirri* has its own particular name that explains its features and how the person occupying the ladder should lift water. Some positions require workers to sit down to lift water, while others require them to stand or crouch. The following terms refer to some of the particular *hirri* positions in one of the wells at Melbana: *Tetto* is a position that requires sitting down and handing *okole* up and down, whereas *bargayyee* refers to a position in which the worker stands with legs apart to facilitate the movement of *okole*. *Quccitti* is a position where the worker sits, partially bending, to hand up the full *okole* and to receive empty ones coming down. *Quccitti* is less comfortable than *tetto*. *Hirri godaa* is a position hidden in the cave-like structure whereas *hirri fuuloo* refers to a narrow structure on which the labourers stand. *Cunqurro* (spinning) requires the worker to bend in irregular ways. Such naming characterises each position and informs the workers to take up the particular position when water is being extracted from a well.

The structures of each well are inter-related. For instance, there is a strong positive correlation between total ramp length and the depth of the trough below ground level, which may indicate a reduced slope for easy access (Table 1). A negative relationship between shaft

diameter and depth of the well (the source to reservoir) shows that the deeper the well, the narrower the diameter. Most wells with long human chains have one *gogessa* (parallel lines lifting water) and a narrow diameter. Generally, wells that have a greater depth of trough below ground level have a long ramp. This is due to the fact that huge efforts have been made to reduce the length of the human chain by reducing the height from source to reservoir. The shorter the distance from source to reservoir, the shorter the human chain needed to lift water (see Figure 4). Conversely, the greater the distance between the source and reservoir, the greater the number of labourers needed to lift water.

Table 1 here
Figure 4 here

The lengths and widths of different well structures vary across clusters and even within clusters. The ramp length ranges from 82.3 m at Dubluq to 127.8 m at Web, where the wells have been modified to reduce the human chain required, and flattening the *baqassa* (ramp). However, this is not uniform, even at the Web cluster. Some of the wells have a long ramp and a flat, gently sloping structure where animals can walk in with comfort, but they have a sudden drop near the watering trough (15–30 m), which makes access difficult for the weaker animals as well as for women who fetch water. The slope of the ramps is a major problem in all the old *tula* wells that have not been modified in recent years. However, flattening the structures requires a huge investment of finance and labour.

The total depth of wells also differs both across and within clusters. The Melbana cluster has the deepest wells (35.5 m), while the Dubluq cluster has the shallowest (24.9 m). The wells have an average depth of 28.3±4.6 m, with an average ramp length of 107±26.2 m. The average depth of trough below ground level is 12.8±2.8 m and the depth that requires a long human chain (from source to reservoir) is 11±4.8 m. Generally, the depth at which labour is needed to lift water ranges from 7.1 m at Web to 27 m at Melbana, with a mean depth of 15.8 m. Pastoralists measure the depth in terms of human chains, rather than meters. This means that the greater the number of people in the human chain, the deeper the well. Thus terms such as a 5, 10, 12, 14 or 20 man well are often used. The Borana refer to the numbers as *to'a,* whereas the

position occupied by each labourer in the human chain is known as *ejja* (standing in line). *Ejja* measures the depth, while *to'a* measures the numbers of labourers involved.

The volume of a reservoir determines the volume of water that can be drawn on a daily basis, while the length of the trough determines the number of animals that can be watered per watering batch (*murnya*). This also determines the daily watering capacity of the well. Assuming the area covered by an adult cow to be about 0.65 meters, Cossins (1983) suggests that a 40 to 48 m long trough would accommodate about 75 cattle at a time. This length has not in fact been achieved: the current maximum length of trough is 28 m, with a mean length of 16.7 m. The length is more important than the depth or width. However, increasing the length of trough requires the excavation of hundreds of cubic meters of earth and the breaking of rocks, and this cannot be done as part of the usual well rehabilitation work.

Wells with wide and straight shafts and shallow depths are preferred, so that the human chain for lifting water is as short as possible. A wide ramp which slopes down gently facilitates the access and exit of livestock and human beings, while a steep and narrow ramp restricts this and slows down watering (Hodgson 1990). Newly modified wells have wide, gently sloping ramps and wider well shafts to allow freer movement of the labour force. They also have cemented structures (troughs and reservoirs) that reduce water wastage. The new structures are also planned to reduce the risk of cave-ins (Figure 5a). Currently about 90% of the sample wells have cemented troughs and reservoirs. However, only 4 % of the wells have metal ladders (Figure 5b). Improvements in the well structure are dependent on labour availability and financial resources.

Figures 5a & b here

3.2. Labour Organisation

The operation of *tula* wells is contingent on the clan labour organisation. The rules governing labour organisation and allocation among users are dynamic and complex. Individual herd owners must contribute labour and watering buckets (*okole*). The number of labourers a user contributes depends either on his position in the watering rota (as in the past) or on his herd size – if the system applied is a broad-based inter-clan system (*ballitti*). If access is priority based,

those having the right to use the water first, such as well owners, contribute more *okole* regardless of their herd size. The level of obligation is reduced the further down the watering order one goes. Under the *ballitti* arrangement, large herd owners are obliged to contribute more *okole* and hence more labour. Every dry season, users of each well revise the numbers of *okole* and labourers each herd unit contributes, taking into account herd-size dynamics (Group Discussion, January 2008, Dhas). The number of *okole* needed depends on the depth of the well (Cossins, 1983; Helland, 1980; Watson, 1927) while the number of herd units watered at a given well determines the number of *okole* each herd owner contributes. The division of labour takes place at a meeting when users are preparing to return to the wells after an absence of some months during the rainy season. Such participatory meetings help to build trust among users and promote cooperation (cf. Ostrom, 2000; Osés-Eraso & Viladrich-Grau, 2007). Frequent interactions and dialogue promote tolerance and interdependence among water users (Mirumachi & Van Wyk, 2010).

According to information gathered from key informants, the work force for lifting water at an individual well is divided into four. The first (and most important) work party is known as *ganamfattu* (early risers). This group arrives at a well at least two hours before the first herd unit is brought to drink, in order to fill reservoir. Each person in this group is expected to arrive with an *okole* that is in a good condition. The number of *okole* needed per individual well is equal to the number of people lifting water from the well (see Table 2 column 7). Coming late or without *okole* is seen as equivalent to the killing of Borana cattle and is not tolerated. The workers overcome the monotony of standing in one place in the well by chanting cattle songs (*yamu*) to keep up the rhythm of lifting water (Cossins, 1983). Such rhythm also increases the speed at which the water is lifted, and maintains a continuous flow of full *okole* (up) and empty ones (down) (Cossins, 1983). Interruption of the rhythm is discouraged by teasing. The songs usually praise cattle, known herd owners, places where the cattle graze, the productivity and the cultural significance of the well as well as its excavation history, the productivity of the cattle that drink from the well, and the workforce. As a result, some observers call these 'singing wells' (Watson 2003). The work of this group is summarized by one of the early travellers:

> At one well were no less than twenty men standing one above the other, and passing the water in giraffe-hide buckets to be empted into the tank at the top. The full bucket is passed up with one hand, while the empty returns by the other; regularity is kept by the time of a quaint chant, which sounds most weird coming from the dark depth of the well (Aylmer, 1911: 293).

A similar observation was made by David Buxton. He states that "A string of men – sometimes dozens or more disappear into the hole and take up positions at various levels, each holding one of the small leather buckets … the man at the bottom starts passing up filled buckets along the line. Each man, as he hands the full bucket up, catches the empty one coming down in a continuous stream"(Buxton, 1949: 101-103).

Every morning, the watering trough must be plastered with 'fresh' soil to avoid contamination by wild animals during the night, as this might spoil things for the cattle. Red soil that has not been contaminated is used to plaster watering troughs. Termite mounds are one of the preferred sources of soil for plastering the trough. In the case of a cemented trough (one of the technological transformations), washing and cleaning has replaced plastering and takes less time and manpower (Group Discussion, January 2008, Dhas). Plastering is carried out by the second working group, known as *lambubdu* (the plasterers). When the plastering work is finished, some of them form a line and lift water from reservoir to watering trough (see Table 2 column 6). In addition, this working group is responsible for checking the proper functioning of different structures, such as well walls and fences, to ensure the smooth operation of the wells. They sweep away soil that has fallen down and the dung of cattle from the previous watering day; in some cases, the breaking of rocks that have fallen and obstruct cattle are among the daily tasks assigned to this group of workers.

Table 2 here

The third working party is called *dadoftu*. This group keeps the animals outside the fence and facilitates orderly watering. They serve as guides, allowing cattle to come to water in batches (*murnya*), and use vocal signals (*hoo*!). This group may be made up of old men and women who cannot lift water from the deep wells. The fourth group is called *ararsitu* (reconcilers). These are mostly herders of the individual herd units and they separate the units after watering. In all groups, the ability to discharge responsibility is more important than gender. Despite the division of working parties into four, the Borana also make use of two other important working groups (*ganamfatu* and *lambubdu*), without which watering is impossible.

Our labour census shows that there is a need to mobilise 586 able-bodied people (*ganamfattu* and *lambubdu*) to lift water each day from the 48 deep wells that constitute 60 per

cent of the operating wells in the six well clusters (Table 2). This means mobilising an average of 12 people to operate a single well. If we assume the normal three days per week watering for all wells, then there is a need to mobilise 1728 workers to lift water over a three-day watering cycle. This huge labour requirement puts immense pressure on the limited labour supply and can jeopardise the use of wells. The third and fourth working parties were not evaluated as their mobilisation depends on the availability of clan labour. Sometimes people lifting water may do the work of other parties until the first cattle arrive, after the reservoir is filled. The workers may alternate between two places of work. However, as shown in the following sections, both labour and the *okole* technology have been transformed.

3.3. Transformation of *Okole* Technology

Water is lifted from the deep wells using *okole* (watering buckets) made of giraffe and buffalo skins. There are experts who specialise in making hides into convenient shapes for handling (Cossins 1983). The skins are shaped according to their size and serve different purposes. Traditionally, the biggest size is used to lift water (*okole tula*), while the second biggest size (*okole elema*) is used when milking cows (Leus & Salvadori 2006). In practice, the same *okole* may serve both purposes. Other smaller *okole* are used to hold milk for ritual practices. The hide from a single giraffe can yield about 12 *okole*. Cossins (1983) estimates the number of *okole* from a single giraffe to be eight to ten, each with a capacity of 5 to 6 liters, and two to five *okole*, each with a capacity of 2 to 5 liters. This usually results in a yield between ten and fifteen *okole* per adult giraffe skin.

Since both giraffe and buffalo are trophy animals, in the past all men were encouraged to claim trophies. In addition, *okole* are one of the most valued personal possessions in a Borana household. It is therefore desirable for herders to have as many *okole* as possible. The optimum number of *okole* per family is considered to be more than four (Cossins 1983), but in practice many factors prevent this number from being achieved. With good care and management (washing, regular fumigating, drying, repairing, etc.) an *okole* can last a lifetime. Their durability also depends on frequency of use. Giraffe and buffalo are no longer found in the land of the Borana, so their hides have become both scarce and expensive. Some herders used to

make the long journey into Kenyan territory to poach giraffes, but these animals are no longer to be found.

To solve the shortage of *okole*, in the early 1980s it was proposed to import buffalo and giraffe hides from other countries, to use camel skin as a substitute, or to install mechanical or motor-driven pumps (Hodgson 1990). Apart from the shortage of *okole*, their capacity and uniformity were also of concern (Cossins 1983). These problems have been solved by the introduction of plastic jerry cans. Cutting a 20 litre plastic jerry can into roughly equal halves produces two *okole*, each with the capacity of 9 to 11 litres. A stick is fixed inside and nailed in from both ends to serve as a handle. Informants confirmed that jerry cans are easy to obtain, uniform in size and shape, cheaper, and hold more water.

This substitution was made without jeopardising the cultural importance of *okole*. The Borana reserve traditional hide *okole* for milking and other cultural practices, while plastic jerry cans are used in all the well clusters for lifting water. There are, however, some problems with the use of jerry cans for milking. Herders believe that the disturbing sound produced by plastic jerry cans makes the cows 'withhold' milk. Fumigation is also part of the Borana milk management system, and this is difficult if fire is used, as plastic items burn.

The water lifters claim that the traditional *okole* holds less water (Group Discussion, December 2007, Gayo). They are also inconvenient to lift up and hand down with the necessary speed. The risk of damage increases the longer they are used as they become slippery and softer. All respondents preferred plastic jerry cans for lifting water, whereas for milking and other cultural purposes, traditional *okole* were preferred. This transformation of *okole* technology from traditional giraffe skins to plastic jerry cans is said to have contributed to increased water production, and hence the number of livestock supported by individual well.

3.4. Livestock Census

The Borana pastoralists water cattle every third day. The number of cattle watered and the frequency of watering depends on the availability of water, the number of cattle, the availability of labour and the distance the animals have to travel between pasture lands and water points. Partoralists who travel long distances prefer to water every third day, while those who live in closer proximity to water and have enough labour, water their herds every second day. Borana

pastoralists do not use head counting to determine the number of herds a well can support or the amount of livestock watered at a given well. Rather, they use *bu'a* (Table 3) to refer to groups of herds arriving together, or to herding units that graze together. The number of *bu'a* is determined by the yield of each well. *Bu'a* also indicates the productivity of a well and the amount of livestock it can support. The average number of animals in a *bu'a* varies from 30 to 60.

Cattle are allowed to water in batches (*murnya*) according to the space available at the watering trough. According to the census conducted in January 2008 at sample wells (Table 3), the highest daily average of livestock watered was 1117 head of cattle at Dha'e well in the Melbana cluster, while the lowest daily average was 321 head of cattle at Dambicha well in the Web cluster. The large number of cattle watered at Dha'e well may have been due to the limited number of wells operating in the area. There were four wells operating at Melbana cluster, while 18 wells were functioning at Web cluster, when the census was conducted. The number of smaller stock watered at the Dubluq cluster (Table 3) was lower than in the other well clusters. Herders probably prefer to water smaller stock and camels at motorised water pumps (Waktole Tiki, unpubl. data).

Table 3 here

The improvement of wells has been crucial in increasing the number of animals that a well can support. The Borana informants explain this improvement by comparing the time spent watering animals, and the herd units the individual well can water. They report that since the 1990s watering time has been shortened by at least half, while the herd unit watered at each well increased. Previously watering continued into the night, whereas now it usually takes about five hours, including the rest period and time spent waiting for animals to arrive. The reduction of the human chain, changes in *okole* technology, and the cementing of reservoirs and watering troughs are some of the factors that have increased the yield of water and shortened the time spent watering cattle. These modifications and improvements are, however, largely dependent on the availability of labour, on the status of the pastoral economy, and on technological transformations.

3.5. The Traditional Technology in Well Re-excavation

It was reported that re-excavation of a single well would require many hundreds of bulls to feed the work force (Legesse 1973). Such costs could only be met by wealthy clans; in the case of poorer clans; their wells might remain inactive for generations. Indeed, one of the late 19th century travellers who visited the wells in south-eastern Ethiopia reported on the investment needed to reclaim disused wells: "The water supply could only be restored by a great expenditure of capital for which there could perhaps be no adequate return for some generations" (Swayne 1895: 27). The continuous operation of wells has been contingent on the institutional capacity to mobilise labour and on the cattle economy. Well re-excavation requires collaborative work, and a high (and continuing) investment.

Completing well excavation during one dry season reduces the chance of silting and structural damage from heavy rain. However, acute labour shortages occur during the dry season because many young people are involved in lifting water for cattle. This delays the completion of digging, sometimes for several years, thereby increasing the investment cost. Furthermore, the use of traditional technology slows down the rate of excavation and extends the work for years (cf. Kobori 1973). Informants claimed that in ancient times the Borana used Oryx horn, wooden materials and small metal tools to dig wells, and they transported excavated soils using hides and skins. Fire was also used as an ancient indigenous well-digging technology. Watson (1927:51) explains how this was done: "Fire is lit and on burning itself out the crumbled rock is scraped away. The process is repeated until water is reached." This technology is still being used (Figure 6), but for the most part the availability of modern digging implements, including heavy earth-moving machines, has simplified excavation work.

Figure 6 here

Traditionally, the different stages of well (re)excavation were marked by ceremonial or ritual practices in which two ritual leaders, the *konfi* (well owner) and his *sunsuma* (ritual co-operator), played important roles. The ritual leaders present themselves in full regalia. They wrap their heads in cloth (*ruufa*) and hold sticks (*hororo*) and horsewhips (*licho*) in their hands (Dahl & Megersa 1990; Oba 1998). These objects symbolise peace and social authority

(Helland 1998). The ritual starts with *hulluqqoo (*Leus & Salvadori 2006), a ritual practice that involves passing through a passageway made in front of the well from branches of various auspicious plants that are believed to protect one from evil, or to repel any evil that might be at the well. After a blessing by the ritual experts, an old cow (*dullacha konfi*), and a sheep (*holaa sunsuma*) are slaughtered. The initial ritual is referred to as *konfi ka'u*, or "putting in the *konfi*" (Borbor, Pers. Comm. November 2007, Dubluq*)*. The ritual is detailed and complex: it is believed that each component enables trouble-free digging and enhances the productivity of the well. Using the *konfi* stick, (*ulee konfi*, made from *hallo* [Acacia bussei] that symbolises the social position of the well owner), the two ritual leaders symbolically pierce the ground (*jinfessuu*) by imitating digging (Dahl & Megersa 1990). This marks the beginning of the actual digging. The ritual leaders bless the well site so that it will be productive, and so that the clan will prosper, and they wish long life to the owner and his ritual cooperator (*sunsuma*) (Group discussion, December 2007, Dhas). The blessings are also symbolically represented by the presence of branches of different species of tree, representing different sub-sections of the clans of the well owner and his *sunsuma*. Some are used to dig, not because they are strong, but because they are believed, by the ritual power vested in them, to have a mystical capacity for breaking rocks. Other branches have their own symbolic roles and stand for well productivity, the prosperity of *konfi*, the continuity of the clan, etc. Some of the tree species are included in the *hulluqqoo* (passage way) and others are used for *gulanta* (a pole laid at the entrance of the well, identifying it as a symbolic ritual hut) (Qalicha, Ritual expert, Pers. Comm. April 2008, Borbor).

When the digging has been completed (after several months or even years) the well is opened for use at a ceremony or ritual performance called *arguga ela*. A cow and calf from the herd of the owner are brought to the well and the cow is milked directly into the well, symbolizing a well with cattle with milk in the udder, and water (Dahl & Megersa 1990). The final stage of well re-excavation is known as *konfi ela kessa fuudhuu*, or 'retrieving the stick of *konfi* that has been kept in a secret place'. This marks two things: the completion of work and the acknowledgement of a clan's investment and fair access for all its members. A bull of the *konfi* is slaughtered to mark the transition of 'ownership' from private to communal. Until this ritual is performed, the well is considered the personal property of the *konfi* holder, who exercises most power over the management of the well. This final ritual performance takes

place when the community is confident of the well's productivity and feels that further investment is unnecessary, at least for the moment. Even though the rituals do not play a role in concentrating power, as they do in other societies (e.g. Scarborough 1998), their significance in exhibiting social respect for the well owner and for well management institutions, and for ensuring social harmony, is crucial. The Borana relate this ritual performance to well productivity and the number of livestock the well supports. The traditional system described has undergone transformation that continues to this day. The social and economic implications have a bearing on the continuity of this unique system of water management. The technological transformations also enable us to measure changes in the physical structures of the wells, such as amount of earth removed.

3.6. Well Re-Excavation and Investment Costs

The volume of soil excavated and the structures built are extraordinary, with heaps of white soil covering many square kilometers at every well cluster. As there is no record of the volume of earth moved or of the time and resources spent on well excavation by the Borana, we have used sample wells that have been improved by SORDU in recent years (by employing Borana as daily labourers) for illustration. The aim was to improve the wells by reducing their depth, making access roads flatter, and widening the well shafts and ramps. The total number of man-days worked on the six wells was 53 092, while the total cost was 488 409 Ethiopian birr (about US$ 39 000). As a result 9451m^3 of earth were moved (SORDU, unpublished). Accordingly, digging and removing 1m^3 of soil needed 5.62 men working a full day. Elsewhere, Erasmus (1965) reported that using primitive tools four men could move 1m^3 of earth a day, while Angulo (1993) estimated that four men, using picks and shovels for digging and wheelbarrows to transport the soil, were able to move 2m^3 of earth. According to Angulo (1993), if digging sticks were used instead of picks and shovels, and pack-baskets were used to carry soil instead of wheelbarrows, this could reduce the volume of earth moved by half, to 1m^3. From the above, one may conclude that an immense amount of labour is required to make traditional Borana wells operational by removing soil and rocks. We presented the investment costs of sample wells that have been re-excavated in the past two decades, either by the Borana themselves or in collaboration with development organisations (see Table 4). The investment cost varies greatly

from well to well. This may be attributed to different geological conditions or to different levels of use or disuse, or to faulty memory on the part of informants, since there are no written records. Despite differences in investment levels (Table 4), a great deal of money and labour are needed for the re-excavation of a single well.

Table 4 here

3.7. Implication of Labour and Technological Transformation

The re-excavation of *tula* wells requires the replacement of traditional hand tools with improved metallic tools and the introduction of heavy earth-moving machinery. The use of heavy earth-moving machines was common in the 1990s, but improved metallic hand tools are now widely used. The Borana's recent reluctance to use earth-moving machines was attributed to the pressure these apply while digging; this loosens the soil and increases the wells' susceptibility to collapse (Group Discussion, January 2008, Dhas). As the result, the Borana prefer to use metallic hand tools and hired labour for well re-excavation; they would rather modify the existing wells to reduce the labour needed to lift water and to increase the water yield.

The introduction of paid labour for well digging is welcomed by the Borana as a partial alternative to clan labour because of its greater availability. There is a general understanding that cash payment encourages greater participation by individuals who are not motivated by clan-level obligations unless they receive a proportional benefit. The Borana now contribute economically by selling cattle and using the cash to hire labour (Bassi 2005; Oba 1998). They continue to adjust their system of well-water management to technological changes and labour shortages; this reflects the society's capacity to respond to changing needs. According to our informants, this has enabled the Borana to modify and improve most of the operating wells.

Prior to 1980 modifications to the structure of wells were aimed at solving the water scarcity problem by digging deeper; since the 1990s modifications have been aimed at solving structural problems and reducing the labour needed to operate the wells. For instance, informants agree that most of the wells had 5 to 9 *ejja* (stand in line) before 1960. The need for an increased water supply and the introduction of better tools and paid labour meant that users dug deeper, which increased the *ejja* at most wells to between 9 and 15 during the 1980s. This

increased water yield at individual wells, but additional labour was required to operate the wells. With the introduction of machines, paid labour, and continuous use of 'Food for Work' program, the *ejja* were reduced to between 4 and 7 for well clusters such as Web, between 6 and 9 at Erdar, and 6 to 12 at Gayo in the 1990s and then after. Melbana is still one of the longest *ejja* in Borana, with 13 to 15 people in the human chain. In some of the wells the labour required for a single line was reduced by about 72 %, while in others the reduction was about 25% (see Table 2 column 8). The labourers who are freed up are either used to form the second line (*gogessa*), or are reallocated to other activities. This reduction in the human chain may also be a response to a dwindling supply of labour in the pastoral economy. These modifications have increased labour efficiency: by increasing water production and by reducing the number of labourers required in the human chain for the lifting of water. Informants say that the shortening the human chain (cutting *ejja*) has solved many of the labour problems. The advantage is that few households can now cooperate to operate the wells. Doubling the line, on the other hand, amounts to doubling the number of cattle watered per unit time, if there are no labour constraints. One of our informants explain this as, "Nowadays it is much easier to use the wells in most clusters than it was 30 years ago because of structural transformations to the wells and the shortening of the human chain" (Borbor Bule, personal comm.). These transformations have reduced well collapses, increased water yield, reduced watering time, and increased labour efficiency. The new well structures have also reduced the risks to the labour force posed by the old well structures.

The Borana response has been to extend access to other clans. This is referred to as *ballitti* (broad-based). Under current conditions, the watering order at most wells depends on who arrives at a water point first, rather than on the customary clan-based watering order. This has changed the system used to regulate labour and *okole* contributions from one based on 'seniority' to one based on the size of the herds owned by individual users. This change has been welcomed by well managers and the general public alike. The *ballitti* system may also have encouraged the use of hired labour. However, these external interventions to facilitate well modification have not been without cost.

In addition to the modification of well structures, new water resources such as boreholes, ponds and cement cisterns have been established. These new water schemes may affect the sustainability of the wells in the future. Similar trends have been noted among the pre-Hispanic

Maya and in Middle East where modern water-harvesting methods have made old technologies unnecessary and obsolete (Scarborough 1993; Lightfoot 2000). Many scholars have expressed concerns about the socio-cultural and institutional implications of such technological change (Lightfoot 1997 & 2000; English 1968). According to the informants, however, the benefits in terms of increased water yield and more efficient water harvesting outweigh the negative impact of changes to the traditional system.

3.8. Sustainability of Technological Transformation

It is not yet clear whether the Borana can sustain the new structures and technology. What will happen, for instance, if these cemented structures collapse? The Borana may attempt to maintain the structures, provided that they have enough cattle to enable them to hire labour and supply the necessary inputs. It seems that the cattle economy is becoming the most important internal input – so long as it is possible to hire labour. On the other hand, the sustainability of the wage labour system cannot be assumed. Despite the benefits of the new technologies, Borana informants have some reservations about some of the more negative impacts. Evidence of this cautious approach is their preference for paid labour: heavy machines exert pressure on the ground around the well, loosening the soil and increasing its vulnerability to collapse. The Borana are also well aware of the possible breakdown of heavy machinery and risk of becoming dependent on this machinery for well re-excavation. It is therefore reasonable to suggest that the Borana have adopted the technology that they are able to sustain for the re-excavation, rehabilitation, and utilisation of wells.

4. Conclusion

This paper has examined the effect of labour and technological transformations on the use and management of the ancient *tula* wells in southern Ethiopia. It has discussed the capacity of the Borana to mobilise labour and the cattle economy for well re-excavation, as well as the transformation of water buckets (*okole*). The study has highlighted changes to the way in which individuals contribute their labour and contribute to the economy, and has pointed to the ability of indigenous institutions to adjust to changing local and regional socio-economic and political

conditions. The study has also examined the way in which the re-excavation and rehabilitation of wells has improved their physical structure as well as their water yields. The study has identified fundamental transformations in the mobilisation of labour, in the use of technology, and in the economic contribution of the Borana to the re-excavation, rehabilitation and utilisation of *tula* wells. The Borana pastoralists now use hired labour to rehabilitate damaged wells and re-excavate disused ones, rather than the traditional clan-based labour system. The financial and technical involvement of external organizations in well re-excavation has increased over time. Collaboration with development agencies in the use of heavy earth-moving machinery has facilitated the modification of many difficult wells. Flattening ramps (*baqassa*), reducing the depth of wells, shortening human chains (*ejja*), increasing well-shaft resistance to collapse, improving access to the water table, and cementing reservoirs and watering troughs have enabled Borana pastoralists to make better use of wells by pooling labour and watering their herds more efficiently than in previous decades. The economic contribution has changed from one based on cattle (payment in kind) to one based on cash. The clan-based labour system is therefore in a process of transformation. The pastoralists regard most of these transformations favourably as they promote labour efficiency, improve access to water and increase water yield. The improved water yield of modified wells has resulted in the abandonment of the traditional priority-based watering system in favor of *ballitti* (use by the wider public). However the Borana continue to resist the use of engine power for lifting water. They may in future accept diesel engines or solar pumps for lifting water, but this is currently resisted for fear it will transform a communal (clan) resource into private property.

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Table 1 Correlation matrix of different well structures

	Trough below Ground level	Total Ramp length	*Ela* to *Facana* height	Shaft diameter	Total depth
Trough at below ground level					
Total Ramp length	0.735**				
Ela to *facana* height	-0.355	-0.167			
Shaft diameter	0.113	-0.246	-0.702**		
Total depth	0.202	0.230	0.798**	-0.640**	
Trough length	-.077	-0.221	0.111	0.160	-0.050

*P <. 05, **p <. 01, (2- tailed)

Table 2 Number of people needed to make the chain and line of the chain (*gogessa*) in the shaft

Well cluster	Well	*madda –facana*		*facana -naniga*			Change on the chain
		Gogessa (2 lines)	Single line	*Gogessa* (2 lines)	Single line	Total	
Gayo	Nonicha	1	7	2	3	13	
	Dhibay	2	8	2	2	20	2 *ejja* cut, changed to *gogessa*
	Gadulticha	2	5	2	1	12	
	Kora	1	9	1	3	12	Increased
	Ababa	1	10	1	2	12	
	Arbora	1	9	1	2	11	
	Odicha	1	8	1	2	10	
	Ade	1	9	1	2	11	
	Dacicha	1	8	1	2	10	
	Bidiru	1	9	1	2	11	
	Godole	1	10	1	2	12	
Web	El yabbi	2	8	2	2	20	
	Babbo	2	2	2	3	10	8 reduced to 2
	Dacicha	2	2	1	2	6	
	Dambiccha	2	3	2	2	10	
	Odicha	2	5	2	2	14	
	Galanticha	2	5	2	2	14	9 reduced to 5
	Doranticha	2	4	2	2	12	7 reduced to 4
	Sadeti	2	4	2	2	12	9 reduced to 4
	Waticha	2	4	2	2	12	
	Golota	2	4	2	2	12	
	El yabbi	2	6	2	1	14	6 *ejja* cut, changed to *gogessa*
Erdar							
	Sunqanticha	1	5	1	3	8	7 reduced to 5
	Hiddo	2	7	2	2	18	
	Kokiso	2	7	no	no	14	reduced
	Boku	2	4	2	2	12	9 reduced to 4
	Jaba	1	7	1	2	9	
	Qilxa j.	1	5	1	2	7	7 reduced to 5
	Qolxa qa’	1	5	1	3	8	4 and 3 *ejja* cut respectively
Dhas	Korman gal	2	6	2	2	16	8 reduced to 6
	Qallu	2	6	2	2	16	
	Dambicha	2	6	2	2	16	
	Dacicha	2	6	2	3	18	8 reduced to 6
Melbana	Dubana	1	11	2	4	19	
	Dha’e	1	11	2	2	15	
	Nonicha	1	11	2	3	17	
	Arusicha	1	12	2	2	16	Increased from 9 to 12
Dubluq	Anna wante	1	3	1	2	5	11reduced to 3
	Gadulticaha	1	10	2	3	16	
	Yota doyo	1	7	1	2	9	
	Borbor	1	5	1	2	7	
	Darato	1	8	1	2	10	
	Dhibayu	1	12	1	2	14	
	Liban aliya	1	8	1	2	10	
	Homa	1	9	1	2	11	
	Halake Burra	1	10	1	2	12	
	Feqadu	1	4	1	2	6	
	Mandida	1	5	1	2	7	
Total						586	

Table 3 Average livestock watered per individual well

cluster	Name of the Well	Cattle watered	Small stocks	Calves	Camel	Watering frequency	*Bu'a*
Melbana	Dha'e	1117	699	123	33	2	19
	Nonicha	542	286	86	21	2	11
	Dubana	521	345	65	2	2	12
dubluq	Mandida	440	150	177	13	2	7
	Feqadu	502	157	126	51	3	9
	Gadulticha	564	6	87	5	3	10
Dhas	Korman gali	515	705	84	27	2	8
	Nonicha	326	284	76	-	3	8
	Dacicha	546	467	87	29	3	6
Web	Babbo	385	276	276	-	3	7
	Dambicha	321	316	227	-	2	10
	Waticha	647	107	82	69	3	10
Gayo	Gadulticha	697	108	112	23	2	10
	Nonicha	624	101	57	-	2	8
	Dhibayu	646	392	151	-	2	8

Table 4 Cost of well (re)excavation

Cluster	Well	Gada period	Cattle Invested	Birr Invested	Current estimate in birr (1USD=12.5 birr)	status
Melbana	Dubana		150	-	375000	Re-ex
	Nonicha	Arero Gedo	129	-	322500	Re-ex
Gayo	Gadulticha	Boru Madha	40	Plus aid	100000	Rehabilitation
	Nonicha	Adi Doyo	300	-	750000	Re-ex
	Dirbu			300000	300000	Re-ex
Dubluq	Liban aliya	Jilo Aga	370	-	925000	Re-ex
	Arero sora	Jilo Aga	42	Plus aid	105000	New
	Dida wario	Jilo Aga	176	Some aid	440000	New
	Molu bamba	Jilo Aga	88	Plus aid	220000	New
Dhas	Dambicha	Boru Guyo	85	16000	228500	New
	Korman gali	Guyo Boru	45	-	112500	Re-ex
	Nonicha	Arero Gedo	125	-	312500	Re-ex
Web	Galanticha	Guyo Boru	150	-	375000	Re-ex
	Galan	Jilo Aga	100	-	250000	Re-ex
	Odicha	Arero Gedo	60	-	150000	Re-ex
	Arbora	Jilo Aga	60	Plus aid	150000	Re-ex
	Golota	Boru Madha	72	-	180000	Rehabilitation
	Badda		-	60000	60000	Re-ex
Total			**1992**	-	**5356000**	

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4. **Figure 4** The sketch of well that shows the position of old and new structures of the well. After digging down to cut the human chain lifting water, the well structures shift to the new position, reducing the height between the source (*madda ela*) and reservoir (*facana*).
5. **Figure 5** A) Improved well structure designed to reduce cave-ins, and **B**) Newly introduced metallic ladder (*hirri*) in one of the wells at Gayo cluster. This structure is built by Action for development, a local humanitarian organization actively involved in well re-excavation and rehabilitation.
6. **Figure 6** The use of fire to break hard rock while excavating the well, November 2007 at Melbana. Photo by WT.

Figure 1

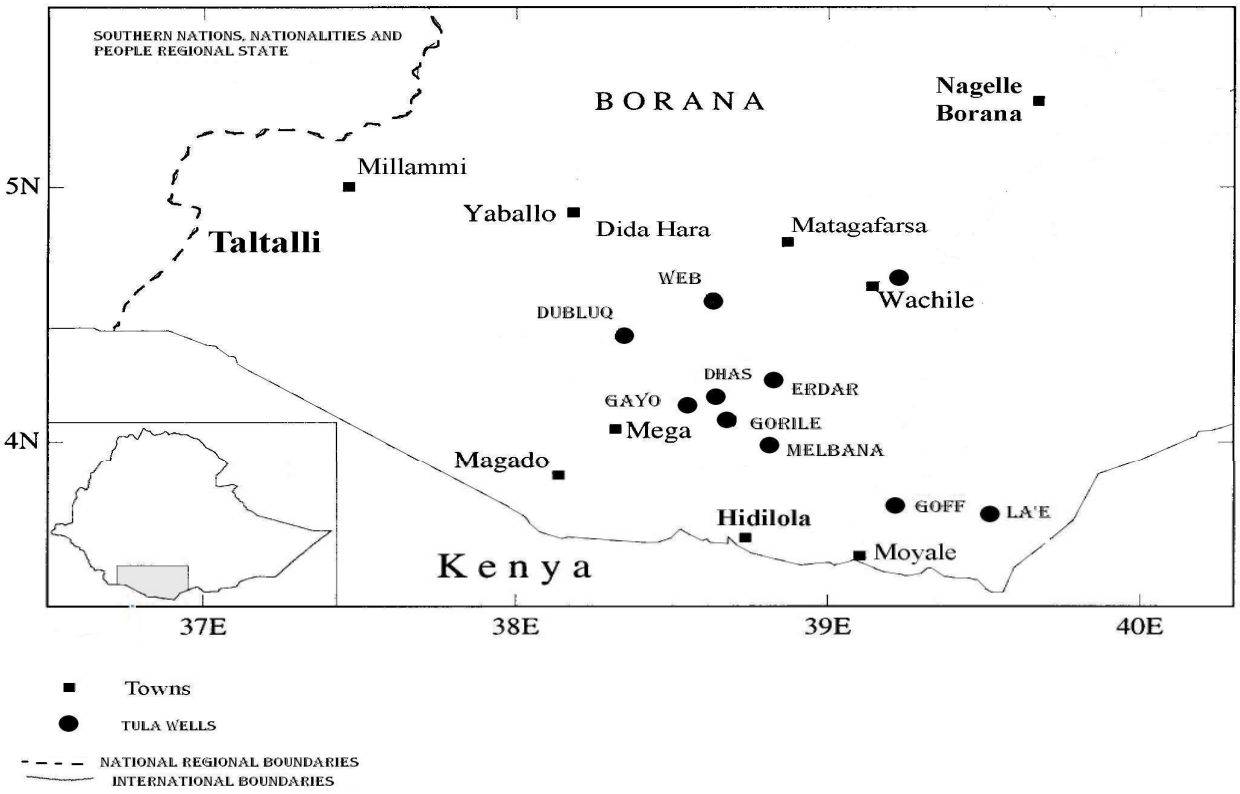
SOUTHERN NATIONS, NATIONALITIES AND PEOPLE REGIONAL STATE
BORANA
Nagelle Borana
Millammi
5N
Yaballo
Dida Hara
Matagafarsa
Taltalli
WEB
Wachile
DUBLUQ
DHAS
ERDAR
GAYO
Mega
GORILE
4N
MELBANA
Magado
GOFF
LA'E
Hidilola
Moyale
Kenya
37E
38E
39E
40E
Towns
TULA WELLS
NATIONAL REGIONAL BOUNDARIES
INTERNATIONAL BOUNDARIES

Figure 2

A)

B)

C)

Figure 3

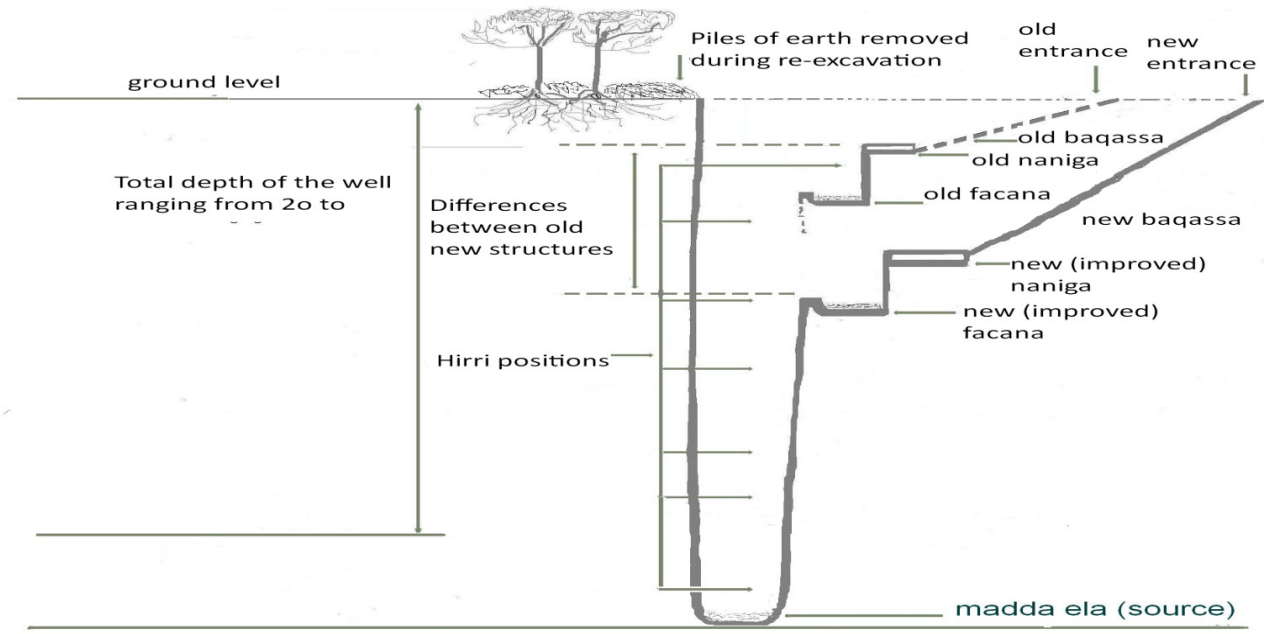
Piles of earth removed
during re-excavation
old
entrance
new
entrance
ground level
old baqassa
old naniga
old facana
Total depth of the well
ranging from 2o to
Differences
between old
new structures
new baqassa
new (improved)
naniga
new (improved)
facana
Hirri positions
madda ela (source)

Figure 4

A)

B)

Figure 5

Figure 6

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Article no.:I

Title: Reconstructing the impact of disasters on the *Tula* well cultural landscape in Southern Ethiopia, 1560–1950

Candidate: Waktole Tiki
The contribution of the candidate:
Research design, data collection, analysis and writing the draft and revise on the basis of comments from Co-authors

Co-author: Gufu Oba
Co-author's contribution:
Guiding, commenting and sourcing

Co-author: Terje Tvedt
Co-author's contribution:

Co-author:
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Co-author's signatures:

Waktole Tiki	.....	.....	.....
name	name	name	name

Tiki Uma Waktole

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Sent: 2. oktober 2010 13:39
To: Tiki Uma Waktole
Cc: Peter Gufu Oba
Subject: SV: Authorship declaration

Dear Waktole

I am not able to put my signature on the form since I am out of office for the next ten days and I have no scanner available. I confirm, however, my co-authorship in this email, dated 2.10.2010.

All the best

Terje Tvedt

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The contribution of the candidate:
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Co-author: Gufu Oba
Co-author's contribution:

Co-author:
Co-author's contribution:
SUPERVISION

Co-author:
Co-author's contribution:

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Waktole Tiki	Gufu Oba		
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Co-author's contribution:

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Co-author's contribution: SUPERVISION

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Co-author's contribution: SUPERVISION

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Co-author's contribution:

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Co-author's contribution:

Co-author:
Co-author's contribution:
Supervision, guiding, commenting & sourcing of materials.

Co-author:
Co-author's contribution:

Co-author:
Co-author's contribution:

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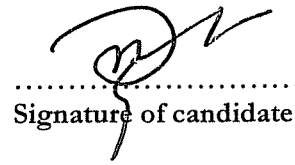

.....
Signature of candidate

Co-author's signatures:

Waktole Tiki	.....	Gufu Oba	
name	name	name	name