Community-based approaches in the construction, ownership, and management of water infrastructures and the development of socio-political complexity among the Chagga, Kilimanjaro, Tanzania

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Abstract

Since the second half of the second millennium AD, water management among the Chagga people of Kilimanjaro in Tanzania has involved community collaboration in the construction, ownership and management of water infrastructure. Chagga settlement on the lower slopes of Kilimanjaro transformed the landscape significantly to reflect an agrarian society characterised by decentralised forms of socio-political and economic organisation. Such organization involved conception, construction, and post-construction management of water distribution systems, constituting high-level socio-political complexity. The study employs ethnography, archaeological surveys and GIS to document water infrastructures on the lower slopes of Kilimanjaro. We conclude that community collaboration was key in management of the water infrastructure and by extension, agriculture, which sustained Chagga and chiefdoms for centuries.

Keywords: Chagga, water infrastructures, water management, sustainable farming, social complexity, community collaboration, landscape

 doi:10.20944/preprints202212.0456.v1

Introduction

The lower slopes of Mt Kilimanjaro are home to Chagga agro-pastoralists. The Chagga have traditionally lived here as well as on the eastern part of Mount Meru for at least four centuries, exploiting these vast mountain ecosystems. To attain their daily subsistence needs, the Chagga began transforming the native mountain forest. Trees that provided fodder, fuel and fruit were retained. In contrast, the less useful ones were eliminated and replaced with new tree and crop species [1]. The resultant cropping system must have resulted in a high population in the region. These highly fertile ecosystems have generated considerable agricultural wealth for the Chagga, based on indigenous traditions of extensive irrigation systems, terracing of the mountain slopes, and organic enrichment of soils. In this paper, we engage using ethnographic and archaeological approaches, contemporary Chagga communities and remembered Chagga pasts, to understand water distribution systems on the lower slopes of Mt Kilimanjaro and how these are connected with the origins and development of social complexity around the mountain. The Chagga still use these water infrastructures. Today they neither construct new irrigations infrastructures nor follow the ancient post-construction rituals. It is the memory and reverence to the art and skills their ancestors invested in furrow construction that still live with present day communities and that attest to the origins and development of social complexity among small-scale societies in eastern Africa. Listening to the Chagga narrating such memories, one discerns how they value their pasts, and their roles in shaping the present. Such narratives from contemporary local communities on the nature and systems of water distribution and management gives the Chagga a deep sense of ownership on these infrastructures, which they maintain and preserve. This contributes towards understanding Chagga origins, and present.

Sub-Saharan Africa is home to “islands of intensive agriculture”, involving innovative forms of water management. Such ecosystems have never been considered within the context of socio-political and economic complexity. The Chagga remain some of the few societies in Africa living in a similar environment. Numbering about 2 million, they are regarded as the wealthiest ethnic group in Tanzania. This follows centuries-long development of socio-political complexity that was not monarchical, but rather,

 doi:10.20944/preprints202212.0456.v1

primarily organised at chiefdom level, and comprising 400 clans that managed an ever-increasingly dense and growing population on the slopes of Kilimanjaro. Water infrastructures in the form of furrows were engineered to support agriculture practices which have sustained the Chagga for centuries.

Environmental and Historical Background

Mt Kilimanjaro is Africa's highest mountain located in northern Tanzania, in eastern Africa. Comprising five ecosystem zones, it has the cultivation zone on the lower slopes (800-1800m above sea level), the montane forest (1800-2800m), heather-moorland (2800-4000m), the alpine desert (4000-5000m) and the arctic summit, over 5000m. The cultivation zone is home to a number of ethnic groups, comprising the pastoral Maasai on the northern and north-western slopes, the Ongamo on the eastern slopes, and the Chagga on the southern and western slopes of the mountain. The term 'Chagga' or Wachagga, according to written records, connotes a unifying word that signifies a common identity of the largest group of people on the slopes of Kilimanjaro [1] (Figure 1). The Chagga are divided into several chiefdoms, prominent ones being Kibosho and Keni-Rombo. They have always been entrepreneurial and adaptive, a common cultural trait strongly associated with the lower slopes of Kilimanjaro [2-3]. Monumental structures, such as underground boltholes, and water management features such as furrows, attest to complex Chagga pasts, warfare and organisational capacities beyond family levels.

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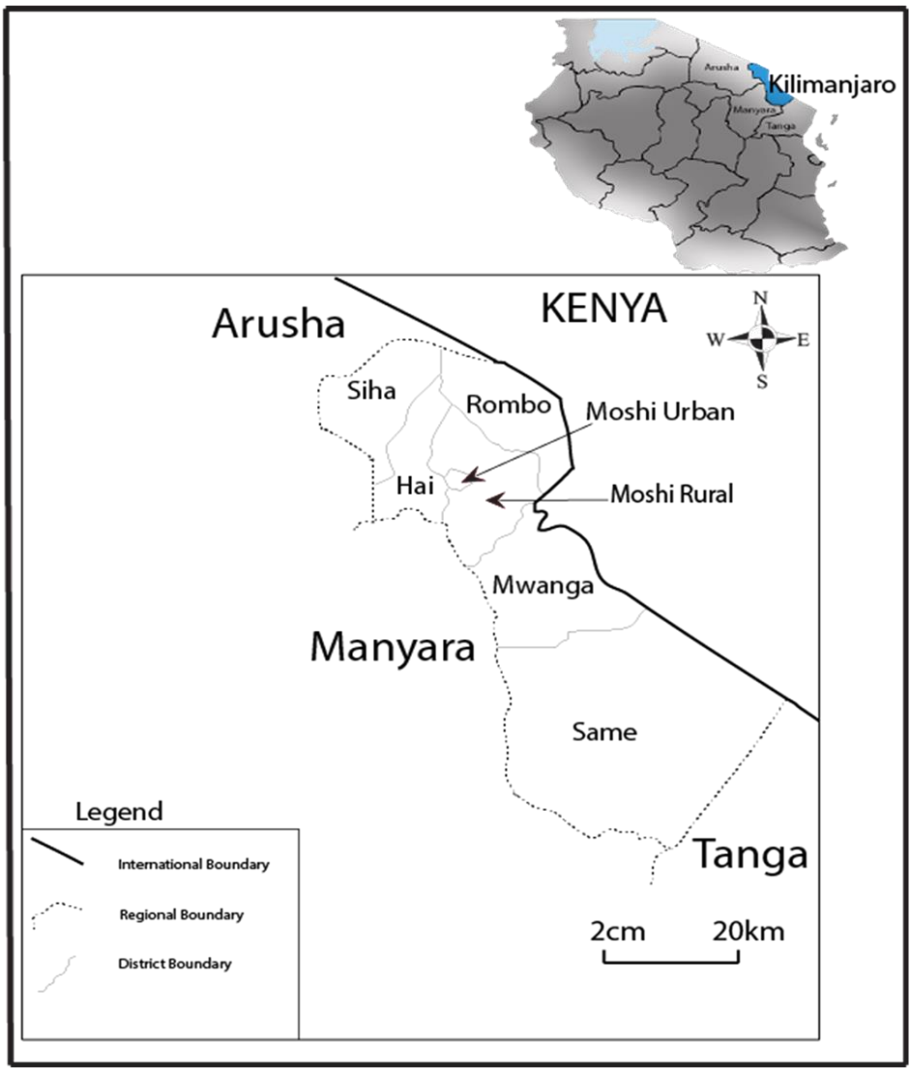

Figure 1: The Kilimanjaro region showing some of the places mentioned in this paper (Image courtesy of Valence Silayo)

The settlement history of the Kilimanjaro region remains poorly known. Evidence from western Kilimanjaro suggest human presence since Neolithic times [4], while pottery from Marangu, east of the mountain, points to Iron Age farmers during early first millennium AD. Elements associated with ancestral Chagga settlement such as irrigation and associated water infrastructures date some 400-500 years ago [5]. Recent work [2] provides evidence of complex forms of settlement incorporating furrow construction and water management dating from the mid-fifteenth century AD. This is supported by early visitors to Kilimanjaro [6, 7, 8]. Bishop Hannington recorded an account from Mangi Mandara of Moshi, who claimed ancestry dating back fourteen generations, which, according to oral traditions would date to 450 AD [9].

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The Chagga exploited the favourite mountainous environment primarily based on agriculture “The Kihamba system”—home gardens—enabled farmers to sustain production using local resources [1, 10]. Their land-use patterns are characterised by intensive smallholder production of subsistence and cash crops on the eastern slopes. The home garden is typically a complex multi-cropping system that has evolved over many centuries in Kilimanjaro through a gradual transformation of the southern and western slopes of Mount Kilimanjaro. It is also an explicit example of agricultural resilience as it integrates numerous multi-purpose trees and shrubs with food crops and animals without a specific spatial arrangement. The system still comprises four layers of canopies: food crops (such as maize, millet and beans), coffee, bananas, and trees, maximising the use of limited land and increasing resistance against droughts and pests while ensuring environmental protection. Chagga agriculture intensified in the nineteenth century, after the introduction of coffee beans and other exotic crops [10, 11]. Millet and banana are very special as they are central to Chagga culture and identity. Sir Theodore Morison remarked, the Chagga grew a “sort of canary seed used to brew local beer, and also grew a variety of bananas—for food, cattle, and some were dried up to make flour, and yet another one mainly used or eaten with meat” [12]. Long-distance caravan trade between the coast and the Great Lakes during the early decades of the nineteenth century contributed to the rising power of chiefdoms in the area [13-15]. A caravan was composed of various ethnic groups and with a substantial number of people. The Chagga were strategically located to refuel such large groups of people with essential supplies [16]. Chagga chiefs had to mobilize resources such as food, water, ivory, and slaves to meet the needs of the traders. This intensified conflicts between chiefdoms. Over time, some chiefdoms dominated the trade, negotiating on behalf of their people, raiding neighbouring chiefdoms to procure slaves and other commodities.

Early Chagga settlements were usually located on river and streambanks, with fast-moving water flowing toward the plains. This served a dual purpose; security and easy access to water. Riverbanks served as entry and exit points of boltholes and also

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supplied water for domestic use [3]. From the numerous rivers flowing from the mountain, the Chagga developed an intensive agricultural subsistence economy. Water also played an important role as an agent of social complexity. The forest zone, between 1800 and 3000 metres above sea-level, provides most of the water used in the cultivation zone, which, according to Ramsay [17] is "a network of irrigation channels and furrows". The furrows (*mifongo*) run for several distances, sometimes up to 15 kilometres, tapping water from different streams and rivers flowing from the mountain. There are so many furrows in most of the populated areas such that Chagga settlements may have aligned to these water infrastructures as much as possible [18]. The origin of *mifongo* in Kilimanjaro remains uncertain. Some scholars argue that the idea might have been borrowed from neighbouring groups, such as the Engaruka north of Kilimanjaro or the Kamba in Kenya [2, 19]. Bender believes that the Engaruka and the Kamba may have practised irrigation much earlier than the Chagga, who only started irrigation during the first half of the seventeenth century AD. This falls in the formative phase of Chagga settlement in Kilimanjaro, between the fifteenth and seventeenth centuries, characterised by numerous wars between chiefdoms, and accompanied by the building of war ramparts. Such battlements included underground tunnels, ditches and stone fortifications [2, 11].

Water furrows in the Kilimanjaro region have been extensively documented [2-3, 19, 20-30]. Historians such as Stahl [31] and early visitors such as Johnston [7, 9] described the furrows and water flow from mountain streams to the fields as a spectacular feat of engineering. In the past, streams and rivers such as Kikafu, Weruweru, Kikuletwa, Mue, Karanga, Rau and Wona had running water throughout the year, and water furrows were connected to these. This paper also highlights the complex interconnectedness between social organization and maintenance behind these structures. The physical landscape poses considerable obstacles that required sophisticated planning of water infrastructures from the gorges to the banana and settlement groves [18, 32-34]. This also explains the ritual practices and seriousness Chagga clans attached to water management [3, 32]. Since it is costly to construct a furrow and channel water through them, the Chagga adopted very strict rules to ensure sustainability, safety and cleanness of the water flowing therein.

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Methodology

This paper employs ethnographic and archaeological surveys to examine the present Chagga landscape for cultural markers left by their ancestors - markers that give insights into water availability, distribution and use. An ethnographic inquiry was conducted to collect primary data on furrow construction. Using snowballing, key informants were interviewed and this helped in mapping some of the irrigation furrows identified. From this and other studies in eastern Africa, one realises several examples of communities such as the Pokot, Marakwet, Pagasi, Baringo, Sonjo, Taita and the Pare, engaging in intensive agriculture, using both non-intensive and intensive irrigation [33-36]. Chagga social organization and agropastoral economy is intricately tied to their water management systems to irrigate their fields. Their ancient water infrastructures offer a window to investigate the origins and development of their socio-political complexity [37].

Archaeological surveys which were largely aided and guided by information from local communities, identified and mapped various irrigation structures and their layouts in three districts: Rombo, Moshi Rural and Hai (Figure 1). The archaeological survey had two aims; first, to identify and map the distribution of accessible irrigations and the water courses they originate from, and, secondly, to understand the physical landscape in relation to the river sources as well as the intended distance from such sources to the villages and the technological complexity involved in the construction of particular water infrastructures. The data were digitized and analysed in geospatial databases.
An archaeological study on the Chagga must include water infrastructures [2], how rivers, streams and furrows relate to water use. This is connected to Chagga social and political organization. We use the term water infrastructures in broad terms [32] as social and technical assemblages of materials and matter as well as people and their behaviors in the context of sociotechnical, technopolitical, and phenomenological perspectives. Chagga origins have been understood using sociotechnical approaches that emphasizes ways in their water infrastructures mediate the relationships between people and social institutions, and between people and the mountain environment.

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Technopolitical approaches were also used in this research to understand how chiefs and clan leaders governed water infrastructures, to ensure sustainability and continuity. Such approaches are phenomenological in approach. Phenomenology, in this case the Chagga lived experience of the worldview of the lower slopes of Kilimanjaro, is also employed, to understand local, indigenous perspectives around management of traditional irrigation technologies and infrastructures and how socio-political complexities emerged [33, 37-38]. With substantial evidence of anthropogenic modification of the landscape over centuries, the lower slopes of Kilimanjaro bear testimony to the evolution of socio-political and economic complexity in eastern Africa [25, 27-30].

To understand the development of Chagga socio-political complexity, we investigate the meaning of contemporary water infrastructural developments of the residents living on the slopes of Kilimanjaro around. Given their reliance on mountain water, there must have been concerns around infrastructural provision, soil fertility and water supply. We argue that Chagga water infrastructures were an investment to cope with continuous environmental change and future uncertainty over sustainability of resource use on the mountain slopes. This argument is supported by ontologies and politics around water, and informed by ethnography. Water infrastructures premised survival of the Chagga, into the future. Thus, this paper goes beyond discussion of water infrastructures as evidence of complex Chagga pasts, demonstrating the intersection between the natural and cultural environment, and contemporary relevance. Such connections between humans and places, settlement and ritual are informed by landscape approaches [39].

The presence of these complex irrigation systems implies the existence of an advanced socio-political organization in Kilimanjaro. Literature on the Chagga gives detailed accounts on how irrigation was used in all parts of the mountain especially the southern slopes. Masao [27] argues that *mfongo* technology and *nduwa* (water collection dams, for storage) are “as old as the Chagga people”. On the same note, Mattias Tagseth [28-29] points to Chagga oral accounts indicating that irrigation has been practised for a very long time. Chagga settlement on the lower slopes of Kilimanjaro required intricate integration with the rugged mountain terrain, whose biggest advantages were the rich volcanic soils, and a reliable water supply from the rainforest. With these, the Chagga

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developed farms (*vihamba*), irrigated with water captured from the rivers and streams by way of *mfongo* and *nduwa* [2]. Overtime, this created an intricate relationship between the Chagga and their physical environment, shaping their worldview. Water, land and livestock are the most important and highly valued Chagga possessions, a fact reflected in their numerous legends, songs and proverbs. The latter are used to guide the young and convey wisdom for future generations [40-44]. Water sourcing, usage and maintenance are central to Chagga legends and wisdom. These resources and practices have always been highly localized and controlled. Our investigations aimed towards understanding Chagga cultural material around water infrastructure and the lessons archaeologists could learn from their inherited pasts. Thus, this research must also be considered within the context of community archaeology and cultural heritage. Chagga centuries-long histories settlement on the slopes of Kilimanjaro provide social meaning of material culture that still shapes societal dynamics today.

Figure 2: Mamba furrow complex in Machame, Kilimanjaro (image by Valence Silayo)

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Results

Ethnographic accounts indicate different roles played by different individuals in the community hierarchy regarding water ownership, furrow construction and management. Although the Chagga chiefs (*mangi*) did have the final say regarding various issues on water such as permitting the cutting of furrows from a specific river to officiating and deciding on water disputes that water boards or committees could not resolve, they did not own water distribution structures. Supporting evidence is drawn from ethnographic accounts collected during our fieldwork. "The idea begins with an individual, mostly a clan furrow engineer," according to Mr Tobias Milioni Mushi from Kibosho (pers. comm). There must be a necessity for that furrow and consultation with villagers regarding the specific needs and uses of the water from the new furrow. This is also evidenced by the fact that the furrow is not owned by a specific family, but a clan or the entire village. All the furrows identified during the study are under the ownership of specific clans and or villages, e.g., the Mamba furrow in Machame, which is owned by Mamba village. This gave rights to water access to every individual in that village. According to Mr Tobias, the current chairperson for Orosise furrow (pers. comm) (Figure 3), after internal consultations among the immediate users of the intended furrow, a formal request is submitted to the chief (*mangi*) by the clan through the *mchili*, the chiefs's local representative, to allow the clan/village members to cut a new furrow.

Oral histories collected during our fieldwork show that after construction, furrows were placed under a management committee led by elders. The committee was a custodian for an asset owned collectively by the clan. In consultation with the Mangi, the committee was responsible for the daily operation of the furrows, directing and redirecting water depending on need and availability. A strict schedule was maintained when releasing water to irrigate fields, feeding the animals and for household consumption. Every clan member was obliged to report a damaged or leaking furrow. Therefore, everyone had an obligation to protect the furrow. In the event of damage or leakage, a furrow elder would announce during the evening a message known as "*Ole lo mfongo*" (call for furrows). Regardless of personal routine, everyone was expected to attend to this call the next morning.

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Archaeological surveys focused on the construction of water furrows in relation to the associated physical landscape. In Kibosho, surveys along the Isie river identified four furrows: Manga'tu, Mmasi, Orosise and Miroshi. In Machame, along Kikafu river, two furrows were identified: Uwia, and Mamba, while along Namwi river Ngira furrow was documented. In Marangu and Kilema we observed several furrows in different rivers. Survey in Machame revealed how difficult it was in mapping and constructing water channels for irrigation. This required intense knowledge of the entire landscape, including measuring the actual distance from the intake point, and all the intrinsic challenges. Water flow velocity is another important aspect. Results reveal that the proximity of the village (the user) to the source or intake point (the river) was not as essential as the contour and the users' maintenance discipline. For example, Mamba is one of the biggest furrows in Machame (Figures 2, 3). Its source is the Kikafu river and the initial intake lies in the Kilimanjaro Forest Reserve and runs several kilometres from there to the village. During an interview with Mr Aleangusiyo Oto Mushi, he indicated the furrow was initially intended to feed different villages. As such, a stable intake was essential but the deep Kikafu valley and the hill contour of Machame made it impossible to find a suitable intake. We also observed that although there may be different physical obstacles mostly to do with the hill contour, engineers found ways to navigate around these. This is evidenced by furrows cut deep in gorges as well as the mechanism used to reduce or increase water velocity in the furrow (Figure 4). This included reservoirs (*nduwa*) built a few meters up the intake, which regulated the amount of water allowed into the furrow.

Chagga engineers used unique technology to divert water from mountain rivers. This involved a low embankment of stones and boulders at a convenient place where the water flows calmly, into furrows. Where valleys are deep, furrows run along hillsides for many kilometres until they reach households. Archaeological surveys show some furrows originating from the deep forest higher up the mountain, meandering downslope towards villages. Engineers meticulously mapped the landscape to allow construction of furrows along gradients that would deliver water supplies to the villages located downslope with sufficient velocity and quantity. At times, such villages had to be located some distance from the furrow intake. Several furrows could be cut from the

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same river and one furrow could have numerous twigs. Branches from the main channels extend to reach all parts of the villages where each homestead is allowed to deviate a stream into the adjacent banana grove (Figure 3).

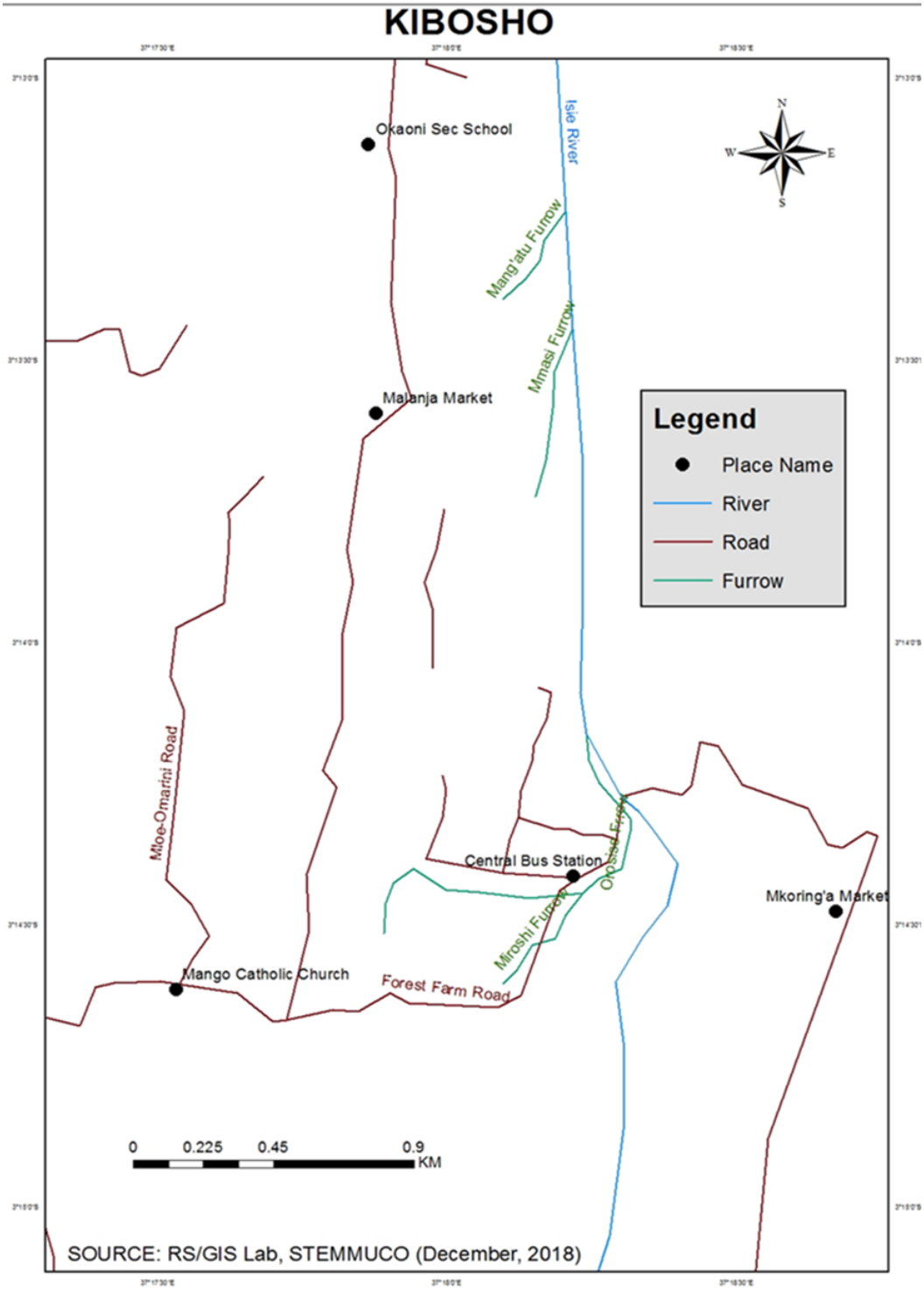

Figure 3: Irrigation furrows along Isie River, Kibosho (Image courtesy of the GIS Laboratory, Stella Maris Mutwara University College)

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At some point, furrows join to form one bigger furrow (Figure 2). From this point, secondary and tertiary channels (Figure 5) may spread, building a network of flowing water arteries [2].

Figure 4: Furrows across deep gorges of Ona river valley, Marangu (Photo by Valece Silayo)

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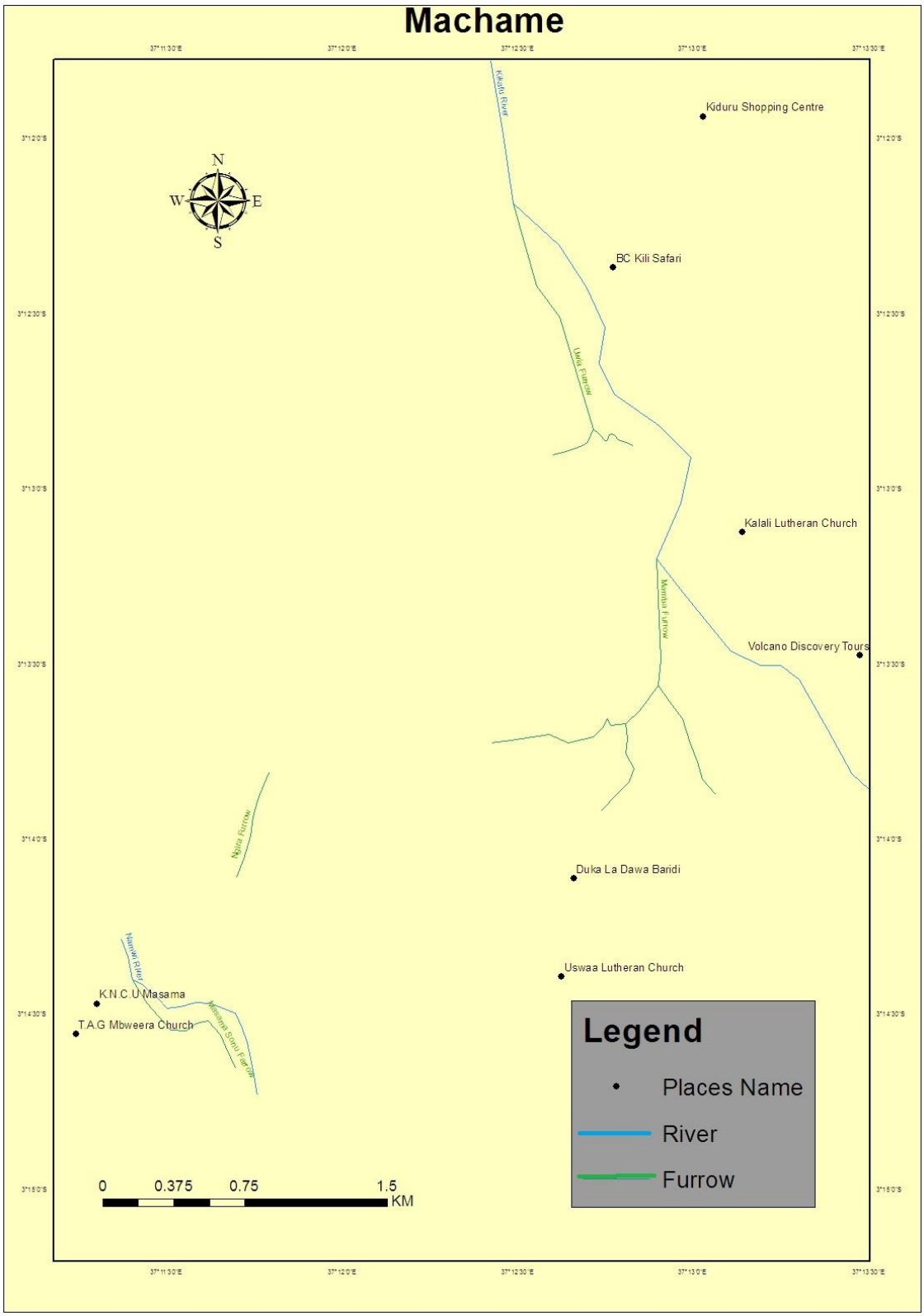

Figure 5: The distribution of furrows from River Kikafu, Machame (Image courtesy of the GIS Laboratory, Stella Maris Mutwara University College)

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Discussion

The floruit of organization and logistics for furrow construction to the water management and maintenance of furrows demonstrates irrefutable elements of socio-political complexity among the Chagga. Links between Chagga chiefdom politics and water is evident. A well-organized social system facilitated and ensured a well-defined division of labour based partly on clan patterns, all for the benefit of the chiefdoms. Chagga clans played different but complementary roles in society; some were smiths, some rainmakers, some were *mfongo* engineers, while others were cattle herders or beekeepers. Such clan division of labour made possible feats of furrow digging manageable [24]. Each chiefdom had a specific clan that owned the art of furrow engineering with the Mbokomu chiefdom at the core of this technology. One of their leaders, Mangi Mlatie, was a revered furrow surveyor [24, 44]. Collectively these clans are known as 'Wakomfongo'. Surprisingly, not every member of Wakomfongo was an expert in-furrow engineering. The vision to start and lead furrow surveying was conceived individually and the person who had the dream would direct the work. In some instances, the idea came from other clan members. The clan would then convene and elect someone to direct the project. To get authorisation, the furrow surveyor would present a gift from the potential users of the furrow to the Mangi, either in the form of a *ndafu* (fattened he-goat) or *mbege* (traditional beer). The Mangi would assess the request including the available human resources and if satisfied, consents to the project. This tradition existed since time immemorial. Mangi's blessings were not enough to warrant the beginning of the furrow construction. A series of rituals, ceremonies and observations by the engineer and furrow users would follow. Mostly, such supplications and sacrifices were directed to the latest deceased elder of the clan, who then forwarded the request to the ancestors using set protocols [2, 28-29]. Oral accounts of these ritual traditions and observations differ, although some of them overlap. A conversation with Mr Anasa Mrema reveals that two immediate actors after the assent of the Mangi—the furrow chief engineer and clan elder—must observe a prayer vigil until they receive a signal. The signal, which comes in the form of a stretch of red ants from the home of the furrow engineer or elder of a furrow-owning clan or the home of the head of the clan, was interpreted as assent of the project from the ancestors. Members of the clan were

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expected to observe purity by abstaining from sexual intercourse and other profane behaviour, including blasphemy against the ancestors, unnecessary conflict and family squabbles. These observances would stay in place until the signal is given, failure of which the project is postponed [28]. Some clans would continue to observe this ritual until the construction of the furrow is completed and commissioned. In the event construction project is completed but water fails to flow in the furrow, clan members took this very seriously, with the possibility that perpetrators who failed to observe the rituals were persecuted or punished (Aleangusiyo Oto Mushi, pers comm). These rituals speak to Chagga worldview, where water is regarded as pure, spiritual and harmless [23, 28]. It was a resource which mobilised the community, who never abrogated responsibilities related to furrow construction, maintenance or repair. This was sustainable in terms of the use “home-grown” resources, including clan participation [30]. This is how social, cultural and political relationships developed around water management in the lower slopes of Kilimanjaro.

Furrow construction was done by men and required enough and reliable personnel [2, 23, 25]. Their maintenance sustained Chagga agriculture. Their deterioration would halt and affect the community’s socio-cultural and economic development. Thus, despite conflicts among some chiefdoms over water, collaborative conservation of water infrastructures united various clans. According to Moore [16]:

"To be able to utilise the perennial water resources, one had to tap water from the rivers at points higher up than the altitude at which the water should be used. To secure the supplies, one needed an agreement with the people living near the water source. Secure water rights imply political understandings among settlements through whose territory, or near whose land, the water passes. Water thus constituted a major reason for alliances between chiefdoms above and below and was a motive for amicable relations with chiefdoms on either side”.

The furrow system involved very complex social systems, built over a long time [24, 28]. It is striking considering the number of people required to undertake such a breath-taking job. Many people required to construct and maintain the furrows indicate the level of social complexity and organization the Chagga had reached between 1400 and

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1700 AD. Oral history in Kilimanjaro [2, 20, 44] show the Chagga clans persistently fighting among themselves and with other groups, for expansion and influence. Most remembered are the wars waged waged by Horombo of Keni, Mandara of Old Moshi and Sina of Kibosho. Wars fought from the seventeenth to the first half of the eighteenth century allowed very little time for the construction of water infrastructures, thus the only time furrows could have been constructed without interruption was before this period.

Early visitors to Kilimanjaro describe these complex water distribution structures but did not witness the Chagga constructing them. Sir Charles Dundas [44] associates the development of furrow networks in Kilimanjaro with the cultivation of eleusine and intensification of other agricultural activities. This makes a convincing argument since most eleusine was cultivated during times of less or no rain, hence the need for alternative methods to irrigate the crop [46]. Masao [27], however, disagrees, arguing that eleusine was a major Chagga staple and who would not risk adopting it if environmental conditions were inadequate to grow it. Therefore, eleusine cultivation was synonymous with the development of furrows. Oral accounts from the study area echo Masao's suggestion, pointing out that the local brew, *mbege*, was integral to the ritual and ceremonial ingredients required in the process of furrow construction and maintenance. *Mbege* is a social drink that accompanies all major Chagga gatherings, including meetings where decisions to construct new furrows were taken. We suggest the development of irrigation intensified eleusine production in Kilimanjaro.

According to Sunday [45], the coping, adaptive and transformative responses have long been characteristics associated with the vulnerabilities of Chagga *mfongo* water management system. The nineteenth century caravan trade not only stimulated the Chagga farming system, but also their socio-political system [46]. The lower slopes of Kilimanjaro witnessed population growth and expansion of the agroforest area. The demand for water increased proportionally. Håkansson et al. [47], commenting on agricultural intensification in the nineteenth century, noted that communities living on long-distance trade routes needed substantial agricultural produce to feed the caravans and suggested that this demand might have prompted agricultural intensification along the caravan route. Earlier, Håkansson [48] argued that population densities in the

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Kilimanjaro region during the nineteenth century were low and the region received sufficient rainfall. Irrigation, they argue, only emerged as a consequence of the need to intensify agricultural production to generate surpluses to meet the commercial needs of the passing caravans. This however ignores other uses of water by the Chagga in the past. The Chagga also used water for millet (*Eleusine coracana*) cultivation. Apart from the Rombo region located on the leeward side of Kilimanjaro and thus a rain shadow area, the southern, windward slopes of the mountain witnessed eleusine cultivation during the dry period from June to October, using irrigation [45]. Furrow irrigation thus developed prior to the caravan trade, for the cultivation of millet and other crops as well.

Chagga markets radically transformed during the late eighteenth to the early nineteenth centuries following the introduction of regional markets and the increasing demand for agricultural produce for the caravans. The Chagga, as the main suppliers and providers of the caravan trade, experienced shortage of agricultural produce and resorted to intensive agriculture to produce surplus food for the traders. By 1840, caravans to Kilimanjaro comprised large, diverse, multi-ethnic groups [49, 50]. Although the Chagga had traded among themselves and with their neighbours for centuries, caravan trade intensified their irrigation systems, further entrenching socio-political complexity. Chagga markets were run by women and protected by the Mangi and his men. In 1861, Karl Klaus von der Decken visited Old Moshi and described a market with about 500 women [51]. According to Tobias Milioni Mushi of Kibosho (pers. comm), every Mangi had a responsibility to protect these markets. While wars might have interrupted market days, these resumed immediately after the war [18]. The most revered warlord and state builder, Mangi Sina (1877-1897) of Kibosho, engaged in numerous wars in the Kilimanjaro region, while his people enjoyed long periods of peace and prosperity, farming and trading intensively [20, 44].

The development of socio-political complexity among the Chagga was centred around water and irrigation. The hydrological engineering involved an intricate set of ritual and ceremonial events, linking Chagga chiefs, clans and villagers to the ancestral world. This attest to continuity and reverence of tradition, which attached considerable importance to water and associated infrastructures as vital components of the Chagga

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cultural landscape. Life among the Chagga was and continues to be shaped by such infrastructures [28, 52]. The investment, high-level organization, construction, use of these infrastructures was impressive and speaks to cultural and technological sophistication among the Chagga. Chagga surveyors used only a stick to plot the courses of furrows. They neither possessed nor required instrumentation for grading: their knowledge and skills were adequate for the water infrastructure they constructed [27]. Furrow alignment was done by way of visual inspection, the furrow excavated under rock or banked up [28-29]. It is such high level of local knowledge and manipulation of resources that defined early forms of Chagga socio-political complexity.

Kilimanjaro does not fall under historian Karl Wittfogel's hydraulic theory of civilization where control of water resources is connected with centralization of political power. In discussing the "absolute state", Wittfogel relates the importance of water to the rise of states, arguing that irrigation required substantial government representation and centralized state and economic control. He further argued that irrigation infrastructures such as canals are related to advanced societies [53]. While the Chagga water infrastructures are not comparable to some ancient Near Eastern and Asian complex societies that developed along major rivers, it is important to understand how chiefdom and state-level societies in sub-Saharan Africa interacted with water. The dynamic nature of the Chagga cultural landscape promoted decentralized, rather than centralised political control [23]. Water in Kilimanjaro was pivotal for the growth of what Bender termed "sophisticated agrarian society". Thus, water infrastructures in Kilimanjaro exemplified a society with complex forms of social organization allowing mobilisation and execution of large and complex structures such as irrigation furrows. According to Scarborough [54], the construction of water management infrastructures requires careful planning. This makes water infrastructures such as irrigation canals a reliable measure of political power and state authority. Sir Charles Dundas [44] writing earlier than Karl Wittfogel about the development of furrow networks in Kilimanjaro said; "no small degree of regulation is necessitated and within the course of the furrow, the order must prevail". He attributed the whole process and management of the furrows to the institution of chieftainship and development of a steady organization [44]. Although the furrows were developed and engineered by specific clans, construction

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work was overseen by chiefs. In this way, chiefdoms ensured smooth flow of authority and organisational leadership, vital in resolving disputes emanating from the use and maintenance of furrows. Disputes arising from the use and maintenance of furrows and water rights were very few and well-handled [29]. The meticulous management procedures involved resulted in the drafting of community-by laws on water [23].

Conclusion

Integration of archaeology with oral interviews enriches our understanding of Chagga history and their development of complex socio-political and economic systems. Since the second half of the second millennium AD, the lower slopes of Mt Kilimanjaro witnessed intensification of agriculture aided by water infrastructures such as water furrows, to support the Kihamba home garden system. Chagga home gardens are a climate-smart production system that indirectly ensure agricultural resilience and food sustainability for communities in the lower slopes of Kilimanjaro. It was and is still practised to meet community needs in changing environmental conditions and enhance innovation capacity. Oral accounts affirm that the system entirely relied on and promoted self-reliance, using local labour and material. This was possible through investing in community-based workforce and use of an adaptive management system of "learn-as-you-go". The home garden system created a ripple effect throughout the entire subsistence system, sustaining local and regional markets and maintaining the long-distance caravan route in the eighteenth century. For the Chagga, home gardens were a measure of agricultural resilience, in an environment confronted with warfare or the demands of external traders. Linking the home gardens are the furrows that convey water from the rainforest or the rivers emanating from there, which demonstrate Chagga efforts in transforming the lower slopes of Kilimanjaro, creating water infrastructures that are monumental in scale. Such developments are often associated with ancient complex societies [55]. Given the Chagga were never a unified state system, the scale and extent of their water infrastructure would categorise them as advanced chiefdoms [56-57] around which they evolved complex socio-political and economic systems. We invite researchers working on the origins of "islands of intensive agriculture" to reconsider concepts of socio-political complexity around these and how such "islands" may have developed alongside major ancient state systems or kingdoms.

 doi:10.20944/preprints202212.0456.v1

Acknowledgements

This study was undertaken as part of the African Humanities Program (AHP) fellowship awarded to Valence Silayo as well as the South African National Research Foundation (NRF) Competitive Program for Rated Researchers (CPRR) (Grant No. 105866) (2016-2019) project titled 'Approaching the Complexity of Great Zimbabwe' for which Innocent Pikirayi was the principal investigator. Dr Silayo was awarded the AHP fellowship in the 2019/20 academic year. Research permits were awarded by the Antiquities Department of the Ministry of Natural Resources and Tourism of Tanzania through Tumaini University, Dar es Salaam College Postgraduate Research Office. Particular gratitude is due to all the informants in Kilimanjaro and the local government officials. The authors also appreciate the assistance from Pastor Enock Makundi of the Evangelical Lutheran Church in Tanzania who also heads the Northern Diocese Archive. We thank the University of Ghana and the Nordic Africa Institute for providing practical and logistical support as well as space for write up and discussion.

List of Interviewees

Mr Tobias Milioni Mushi (81) Kibosho, has participated in my various interviews on the history of Kilimanjaro; he is currently the leader/ chairperson of Orosise Furrow.
Mr Anasa Mrema (83), of Mbokomu, 9 October 2018. He is very knowledgeable on Chagga traditions and rituals.
Mrs Yustina John Laswai (75), Mkuu, 8 October 2018
Mr Aleangusiyo Oto Mushi (93), Machame (12 October 1018)
Mr Eliasi Sebastian Ngoiya Laswayi (73) (8 October 2018)
Mr Rafael Mchau (73), Kidia, Old Moshi (9 October 2018)
Mrs Aurelia Clemence Lymo (80), Marangu (10 October 2018)

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