REFOOTURE

from sustainability towards regenerative thinking

Story of Place

Example of first or second drafting

Accompanying document to "Collaborate to Regenerate" facilitators guide

Sinéad O' Keeffe, Thies Reemer, Bram de Grote

22/12/2022

WAGENINGEN
UNIVERSITY & RESEARCH

Sinéad O' Keeffe, Thies Reemer, Bram de Grote. 2023. Story of Place (SOP). This document accompanies the guide "Collaborate to Regenerate". When working towards Regenerative and Inclusive Food Systems, the story of the place is a starting point. This is the example of what a first or second draft of SoP may look like, for Menengai, Nakuru County, Kenya.

Cover Picture: view from the slopes of Menengai towards Lake Nakuru (picture by the author)

The REFOOTURE project (July 2020 – March 2023) has been commissioned by University Fund Wageningen and has been financially supported by IKEA Foundation.

Contents

Abstract

This is an accompanying document to the REFOOTURE facilitators guide "Collaborate to Regenerate". It is not a standalone document and it should be read in combination with the facilitators guide. The work that is contained in this document aims to start understanding the story of place, in this example, Menengai, Nakuru in Kenya. This is because we want to understand *"what makes a place unique....what is the inherent potential of this place" (Mang, Haggard et al. 2016)*. An important consideration to note is that this is not a scientific reporting process. Although the information presented in this document appears as such, this is in general not the case. It is usually for internal purposes only and would not be published. The development of story of place is a process to find as much information from many different (valid) sources as possible in order to gain a deeper understanding of the place and its communities through time.

From this drafting of the story of place (SOP), we could identify the following aspects for Menengai community (forest and people). It is a very unique place and there is a deep and rich history of people living and settling in the Nakuru/Menengai region. As a volcanic region, it is naturally a place in a constant dynamic flux, a place of energy travelling through it – of animals , water, magma and people. The extensive fossil archives found in and around the Rift valley enable a very good understanding of the historical patterns needed to develop the story of place. This also means it is a hotspot for scientific research and potential science related tourism (e.g. volcanologist, anthropologist). Therefore, also a potential opportunity for earning diverse revenue streams across the region. Understanding the hydrology of the area and how it is shifting is key to determine which adaptation strategies might be needed to support the ecosystems within it (people and nature combined). This is especially prevalent due to the predictions of vulnerability to impacts from climate change. Forests play a fundamental role for building resilience of the region against the impacts of climate change. Starting to restore and regenerate the forest is key to beginning the journey towards regenerative practices and RIFS. There are more than likely still legacies due to colonialism and this is something to be conscious of with regards to mindset and the potential patterns found in the food system. Gender equality and understanding the dynamics of families are also important to ensure inclusivity and longevity in the transformation process. For this, cultural norms may need to be navigated delicately to raise awareness effectively to stimulate a mindset shift

The information provided in this SOP can provide a deeper and richer understanding of the potential of the Menengai forest and its community. It can help to see the opportunities, and also some of the barriers facing the community (both forest and people) in reaching their potential of undergoing a transformation towards RIFS. Such a transformation would involve activities that could simultaneously help support their food and nutritional security, their livelihood resilience, the ecosystem health of the forest, and creating an equal and caring community (between themselves and also the forest). This transformation in turn has the potential for wider consequences, a ripple effect to the bigger picture (e.g. Nakuru food system). It is important to use the information in the SOP objectively to provide insight and interpretation of some elements and patterns unique to this area. However, facilitators should be aware of potential unconscious bias due to such information and should not automatically steer workshops towards issues highlighted in this document, these should be enabled to develop in the workshop naturally.

1.Introduction

This document is an accompanying document to the REFOOTURE facilitators guide "Collaborate to Regenerate". It is not a standalone document and it should be read in combination with this facilitators guide. The work that is contained in this document aims to start understanding the story of place, in this example, Menengai, Nakuru in Kenya. This is because we want to understand *"what makes a place unique....what is the inherent potential of this place" (Mang, Haggard et al. 2016)*.

This involves gathering information about the place of interest, such as physical geography (e.g. hydrology, climate, topography) and human geography (e.g. socio-historical, political, cultural)[1]. This is done usually as an accompanying desk study and iteratively combined with discussions with the communities living in place (see collaborative guide). Thus, enriching the knowledge base to support a more wholistic understanding of the living system that the team is working with (see Figure 1) .

Story of place is a continuous companion in this process and feeds into the discussion and selection of tools. It is an important instrument to continuously zoom in and out of the system: zooming out to have a birds-eye view and see the regional drivers and their effects and finding entry points for change; zooming in to experiment with and make use of leverage points for systemic change. The example provided here, is somewhere between a first and second drafting, as we have already started to use information and stories from the Menengai community forest association.

An important consideration to note is that this is not a scientific reporting process. Although the information presented in this document appears as such, this is in general not the case. It is usually for internal purposes only and would not be published. The development of story of place is a process to find as much information from many different (valid) sources as possible in order to gain a deeper understanding of the place and its communities through time. This information can come for example from: newspapers, advertisements seen in a shop, stories overheard or also from scientific literature. It is a combination of all valid information sources to build a more wholistic picture, again it is not something necessarily for publication. It is to help us understand the role that Menengai can play in the proximate whole (Nakuru food system) and the role that this can then play for the greater whole (Water towers).

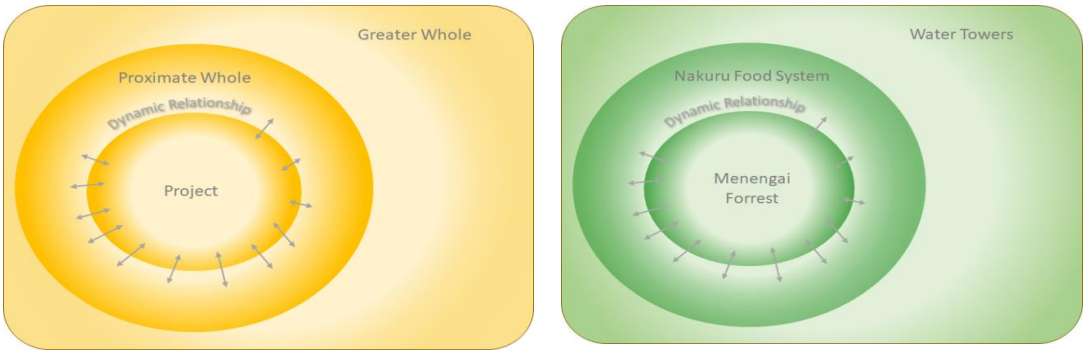

Figure 1 The first box (yellow), shows a place based visualisation tool from the Regenesis Institute to explain the role of Menengai forest in the bigger picture (Adapted from the TRP training guide 2022, Regenesis Institute)

[1] https://www.nationalgeographic.org/education/what-is-geography/

2.Rift valley Kenya, Nakuru and Menengai Caldera

2.1 A brief description how human history is intertwined

"The East African Rift preserves the world's richest Middle and Late Pleistocene (~780 to 12 ka[2]) geological, archaeological and paleontological archives relevant to the emergence of Homo sapiens " (Blegen, Brown et al. 2016). The Late Pleistocene is an important period for the evolution and dispersal of Homo sapiens within and out of Africa, but it is particularly important in East Africa. This is because in the basins (e.g. Nakuru) found within and part of the East African Rift System (EARS) there are extensive sedimentary deposits "relevant to regional and global paleoclimate" which have led to the preservation of many fossils and artifacts providing evidence to the evolution of the humans in this area (Blegen, Brown et al. 2016)

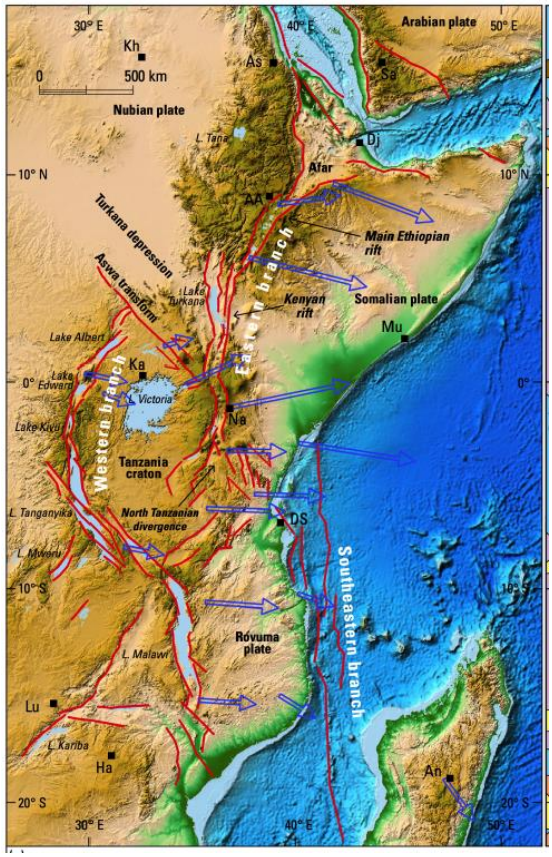

Figure 2. Topographic map taken from Conti et al, 2021. Showing the central Kenya Rift of East Africa. For more in sight please see publication

One key location of archeological relevance which can be found in the Nakuru basin is, Hyrax hill. This was a place which was occupied between 5,000 to 6,000 years ago during the Pastoral Neolithic and iron age periods. It is also linked to the *Sirikwa* people. Paleontological investigations in this area have shed quite some light on how people and their cultural practices, including food production, have co-evolved in and around this area due to changing climate [3] and the volcanic lake systems present in the region (also see section 6).

Another important place within the Rift valley and to the North of Nakuru is the Menengai Caldera. This is strongly affiliated with the Maasai tribe, who used to graze their animals across the rift valley and still come every year to graze their cattle there. The word Menengai comes from the Maasai community, thought to have been given after a ferocious battle decimated two clans fighting over the caldera. They named the caldera "Emenega" meaning, mass death , not of God, a burial site or place of evil". The name changed to Menengai due to non-Maasai speakers.[4] During colonization by the British, much land used by the Maasai in their pastoral system, was taken by colonial settlers and after Kenyan independence (1963) was allocated to Kikuyu [5]agriculturalists under land redistribution programmes[6] .

[2] Meaning 1000 years

[3] https://en.wikipedia.org/wiki/Hyrax_Hill, was used primarily for this information, however references were checked for validity and most refer to scientific papers of Mary and Louis leaky. This video provides further information https://news.climate.columbia.edu/2016/06/08/seeking-humanitys-roots/

[4] Menengai PFMP Participatory Forest Management Programme (2022-2027)

[5] Jomo Kenyatta was from Kikuyu origins. https://en.wikipedia.org/wiki/Kikuyu_people

[6] http://www.bluegecko.org/kenya/tribes/maasai/history.htm

The Menengai Caldera is a place of many stories and superstitious beliefs[7]. It is a place of reverence[8] where sacred caves are located. People of all faiths come here to pray and to pilgrimage. The same caves are also a place of cultural relevance, as they were also used to hide the Kenyan Freedom fighters during the Mau Mau rebellion[9]. Indeed in and around the Nakuru basin was a very important place during the struggle for independence.

Figure 3. The Menengai sacred cave, as seen from outside (own photo)

2.2 Menengai calendra and forest – who is here?

2.2.1 Geological foundations

Menengai is situated approximately two kilometers north of the city of Nakuru , one of the most prominent and youngest caldera volcanoes in the Kenya Rift. "*It is a largescale, Late Pleistocene volcanic edifice with a total diameter of c. 20 km and a collapse caldera with a diameter of 7–12 km"* (Riedl, Melnick et al. 2020). The Menengai caldera[10] is located in the East African Rift System, this is an active divergent (pulling apart) boundary between the Nubian and Somalia tectonic plates and is the ideal place to investigate the mechanisms and dynamics of continental rifting and breakup (Riedl, Melnick et al. 2020, Conti, Pistis et al. 2021). It is a place on Earth where there is a lot of tectonic energy being exerted.

The Menengai Caldera is the main topographic feature in the northern part of the Nakuru area that developed during the evolution of the Late Quaternary Menengai volcano. It is one of the major high-temperature geothermal fields in Kenya and numerous studies have been carried out in the area in relation to potential for geothermal energy generation (Kanda and Suwai 2013). "*The evolution of the Menengai volcano encompasses three stages: 1. Formation of a shield volcano with low-angle slopes (pre-caldera stage); 2. Collapse of the volcanic edifice and formation of the caldera (syn-caldera stage); 3. Eruption of lavas onto the caldera floor (post-caldera stage)"*[11] (Riedl, Melnick et al. 2020).

Menengai has a gently rounded outer profile, smooth grassy slopes rising at first steeply from the surrounding country, but easing off to a very gentle slope near the crater rim (McCallum 1967).

---

[7] A) https://www.standardmedia.co.ke/features/article/2000109936/menengai-crater-where-many-strange-things-are-said-to-happen B) https://ke.opera.news/ke/en/others-natural-disaster/ee85c8463b6159c25c2bf7c1bb2be676, X

[8] https://www.lakenakurukenya.com/sacred-caves-in-menengai-volcano/

[9] https://en.wikipedia.org/wiki/Mau_Mau_rebellion

[10] "A caldera is a large depression formed when a volcano erupts and collapses". Source: https://education.nationalgeographic.org/resource/calderas

[11] "Geochemical analyses of glass shards by electron microprobe demonstrate that the Menengai Tuff is widely dispersed (>115,000 km2) across East Africa, resulting from a caldera forming eruption at Menengai Caldera, Kenya 40Ar/39Ar dated to 35.62 ± 0.26 ka. The distinctive physical and chemical features of the Menengai Tuff, its precisely determined eruptive age, and its presence in geographically distant, noncontiguous depositional basins in and outside of the Eastern Rift Valley of Kenya make it a useful chronological tool for understanding Late Pleistocene environmental, paleontological and archaeological change in East Africa" [Source: Blegen et al., 2016)]

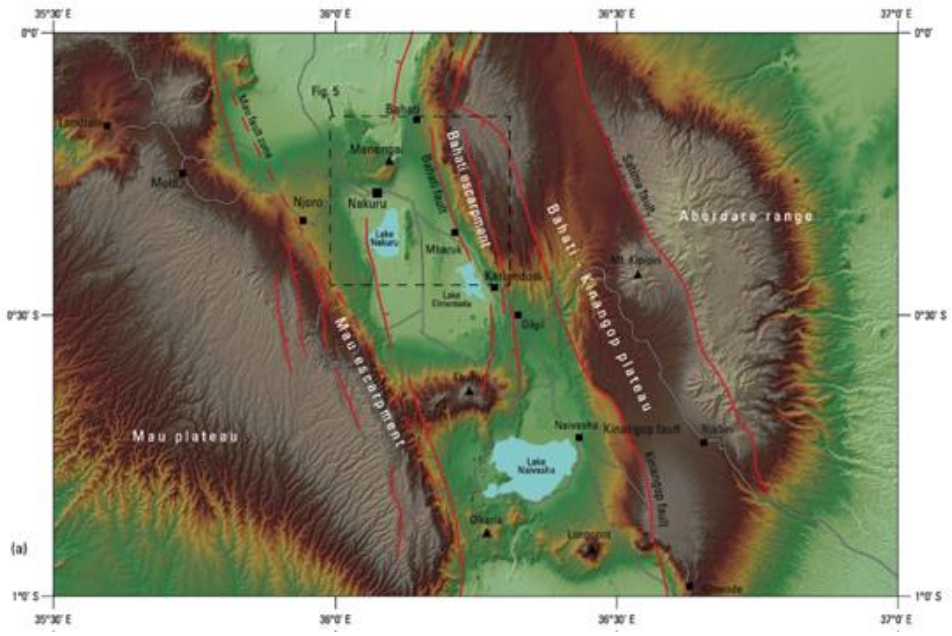

Figure 4. Map taken from Conti et al, 2021 to show the Morphology of the Menengai-Longonot and surrounding areas in the central Kenyan Rift

It is without doubt a very unique place. This volcanic landscape has shaped and continues to shape the story and life found in Nakuru valley - the hydrology , the soils , the flora and fauna and the people living there. Furthermore*, "the accompanying volcanic activity has influenced greatly the nature of the soils and the geochemistry of ground and surface waters, an influence that is reflected in water and food quality "* (Davies 2008).

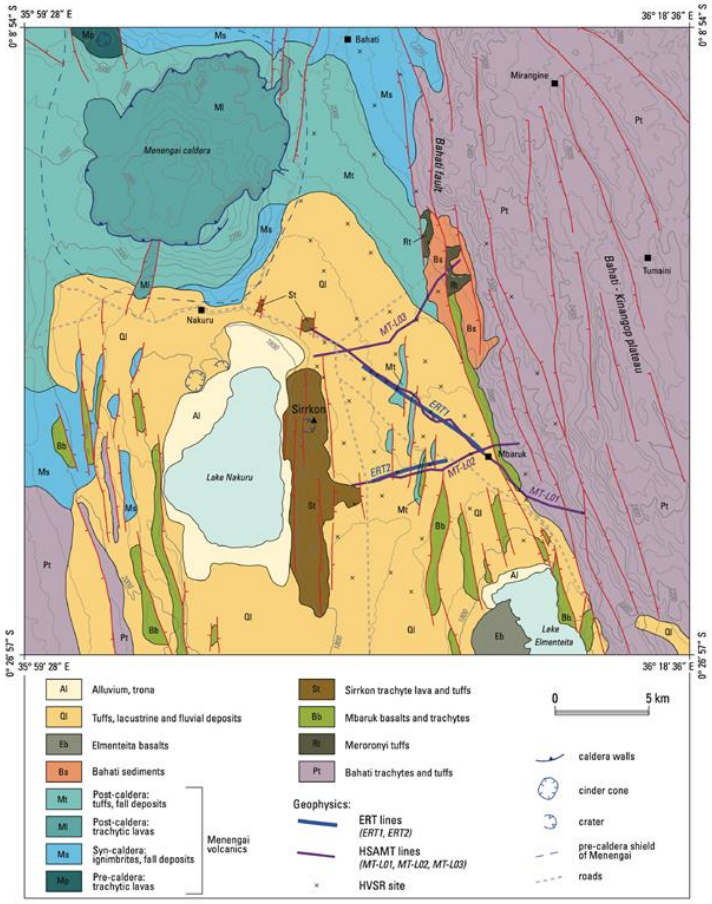

Figure 5. Map taken from Conti et al, 2021 which shows the Geological Map of the Nakuru area

2.2.2 Pedology (Soils)

The soils of the Menengai crater have been formed largely from the solidification of magma and ash after volcanic eruptions in and around the caldera. The areas have been divided into three major zones based on the type of volcanic material that has been deposited[12] (see also geological map above).

The first zone is the Northern zone comprising of scarps that have exposed older lava flows. It covers the area of Kisanana, Lomolo, and Solai. The soil profiles here are shallow, stony and saline.

The second zone is the Central zone which consist of flat grounds that are covered by derivatives of plinian eruptions with few interrupting scarps. It covers the Ol'banita and Ol'rongai areas and consist of low-lying ground covered by thick soils derived mainly from pyroclastics.

The third zone is the southern zone comprising of the Menengai volcano, covering the Menengai caldera and the immediate surroundings. Here there are pockets of alluvial deposits found in low-lying narrow grabens.

"Such volcanic soils, when completely weathered are typically able to retain large quantities of water". In "regions, such as Nakuru where extended dry periods can occur during the growing season, water-holding capacity is probably the most important ecological property. Such water-holding capacity associated with ash-cap soils may be critical to the establishment and maintenance of some plant communities" (Waithaka, Mwaura et al. 2017).

There have also been investigations of the soil microfauna, and according to a study by Waithaka, Mwaura et al. (2017), "*although Menengai crater presents a hostile environment for microbial growth, the number of microbial isolates was high . This could be explained by the capability of microbes to change their genetic constitution so as to suite different environments".* In their study they identified a large range of soil biodiversity living within the Menengai Caldera, they also identified the potential opportunities for using such diversity in the development of antimicrobial treatments in health care. *" The study indicated that Menengai crater has the potential of producing actinomycetes that can produce antimicrobials with high capability of treating diseases caused by tested pathogenic microorganisms" .*

2.2.3 Hydrology

The volcanic landscape also greatly influences the geochemistry of ground and surface waters*. " Direct volcanic impacts result from the up-welling of volatile, potentially harmful elements (PHE), such as F, As, and Hg, that dissolve directly into groundwaters"* (Davies 2008). But to understand these dynamics, we also need to start having a more holistic understanding of the unique hydrology of such a location.

[12] Source the PFMP

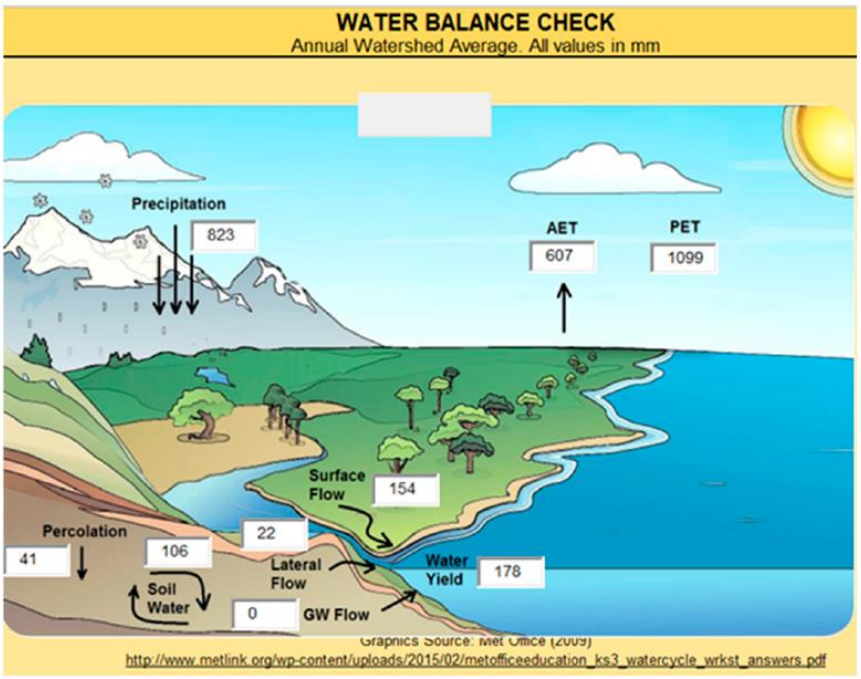

Figure 6. Taken from Kimaru et al, 2019, who showed a diagrammatic representation of the hydrological for Lake Nakuru. (PET= potential evapotranspiration, AET= actual evapotranspiration).

"The general drainage system of the Rift Valley is composed of closed basins, with inflow from the rift flank. Surface water flow is from the elevated rift escarpments which act as catchment areas into the rift floor. Surface runoff is poor in the rift floor due to porous rocks such as the pumice formations leading to high ground seepage" (McCallum 1967). Therefore, loss of water is generally through evaporation (see figure above (Kimaru, Gathenya et al. 2019)).

"The rift floor gently slopes from the Menengai volcano in the north at 2273 m.a.s.l (meters above sea level) toward L. Nakuru basin in the south at 1760 m.a.s.l and slightly rises again in the L. Elementaita trough further south at 1776 m.a.s". (Gevera and Mouri 2018).

Lake Nakuru is a shallow, alkaline-saline lake lying in a closed hydrologic basin. The lakes hydrology is dependent on catchment supply through the rivers feeding it (see map). The surface drainage system is largely from the east and the western scarps. With the Eastern Mau forest complex playing an important role in the catchment basin. This is one of Kenya's water towers[13] (Odada, Raini et al. 2006). Menengai

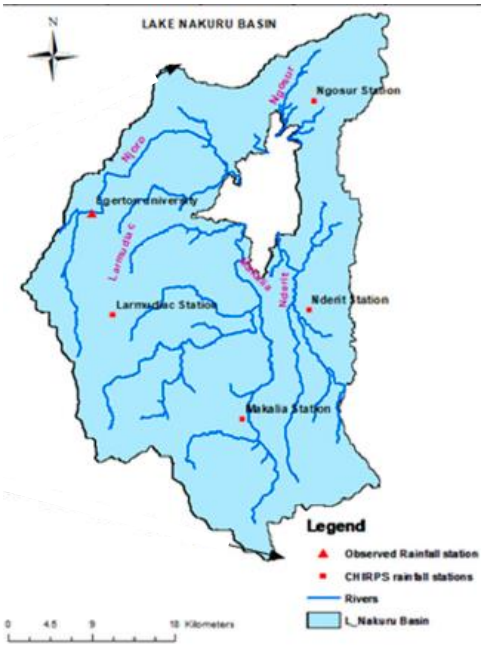

Figure 8. Map taken from Kimaru et al, 2019, showing the lake Nakuru Basin

[13] Most of Kenya's forests are in mountain areas, in particular the Mau Forest Complex, . Kenya, Aberdares, Cherangany Hills, and Mt. Elgon. These areas are known as the "water towers" of Kenya as they form the upper catchment of all, but one of the main rivers in Kenya. The water towers provide an estimated 75% of the country's water resources and are vital to Kenya's economic and social well-being. Despite their critical importance, the water tower ecosystems have been seriously degraded and continue to be impacted by irregular and ill-planned settlements, overgrazing, uncontrolled and illegal forest resource extraction, and the conversion of forest land to agriculture KWTP (2018). "Kenya Water Tower Climate Change Resilience Program. Climate Change Vulnerability Assessment of the Mau Forest Complex, Cherangany Hills, and Mt. Elgon Water Towers in Kenya. Available at:https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjLy4zG5Lz7AhUF26QKHTY1AboQFnoECAsQAQ&url=https%3A%2F%2Fresilience.igad.int%2Fwp-content%2Fuploads%2F2020%2F06%2FClimate-

forest is located in the Eastern Mau complex, at the northern boundary of Lake Nakuru (Wetang'ula, Akama Raini et al. 2014). On the rift floor, the drainage is mainly from Menengai Caldera northwards (Odada, Raini et al. 2006). There is "*evidence to suggest that there is a close relationship between geothermal reservoir liquids, Lake Nakuru waters and local groundwaters. Input from Lake Nakuru into Menengai is suggested on the basis of high concentrations of Na and HCO_3 in the well fluids, and on isotopic composition. The ratio of the two components is, however,difficult to determine as the isotopic and presumably the chemical composition of the lakes vary with time, and the lake water influencing the wells is a mixture of present and older lake water. If the present value for Lake Nakuru is used as the lake end-member, the mixture is 20% lake water and 80% groundwater*" (Igunza and Kanda 2017)

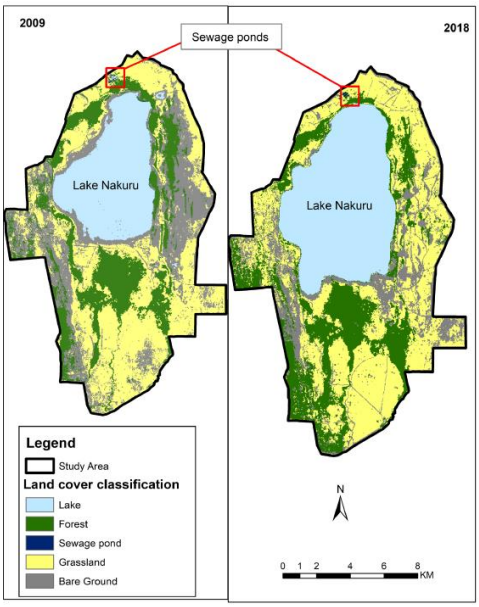

Figure 9. Taken from Hongo and Mulaka 2021, which shows the expansion in area of Lake Nakuru seen between 2009 and 2018.

However, due to its shallow depth, high evaporation rates and seasonal rivers Nakuru lake system is a sensitive hydrological ecosystem, "*since it does not have any buffering capacity to withstand hydrological impacts driven by catchment processes"* (Odada, Raini et al. 2006). This is particularly important, especially due to the potential knock on impacts to groundwater. Groundwater availability for recharge of geothermal systems depends primarily on hydrogeological factors such as recharge, transmissivity and storage. This is also very important in the Nakuru/Menengai area as Groundwater is the main source of water supply for the human communities (domestic and industrial) in the region (Gevera and Mouri 2018).

Tapping shallow groundwater aquifers distributed around Menengai caldera and areas neighboring Lake Nakuru, Kanda and Suwai (2013) found that the depths ranged between a few meters to 240 m below the surface (Igunza and Kanda 2017). *"The groundwaters from Menengai area are somewhat enriched in chloride with respect to local volcanic rocks, possibly due to presence of other chloride sources"* (Gevera and Mouri 2018). Furthermore, results from the study of Gevera and Mouri (2018), show that *"more than 87% of the boreholes are characterized by fluoride levels higher than the limit recommended by the World Health Organization for safe drinking water. Fluoride levels range from 0.5 to 72 mg/l, with a mean of 11.08 mg/l. Several health issues such as dental and skeletal fluorosis occur when exposure to fluoride concentrations is beyond 1.5 mg/l in regions such as the Kenyan Rift Valley where Nakuru County is located. Mineralogically, high-fluoride minerals have been reported in most rocks of the study area"* (see Figure 10, map)

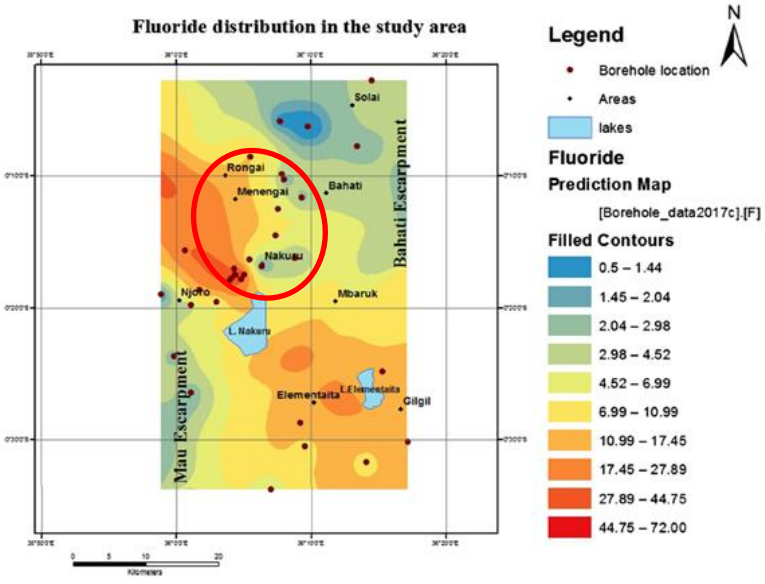

Figure 10. Map taken from Gevera et al., 2018 showing the spatial distribution map of fluoride in the Nakuru, Menengai areas (Circled in Red) showing the potential concentrations of fluoride in the water and the potential hotspots for fluoride

Change-Vulnerability-Assessment-of-the-Mau-Forest-Complex-Cherangany-Hill-and-Mt.-Elgon-Water-Towers-in-Kenya.pdf&usg=AOvVaw06zwkfANIEWVGhstOfDl9G. ."

Another additional hydrological issue in the region relates to Lake Nakuru. In the last decade, the lake has experienced continuous flooding, increasing the lake area from 35 km^2 in 2009 to 54 km^2 in 2018. This has impacted negatively on the available space for wildlife in Lake Nakuru National Park (LNNP) which supports about 56 different species of mammals, 550 plant species, and 450 species of terrestrial birds as well as flamingos and other water birds. The reason is not fully understood (Hongo and Mulaku 2021). But it is most certainly linked to the complex hydrological systems found in the rift basins.

It is believed that deforestation, cultivation and urbanization, individually and collectively have impacted the catchment hydrology (Hongo and Mulaku 2021). Geothermal energy may have also played a role.

2.2.4 Land use patterns

"Lake Nakuru drainage basin, including the entire Eastern Mau forest reserve, in the Kenyan Rift Valley system is among the hotspots where such land cover changes (LCC) have rapidly occurred over the last 3 decades. This is an important study area because Eastern Mau forest is part of the largest closed-canopy montane forest ecosystem in Eastern Africa. The forest is also among the 5 important water catchment areas in Kenya and a major sink of CO_2, which is the main driver of global warming and climate change" (Were, Dick et al. 2013)

Were, Dick et al. (2013) also found that between 1973 and 1985, the major hotspots of the forest-shrubland conversions were distributed in the mid regions and northern side of Lake Nakuru (e.g. Menengai). Another study, which was the combined efforts of the UN Environmental programme, the Kenya Wildlife service, Kenya forests working group and the EWAso NGiro South Development Authority also illustrated the extent of the land use change and deforestation within the Mau forest complex, including in that Menengai forest[14](UNEP 2008)

There have also been land use changes and deforestation within and around the Menengai forest. This deforestation plays a role in the hydrology of Nakuru, effecting not only the lake system, but potentially also the ground water systems. Therefore, it is important to understand more about the hydrology and the communities currently living in and around the Menengai caledra.

2.2.5 Who are the people living around the Caldera ?

The PFMP (participatory forest management plan) from the Menengai community forest association, provides very valuable information on the communities living in and around the Caldera. It contains the results from a KFS survey investigating the communities living adjacent to the Menengai forest. The Menengai Forest covers six (6) administrative locations and ten (10) sub-locations that are adjacent to the forest area (Table below from (PFMP 2022)).

[14] A national forest definition for REDD+ has been agreed through a broad stakeholder consensus as a minimum 15% canopy cover; minimum land area of 0.5 ha and potential to reach a minimum height of 2 meters at maturity in situ. Perennial tree crops like coffee and tea are not considered as forests under this definition irrespective of whether they meet the definition of forests Republic of Kenya Ministry of Environment and Forestry (2019). "The National Forest Reference Level for REDD+ Implementation. Report. ."

Table 1: Population of the Menengai forest adjacent Locations and Sub-locations

Location	Sub-location	Male	Female	No of House Holds	Total population
Kirima	Kirima	3,084	2,962	1,379	6,046
Bahati	Bahati	2,716	2,997	1,743	5,714
	Menengai	4,671	4,993	2,844	9,664
Rurii	Rurii	9,566	10,508	6,175	20,075
Kiamaina	Kiamaina	3,745	3,999	2,217	7,744
	Viwanda	2,306	2,417	1,958	4,723
Viwanda	London	8,424	7,659	4,923	16,083
	Kiamunyi	9,967	10,620	5,864	20,588
	Mercy Njeri	4,748	4,945	2,792	9,694
Rongai	Olive Inn	5,219	5,675	3,074	10,894
TOTAL		54,446	56,775	32,969	111,225

Their results also suggest that the communities "*follow the typical African homesteads where most of the households are headed by males and are generally the decision makers of the homesteads"*. Many of the people have been living in the Menengai area for longer than 18 years. The majority of the community is made of (73%) Kikuyu, 26% Kalenjin and 1% Samburu, Luo, Luhya, Kisii. Their survey also showed that from the survey respondents it appears that "*the community depending on Menengai Forest lives as close as 200m (40%) and extends beyond 3km (4%)"* Between 200m and 2km the majority of people live (46%). It also illustrated *"the importance of Menengai forest resource in the livelihood of the neighboring communities"*

Nearly half of the people surveyed had primary level education with 34% secondary 11% tertiary and 5% informal. " *High literacy levels have a great impact on adoption of new technologies.. it is easier for knowledgeable people to easily understand concepts like deforestation, habitat loss and global warming among others"* .

Family sizes ranged from between 3- 5 family members (43%) to 6-10 family members (35%) to greater than 10 members (16%). *"Poor environmental quality and greater reliance on publicly owned natural resources are associated with higher family sizes"* .

People's reasons for immigrating the area were mostly marriage (34%), buying land (34%) or land inheritance (24%), other reasons are employment or cheap rents.
Most respondents owned their own patch of land (84%) with 9% renting and 5% squatting, with the majority of the farm holding sizes being less than 2 acres. *"The most common economic activity from which the community derive their livelihoods was sale of agricultural food crops (91%) followed by unprocessed forest products (22%) and casual employment (29%)*[15]*"*

[15] Casual labor includes activities such as: herding animals miling farming, quarry mining, transport, shop

According to a report by Sosian Energy (2019), *"the main agricultural activities (both commercial and subsistence scale) around the caldera area are livestock keeping and crop farming. In the areas surrounding Menengai Caldera and parts of the intra-caldera, the main cash crops are wheat, sisal and coffee while the main food crops are maize, beans and potatoes. In the Kiamunyi, Mashiaro, Menengai farm, Valley farm and Kampi ya Moto areas, large-scale wheat, maize and dairy farming are predominant. Large-scale sisal and coffee farming and livestock keeping characterize the Banita and Solai areas. The Bahati area is mainly characterized by small-scale maize, beans, potatoes, horticultural crops (tomatoes and pyrethrum) and dairy farming. In the eastern side of the caldera rim, subsistence farming of maize, beans, potatoes and horticultural crops (tomatoes) is dominant. Livestock keeping is also practiced within the caldera particularly in accessible areas located to the west. Horticultural crop production is carried out in the municipality and Rongai division. Food insecurity exists within the area due to various circumstances. Food shortages in Rongai division are brought on by poor weather conditions"*[16] .

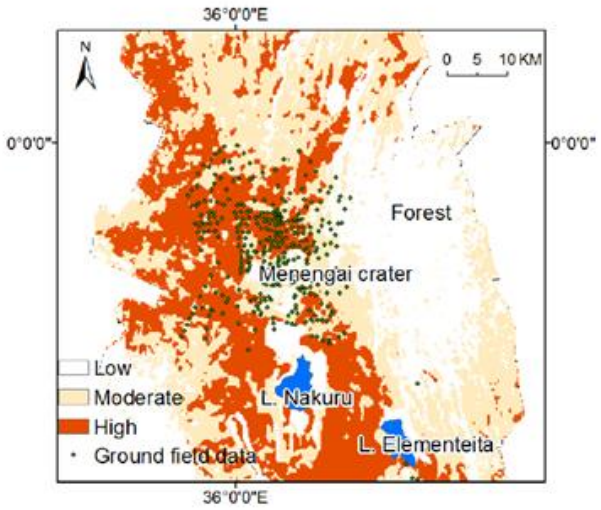

Figure 11. Map taken from Macharia et al. (2018) study (with permission) showing the potential for geothermal energy production

Furthermore, according to the same study when it comes to energy they found that "the main sources of energy for cooking and lighting in the project area are kerosene and wood fuel[17]. Most of the charcoal is obtained by the local population from the Menengai Caldera and the Menengai Forest" . Although there is geothermal energy production in the area, it is unclear if the local residence in and around Menengai truly benefit from such energy production. [18] "The closest electricity power supply line is on the edge of the caldera approximately 2 km to the proposed water borehole drill sites off Ahero Market Centre through the Gingalili Farm" *(Macharia, Mundia et al. 2018).*

[16] In the PMPF more detailed information is given about the farming – for this example we summarise here – in order to keep the red line..

[17] Taken from the forest

[18] INFORMATION ON HOW MUCH ENERGY ...

2.2.6 Who is Menengai forest ?

"Menengai Forest has a total gazetted[19] *area of 7,315 ha including the crater. The forest vegetation is reported (to range) from true savanna to Montane .* But it is difficult to know much about the forest itself as information seems to be scarce. The KFS state that in Menengai forest there are *"over 169 species of flowering plants and 17 species of grasses have been recorded in Menengai Forest. These include Leleshwa (Tarconanthus camphorates), Euphorbia species and Acacia species. Common grasses in the forest include geothermal grass (Fibristylis exilis) and Boma Rhode grass"* . They also report that the mammals to be found *"include Rock hyrax, Tree hyrax, Olive baboons, Black-faced Vervet monkey and Mountain Reedbucks and Kirk's Dik diks and Slender Mongoose. Birds species include Varreaux eagles (only found in Menengai Forest in Nakuru) Abyssiinian Ground Hornbill, Lesser Spotted Eagle, African Marsh Harrier, Horus Swift Apus hours, Turn-tailed ravens, Red-winged Sterling and other birds. Insects in Menengai include Arachnids, Molluscs and various species of butterflies"* [20] . According to (Wetang'ula, Akama Raini et al. 2014) however, *Menengai forest remains to be properly studied for flora and fauna and in particular, the key avifauna and invertebrate taxa"*. Furthermore according to a report by Sosian Energy (2019) *"Cedar is currently being illegally harvested and this has affected its survival in the caldera. Erytherina abbysinica used to be wide spread within the forest but has been decimated by herbalists who use it for medicinal purposes, thus could become endangered if not controlled. There are very few wild animal species due to unavailability of open grazing and dispersal areas. Leopards, Baboons, Wild pigs and Snakes are common within Menengai Caldera. Cases of Human -Wildlife conflicts mainly due to invasions of farms by the Baboons and Monkeys have been reported "*. This means it is difficult to figure out who is Menengai forest*. We do not have a complete picture of her and how she is changing due to the communities dependent on her.*

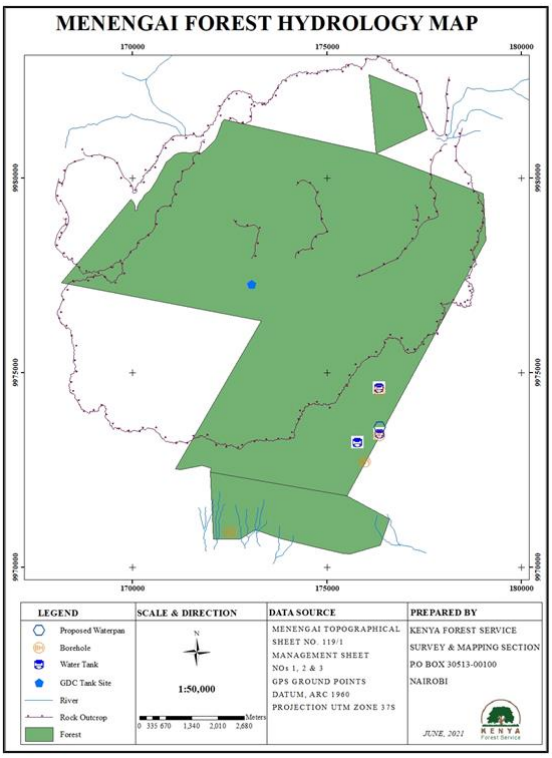

Figure 12. Map taken from PFMP report for Menengai, showing the hydrology and fault lines found around the Menengai Caldera and forest.

"Many people see forests as little more than attractive backdrops to the real stuff of human history, but our human stories are intimately interconnected with forests" – Nancy Langston

According to the PFMP report peoples' utilisation and interaction with the forest was mostly focused on exploitation. *"These results clearly indicated the resourcefulness of the forest as many products were sourced there at different rates as well as the reliance of the community on the forest. If the harvesting of the products is monitored and regulated the community stood to acquire more benefits. This is for resources like herbal medicine and vegetables, wild fruits, honey as well as soil (improved into bricks making as opposed to smearing the mud on walls)".*

[19] "Gazetted forests are deemed to have a more permanent or protected legal status than state land forests; hence the usage of terms such as 'permanent' and 'reserve' that have confused the public. The gazetted forests in turn are further divided into two categories i.e. production forests or conservation forests" . https://gmesgeoportal.rcmrd.org/datasets/1840df8b60aa4b7c8ee553e9c19dd205_0/explore?location=-0.721369%2C37.762785%2C8.00

[20] http://www.kenyaforestservice.org/index.php/menengai-forest/

The report also notes the need of the these activities to be controlled by the custodians of the forest – the KFS. The Kenyan Forestry Service.

3.KFS - Legal custodians of the forest and the Shamba system

Menengai Forest which covers the Northern, Eastern and Southern parts of the Menengai Caldera is publicly owned. The custodians are the Kenyan Forestry Service and they play a very important role in the health of the forest. The KFS government body was established during colonial times. In their thesis Odieny (2022), explored the relationship between the Forest Department, its African workers, Kenya's white settlers, and the colonial government. In essence [21], the thesis explored how each of these actors were engaged in a pursuit for their own idealised concept of a 'good forest'[22]. But one distinct activity or mechanism of the forestry service was their aim to achieve their vision using the Shamba system (today called PELIS). Odieny (2022) hypothesized that the shamba system is under-explored in Kenyan history and the role it played in changing the shape of the Kenyan landscapes and people's lives. Furthermore, there may still be many legacies in the identity, thinking and actions of the KFS, and this can have implications for how the forests are managed today.

Table 2. Showing the forest products used by the Menengai community forest (source: PFMP report)

Forest Products Accessed from the forest	%
Fire wood	83
Grazing Livestock	42
Grass Fodder	12
Cultural/Traditional ceremonies	8
Religious activities	12
Recreation Activities	21
Seedlings/Wildings	10
Honey	8
Medicinal Herbs/Vegetables	29
Wild fruits	16
Logs/Timber	0
Poles/post	4
charcoal	9
Thatch Grass	0
Soil/sand for construction	1
Water	0
Precious stones/gems	0
Others… Fresh Air	1

The shamba system was the main system championed by the Forestry service and the most successful deployment of agroforestry by the British in colonial Africa. It is a system of forest management where tree seedlings are co-planted with food crops. The landless people farming their crops in the forest were also given the responsibility of tending to the seedlings for 3-5 years until they were mature. Then they would be given another patch to farm. What is important to note is the trees that were planted.

" The forestry of the British Empire has also been shown as developing along a web of connections between the metropole, India, the dominions, and colonies..... forestry knowledge flowed around the world.(and) ...with this flow went tree species, most famously Eucalyptus, that were planted (often on appropriated African land) to primarily meet the needs of settler and coloniser but not indigenous peoples or even native fauna.

[21] They used the Kodera forest as their working example to support their hypothesis.

[22] The study adopted a historical descriptive research design It employed purposive and snowballing sampling techniques and it focused on Kodera forest as an example.

Thus, forestry allowed not just the conservation of forest for foreign agendas but also the conversion of forest and grassland to alien ecosystems to meet those agendas". *Furthermore,* Odieny (2022) *noted that* " *Conservation played an integral role in forestry as it developed across the British Empire. This enshrined the principle of forests as state property with limited rights of access and usage to indigenous peoples, all for the greater good*" [23].

However, after independence it is important to note the following: "*Shamba* provided *numerous opportunities to farm and receive education to landless Kikuyu in the colony, but also displayed very strong paternalistic aspects of control, with consequential African protest, as the Forest Department sought to create for itself a loyal and permanent forest workforce (also linked to corruption). Shamba was the keystone of forestry development in the 1950s, and its expansion cemented the position of forestry in Kenya as a top-down, state-centric agent of economic and social development*".

The KFS play an integral role in the health of the forest (e.g. prevention of deforestation) and the livelihoods of those living around the forest and dependent on it. Therefore, it is important to understand the history of such an organization which plays a vital role as the custodian to care for the forest. This might led to greater insights in some decision making processes or potential power imbalances. Currently there are efforts to change this more top down approach, with the adoption of the community forest associations (CFAs) and the mechanism in which the members (the communities living in and around the forest) can be included in some forest management decisions use the Participatory forest management plan (PFMP) process. However, there is evidence to show that , " *The Kenya Forest Service largely remained in control of decision-making contrary to the intention of the collaborative forest management policy... and the current forest governance approaches in Kenya appear not to support participation in practice"* (Mutune and Lund 2016).

There has also been developments (a bill) to change the role of the KFS in relation to forest boundaries. *"If passed, the bill could take away the KFS's power to sanction the variation of boundaries of a public forest. This may grant anyone, including those whose actions could compromise the well-being of Kenya's forests and water catchment areas, to petition parliament to change forest demarcations. Environmental organizations say this will "open up the forests for grabbing," especially for agricultural purposes"*[24]. The role of the KFS as the custodians of the forest is being reflected upon and may change in the future.

4.Role of the community association for Menengai community and forest

The community forestry association (CFA) plays also an important role in the management of forest resources and of their community members. The CFA is an organisation geared to support communities sustainable use of forest resources. "*My love for nature made me get interested in joining the CFA."* - CFA member, Menengai

[23] An important extract from the thesis shows, that as far back as 1944 there have been issues regarding deforestation in the Nakuru region " By April 1944, Gardner felt it all amounted to *"constant but ill formed and quite unjustified criticism of the Forest Department's squatters."* One month before Gardner felt compelled to lodge his disquiet with the Chief Secretary, the Nakuru District Production and Manpower Committee had met and the farmers present argued that the forest squatters *"were a menace to the timber grown in the forests owing to the fires which they started, the extensive cultivation they carried out and the amount of stock they were allowed to keep."*

[24] https://news.mongabay.com/2022/02/indigenous-communities-uncertain-over-proposed-change-to-kenyan-forest-law/

The Menengai CFA[25], for example, has provided scholarships to three local students to attend university. While this type of spending is not linked directly to conservation, it can be helpful in building goodwill in the community and motivating others to consider applying for CFA membership. The key feature of the CFA is that they are a participatory group, everyone who is a member has a right to vote and propose options for forest management. A report from GSMA [26] highlighted their key findings regards to participatory forest management being supported by digital tools. These were: *1. Community Forest Association (CFA) members are united by a passion for conservation and the need for sustainable income generation; 2. The use of digital technology is nascent but growing; 3. Current data collection activities are typically manual and slow, and provide little value to CFAs; 4. Financial incentives could accelerate tree planting and other ecosystem services; and 5. Improved access to information could lead to better conservation and livelihood outcomes.*

However, on community member stated that "*Forest matters are not normal matters. Taking pictures where trees are being cut down is risking your life because you don't know who is watching. If we are confirmed of our safety, and that this information will not be leaked outside then that will be fine."* Which provides a glimpse of much deeper issues between the community and the community and forest.

5.Gender and the role it plays for the forest

What is interesting to note is the CFA membership numbers, with over 60% women as members. Since membership provides access to some of the forest resources, this could mean that women are more dependent on these resources than men (for example firewood, since cooking and collecting firewood are seen as women's tasks). Indeed Ambale (2022) wrote a book reviewing the role of gender in Kenya and how communities dependent on forests for their livelihoods. He identified that gender relations can affect access to forest resources, income, and food generating activities. *" Gender-mediated access to forest products might lead to diverse food security results for men, women, and children. Men are often the sole decision-makers on issues about the conservation of forest resources, which hampers the implementation of forest conservation measures Studies show that women rely more seriously on direct access to forest resources as they are accountable for day-to-day domestic work, which includes finding food and fetching firewood, as their husbands are fixated on work off-farm. Women comprise a substantial percentage of the labor force in forest industries, particularly in tree nursery work and in events extending from wood processing to logging"* . But they do not sit in the places of power or have a voice in the decision making process.[27] It has been

[25] Any member of a forest-adjacent community may, together with other residents from the same area, register a CFA and work with the Kenya Forest Service (KFS) to establish a five-year Participatory Forest Management Plan (PFMP). GSMA (2021). Mobile Technology for Participatory Forest Management. Co-designing and testing prototypes in Kenya.]

[26]

[27] The absence of the necessary legislation to strengthen the two-thirds gender principle has subsequently negatively affected the gradual full management of natural resources such as forests within the country. Section 6(4) of FCMA – 2016 is the only section of the Act that talks about the observation of either the principle of gender or regional representation in the appointment of the members of the Forests Board (FCMA, 2016). This is a serious limitation since it does not trickle down to lower levels as far as forest management, access and use are concerned (Ambale, B., 2022)

identified in many studies that the role of women in forest resource management is vital. However, *" against contrary beliefs, women often have exceedingly specific knowledge of trees and forests in terms of management, species diversity, conservation, and use. However, gender inequality brings about hindrances to effective, sustainable development and livelihoods by preventing or confining women's right to access essential resources and decision-making opportunities. Women participate in the forest sector in several ways, both formal and informal, not excluding forest protection, watershed management, tree improvement, and agroforestry" .* Therefore, women play a key role in caring for both the community and for the forest. This will be an important aspect as it will be women who will also feel most strongly the effects of a changing climate.

6.The role the climate plays for the forest

The East African region has under gone many shifts and changes in its topography due to climate. Some studies even suggest that *" the last connection between Lake Turkana and the Nile River was from ca. 11.5 to 8.5 ka during the African Humid Period, significantly wetter climatic phase in East Africa"* (Dommain, Riedl et al. 2022).

"The river integrated seven lake catchments of the central and northern Kenya Rift Valley into a large ~175,000 km2 subcatchment of the Nile River. Its source was Lake Nakuru–Elmenteita, which maintained an overflow highstand level at 1,943 m asl between 12.0 and 8.6 ka. To the north, this lake bordered directly on the Menengai Volcano and spilled via 80 m steep rapids into the volcano's caldera, where a contemporaneous crater lake—referred to here as Lake Menengai—formed with a water level of 1,860 m asl.

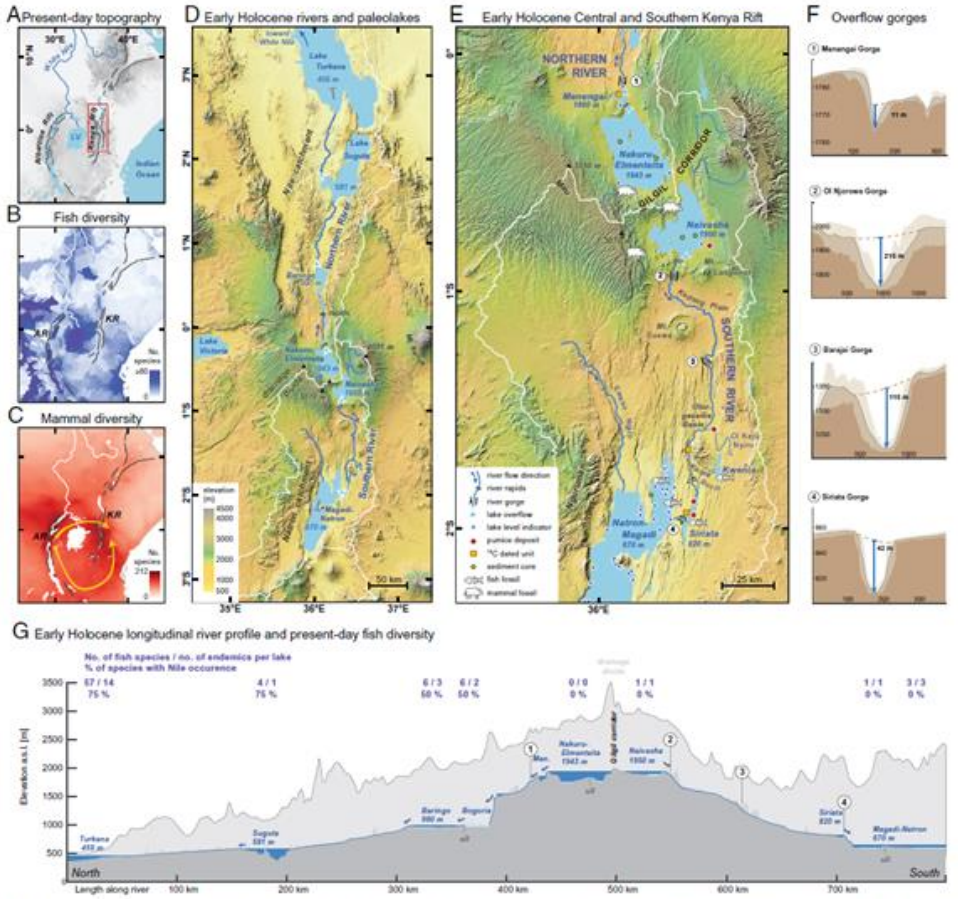

Fig. 1. Study region and reconstruction of the early Holocene river system in the Kenya Rift Valley. (A) Study region with modern topography of the East African Rift System. (B) Present-day species richness of fishes (class Actinopterygii) in East Africa from the IUCN (94). (C) Present-day species richness of mammals in East Africa from the IUCN (94); yellow arrows indicate proposed dispersal pathways of Kingdon (22, 23). (D) Reconstruction of the early Holocene river system between overflowing lakes along the Kenya Rift Valley; elevations denote overflow levels, dark-blue arrows, river flow directions. (E) Study sites, fossil localities, and reconstruction of the early Holocene river system in the Central and South Kenya Rift. (F) Cross-sections of overflow gorges used by the Northern (1) and Southern (2–4) Rivers (locations marked in panels E and G). (G) Longitudinal river profiles of the Northern and Southern Rivers along the Kenya Rift Valley with data on present-day fish diversity (excluding introduced species) and biogeography of Kenyan rift lakes (*SI Appendix*, Table S1). Dark blue areas denote early Holocene lake levels and rivers, and light blue denotes present-day lake levels. Dark gray area shows the topography of the rift valley floor used by the rivers, and light gray shows the topography of the adjacent rift shoulders. Note the dome-shaped topography of the East African Plateau.

Figure 13. Map and graph taken from Dommain, Riedl et al. 2022, which shows a simulation and proposed hypothesis for how the the Rift valley hydrological systems loooked like during the holocene epoch. For further information please read article.

Lake Menengai drained northward, and our fieldwork revealed that the outflow carved a now-abandoned river gorge through the 36 ka old Menengai pyroclastic deposits." (Dommain, Riedl et al. 2022).

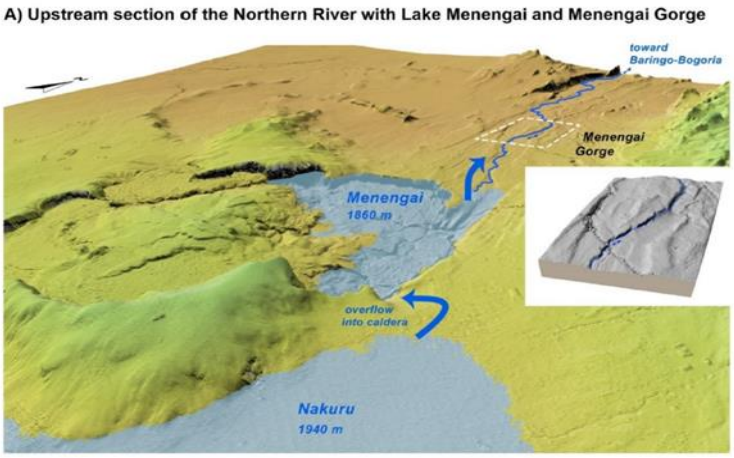

Figure 14. Map and graph taken from Dommain, Riedl et al. 2022, which shows a simulation and proposed hypothesis for the relationship between the hydrological system of Nakuru and Menengai, during the holocene epoch. For further information please read article

These shifts in climate and weather pattern have also effected the diversity gradients found within the region.

Today's climate is much drier. According to the PFMP, the average temperatures range in the Menengai forest from 8.5ºC to 23.31ºC. With the temperatures remaining cool between June and August and ot from December to February. The average annual rainfall is approx. 800mm with long rains lasting between March and June and short rains between September and December. January to March is always a dry period. It is also a time when the forest is sensitive to forest fires, which are promoted by strong winds in the caldera (Wetang'ula, Akama Raini et al. 2014)[28]

Nakuru is indeed in a region which is already experiencing a changing climate. According to the Climate Risk profile for Nakuru[29] . "Drought, intense rains, floods, and high temperatures already challenge productivity, incomes and food security in the County and are expected to pose even greater challenges in the future. Looking to the future in the years 2021-2065, prolonged moisture stress is projected to occur across both seasons of the year analysed and consecutive days of moisture stress are projected to more than double in the first wet season from approximately 35 days to over 70 days on average. While only small changes in intense precipitation are expected to occur, precipitation is projected to increase by 0.3% in the first wet season, and 6% in the second wet season. These all indicate the need of preparing ..... to expected increased incidence of droughts and floods in the future"..

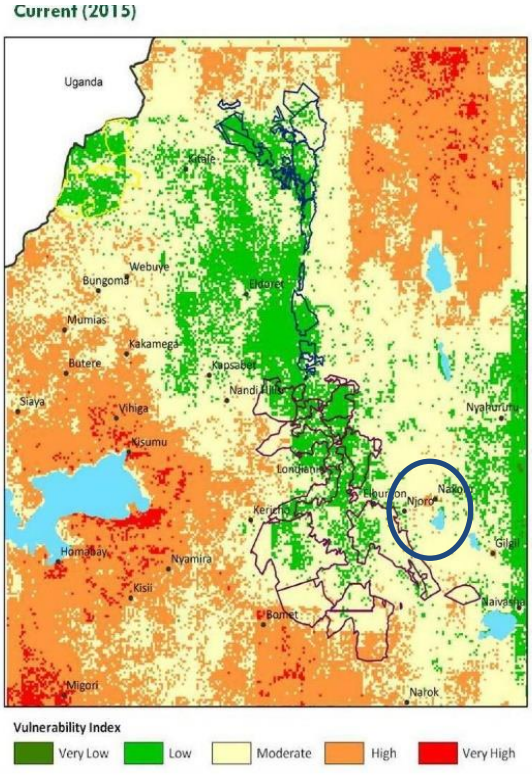

Figure 15. Map taken from KWTP, 2018 study (with permission) , shows the current vulnerability index for the water towers of Kenya

A further study as part of the Kenyan water tower climate change resilience programme (KWTP 2018), investigated the vulnerability of the five water towers in Kenya, including the Mau complex which flanks Nakuru to the west and of which Menengai is a part. Their findings indicated that the

[28] https://www.standardmedia.co.ke/environment/article/2001447309/5000-tree-seedlings-planted-to-revive-menengai-forest
https://www.standardmedia.co.ke/rift-valley/article/2001440221/fire-destroys-50-ha-of-menengai-forest

[29] https://ccafs.cgiar.org/resources/publications/climate-risk-profile-nakuru-county-kenya-county-climate-risk-profile

Mau forest complex will increase in vulnerability to climate change in the coming future and will suffer the most with statistically significant declining rainfall trends during the March-April-May and June-July-August-September periods. They estimated the rate of decline to be approx. 73 mm per decade. For most basins, including Nakuru the water availability peak will shift towards Nov-March season. *"A predicted reduction in precipitation during the long rains and increased precipitation during the short rains means **food production, which is centered on maize, will be disrupted and likely reduced,** unless farming methods and maize varieties are adapted to the new seasonal patterns. Likewise, livestock diseases and conflicts over grazing lands may increase*" .

They identified that *"The forest ecosystems in Kenya have faced serious challenges from stressors that mainly include illegal logging, agricultural land and settlement expansion and livestock grazing...Hotspots in these ecosystems, such as in Mau, include areas where there are high levels of charcoal production"* (KWTP 2018)

They noted that the water towers as socio-ecological systems are not homogenous and there needs to be an area specific approach to enhancing the resilience of these ecosystems through adaptation strategies within the water towers. Building this resilience will need all hands on deck, from those at the top of the power chain to those at the bottom. The latter are generally the community who are the most reliant on the forests for their quality of life. Therefore, livelihood diversification and encouraging the communities through different mechanisms to coexist with the forest to even regenerate the forests will be crucial for all beings within and dependent on these living ecosystems.

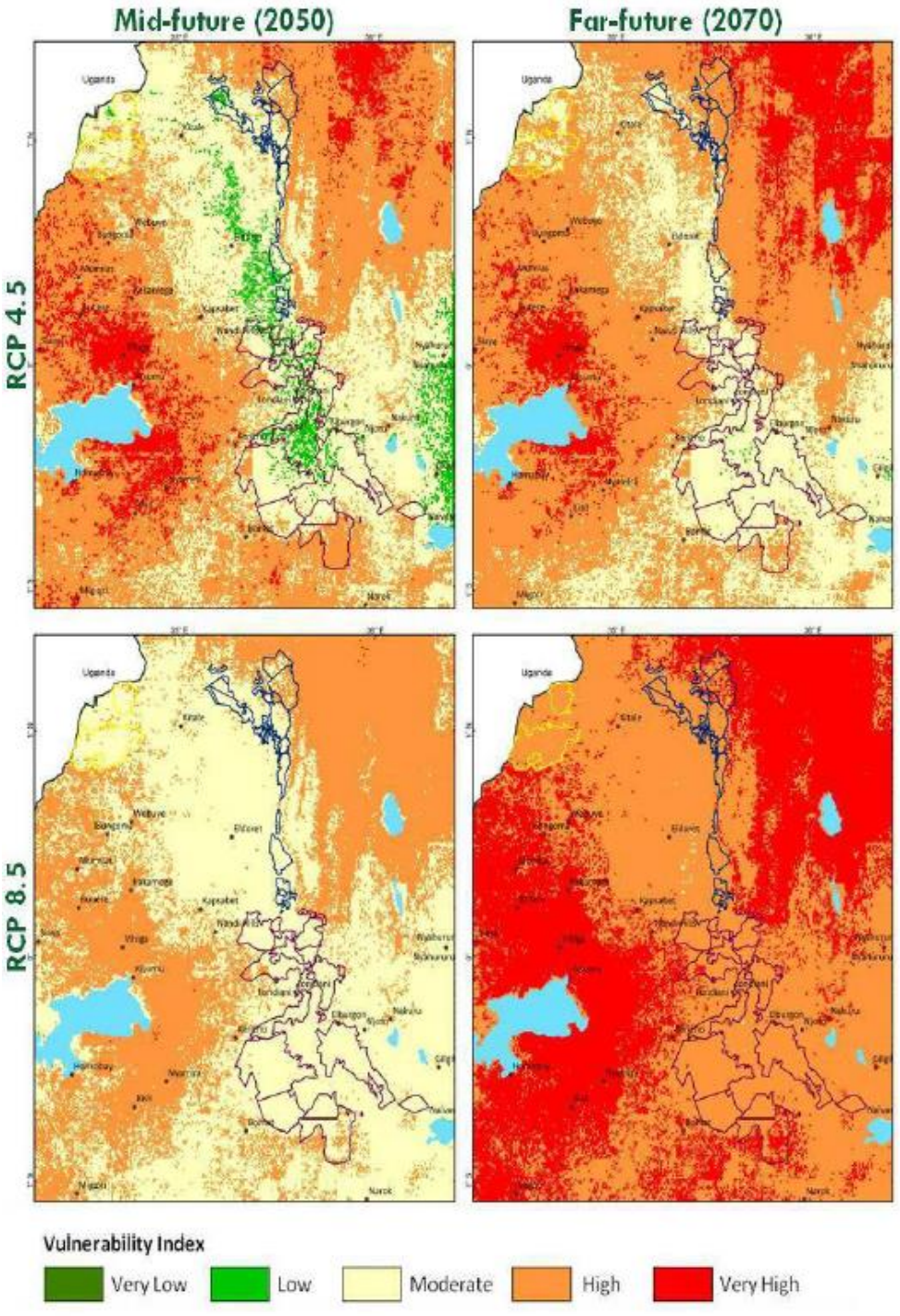

Figure 16. Map taken from KWTP, 2018 study (with permission) showing the projected vulnerability index for the water towers of Kenya under different climate change scenarios

7. Key lessons learned from writing Story of place

7.1 Lessons learned from case study

- There is a deep and rich history of people living and settling in the Nakuru/Menengai region.

- As a volcanic region, it is naturally a place in a constant dynamic flux, a place of energy travelling through it – of animals , water, magma and people.

- The extensive fossil archives found in and around the Rift valley enable a very good understanding of the historical patterns needed to develop the story of place. It also means it is a hotspot for scientific research and potential science related tourism (e.g. volcanologist, anthropologist). Therefore, also a potential opportunity for earning diverse revenue streams across the region.

- Understanding the hydrology of the area and how it is shifting is key to determine which adaptation strategies might be needed to support the ecosystems within it (people and nature combined). This is especially prevalent due to the predictions of vulnerability to impacts from climate change. Forests play a fundamental role in this.

- Starting to restore and regenerate the forest is key to beginning the journey towards regenerative practices and RIFS.

- Gender equality needs to be understood as a strategic issue. Social and cultural norms – such as those related to the gendered division of labour and decision making - strongly influence the behaviour of women and men and their relationship with nature. Social change should be seen as one of the entry points for changing this relationship.

- Understanding internal dynamics of household decision making is critical in order to understand the behaviour of individuals and stakeholder groups in the area. Households are very easily assumed to be cohesive units sharing rights, goals and ideas. This may lead to misguided interventions.

- There are more than likely still legacies due to colonialism and this is something to be conscious of with regards to mindset and the potential patterns found in the food system.

7.2Lessons learned for facilitator team

- The information provided in this SOP can provide facilitators and researchers with a deeper and richer understanding of the potential of place and the community or stakeholders involved in the regenerative process. It can help to see the opportunities, and also some of the barriers they are facing in reaching their potential of undergoing a transformation towards RIFS.

- It is a way to learn that the " earth" has its own agenda and puts into perspective the role a place and community can play in the geological time line of the earth. It can therefore, be used as a means to provide a broader temporal and external lens to approach the workshops, as it may help to remove some of the cultural mindset and to view matters more objectively.

- It is an exercise to help the facilitator or coordination team understand better the long shadow that history and collective experiences can have (i.e. more than generation).

- It is important to use this information in the SOP objectively to provide insight and interpretation of some elements and patterns. However, facilitators should be aware of potential unconscious bias due to such information and should not automatically steer workshops towards issues highlighted in this document, these should be enabled to develop in the workshop naturally.

8.References

Ambale, B. (2022). Review of Gender Roles in Community Management of Forest Resources. A Case of Nandi, Uasin Gishu and Elgeyo Marakwet Counties. Available at:https://www.grin.com/document/1220651.

Blegen, N., F. H. Brown, B. R. Jicha, K. M. Binetti, J. T. Faith, J. V. Ferraro, P. N. Gathogo, J. L. Richardson and C. A. Tryon (2016). "The Menengai Tuff: A 36 ka widespread tephra and its chronological relevance to Late Pleistocene human evolution in East Africa." Quaternary Science Reviews **152**: 152-168.

Conti, P., M. Pistis, S. Bernardinetti, A. Barbagli, A. Zirulia, L. Serri, T. Colonna, E. Guastaldi and G. Ghiglieri (2021). "Tectonic Setting of the Kenya Rift in the Nakuru Area, Based on Geophysical Prospecting." Geosciences **11**(2): 80.

Davies, T. C. (2008). "Environmental health impacts of East African Rift volcanism." Environmental Geochemistry and Health **30**(4): 325-338.

Dommain, R., S. Riedl, L. A. Olaka, P. deMenocal, A. L. Deino, R. B. Owen, V. Muiruri, J. Müller, R. Potts and M. R. Strecker (2022). "Holocene bidirectional river system along the Kenya Rift and its influence on East African faunal exchange and diversity gradients." Proceedings of the National Academy of Sciences **119**(28): e2121388119.

Gevera, P. and H. Mouri (2018). "Natural occurrence of potentially harmful fluoride contamination in groundwater: an example from Nakuru County, the Kenyan Rift Valley." Environmental Earth Sciences **77**(10): 365.

GSMA (2021). Mobile Technology for Participatory Forest Management. Co-designing and testing prototypes in Kenya.

Hongo, P. and G. Mulaku (2021). "Flooding of Lake Nakuru National Park and Its Effects on the Resident Wildlife." Journal of Geographic Information System **13**: 660-670.

Igunza, G. M. and I. Kanda (2017). "Geochemical Evaluation of Groundwater Flow Processes and Mixing in Menengai Geothermal Field, Kenya." Geothermal Resources Council Transactions **41**: 1481-1491.

Kanda, I. and J. Suwai (2013). "Hydrogeochemistry of shallow and deep water aquifers of Menengai geothermal area, Kenya Rift Valley." Transactions - Geothermal Resources Council **37**: 403-407.

Kimaru, A. N., J. M. Gathenya and C. K. Cheruiyot (2019). "The Temporal Variability of Rainfall and Streamflow into Lake Nakuru, Kenya, Assessed Using SWAT and Hydrometeorological Indices." Hydrology **6**(4): 88.

KWTP (2018). "Kenya Water Tower Climate Change Resilience Program. Climate Change Vulnerability Assessment of the Mau Forest Complex, Cherangany Hills, and Mt. Elgon Water Towers in Kenya. Available at:https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjLy4zG5Lz7AhUF26QKHTY1AboQFnoECAsQAQ&url=https%3A%2F%2Fresilience.igad.int%2Fwp-content%2Fuploads%2F2020%2F06%2FClimate-Change-Vulnerability-Assessment-of-the-Mau-Forest-Complex-Cherangany-Hill-and-Mt.-Elgon-Water-Towers-in-Kenya.pdf&usg=AOvVaw06zwkfANlEWVGhstOfDl9G. ."

Macharia, M., C. Mundia, D. Kuria, M. Gachari and Nicholas (2018). "MACHARIA, et al.: A GIS-Based Approach for Exploring Geothermal Resources Along Part of the Kenyan Rift. A GIS-BASED APPROACH FOR EXPLORING GEOTHERMAL RESOURCES ALONG PART OF THE KENYAN RIFT." **3**: 1-34.

Mang, P., B. Haggard and Regensis (2016). Regenerative Development: A Framework for Evolving Sustainability, John Wiley & Sons, Ltd.

McCallum, G. J. H. (1967). Geology and Ground water conditions in the Nakuru area. Degree Sheet no.35. Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiOwdTy1qD7AhV2_rsIHaDRA2AQFnoECAkQAQ&url=https%3A%2F%2Fedepot.wur.nl%2F493285&usg=AOvVaw04BnLkDz3mG71OoeKhRvgW. Accessed: June 2022.

Mutune, J. M. and J. F. Lund (2016). "Unpacking the impacts of 'participatory' forestry policies: Evidence from Kenya." Forest Policy and Economics **69**: 45-52.

Odada, E. O., J. Raini and R. Ndetei (2006). "Lake Nakuru, Experience and Lessons Learned Brief.Lake Basin Management Initiative: Main Report, 299-321.".

Odieny, A. O. (2022). SHAMBA SYSTEM OF FOREST MANAGEMENT AND ECONOMIC CHANGE IN KODERA, HOMABAY COUNTY, 1957-2012.A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN HISTORY, SCHOOL OF ARTS AND SOCIAL SCIENCES. MASENO UNIVERSITY. Available at:https://repository.maseno.ac.ke/handle/123456789/5220.

PFMP (2022). "Menengai Participatory Forest Management Plan (2022-2026) . Joint document of the Kenya Forest Service and Menengai Community forest association. ."

Republic of Kenya Ministry of Environment and Forestry (2019). "The National Forest Reference Level for REDD+ Implementation. Report. ."

Riedl, S., D. Melnick, G. K. Mibei, L. Njue and M. R. Strecker (2020). "Continental rifting at magmatic centres: structural implications from the Late Quaternary Menengai Caldera, central Kenya Rift." Journal of the Geological Society **177**(1): 153-169.

Sosian Energy (2019). "Environmental and social impact assessment summary. Menengai Geo-thermal power project- GDC. Project number: P-KE-FZ0-003."

UNEP (2008). "UNITED NATIONS ENVIRONMENT PROGRAMME, KENYA WILDLIFE SERVICE, KENYA FORESTS WORKING GROUP, EWASO NGIRO SOUTH DEVELOPMENT AUTHORITY. Presentation: MAU COMPLEX UNDER SIEGE Values and threats. Available at:https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwi80-ql6Lz7AhUI7KQKHb2ZAoAQFnoECBEQAQ&url=https%3A%2F%2Fwww.kws.go.ke%2Ffile%2F1451%2Fdownload%3Ftoken%3D_LmapfCO&usg=AOvVaw34Ozq1M0WdBH6fsxRq1Y6t."

Waithaka, P., F. Mwaura, M. Wagacha, E. Gathuru, F. Ngumbu and A. Mwangi (2017). Physico-chemical characteristics of soils from Menengai geothermal crater in Kenya and their influence on plant diversity. Available: https://www.researchgate.net/publication/311113912_Physico-chemical_characteristics_of_soils_from_Menengai_geothermal_crater_in_Kenya_and_their_influence_on_plant_diversity?channel=doi&linkId=583e8f2308ae2d217556efdc&showFulltext=true.

Waithaka, P. N., F. B. Mwaura, J. M. Wagacha, E. M. Gathuru and B. M. Githaiga (2017). "Antimicrobial Properties of Actinomycetes Isolated from Menengai Crater in Kenya. DOI: 10.4236/cellbio.2017.62002 " CellBio **6**: 13-26.

Were, K. O., Ø. B. Dick and B. R. Singh (2013). "Remotely sensing the spatial and temporal land cover changes in Eastern Mau forest reserve and Lake Nakuru drainage basin, Kenya." Applied Geography **41**: 75-86.

Wetang'ula, G., J. Akama Raini and I. Munyeki (2014). Vegetation types and Diversity in Menengai Caldera Geothermal project Area, Kenya. Presented at Short Course IX on Exploration for Geothermal Resources, organized by UNU-GTP, GDC and KenGen, at Lake Bogoria and Lake Naivasha, Kenya, Nov. 2-23, 2014.