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Energy economies, climate change and renewables in East African drylands

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Abstract [0.5]

Economies are based on energy transformation. Pastoralist societies adapt to drylands by using livestock to transform biomass into foods and goods. Constrained by the availability of water for energy conversions, pastoralism is highly susceptible to climatic changes. The global industrial economy could help it using productive capacity more intensively, but not only is that a risky endeavour, business interests compete increasingly with pastoralism for resources. As supplying ever more people with ever more products drives climatic change and rapid loss of ecological capacity, long marginal areas become a new frontier, including in the search for new sources of energy. The combination of high renewable potentials with low population densities, growing poverty and political marginality has brought drylands like the Omo-Turkana region into the focus of both humanitarian and commercial interests. Looking at sugar-based biofuel production in Ethiopia's South Omo zone, Kenya's Lake Turkana Wind Power mega project, solar-powered irrigation schemes, etc., but also at the energy dimension of endogenous conflict, this paper analyses the interplay of indigenous, fossil-based and emerging energy economies; how conflicts of interests play out and how that could change; as well as the increasing value of land and its consequences. It asks what could be done to use the region's potential efficiently, equitably, and sustainably. It argues that pastoralists' socio-economic techniques and communal resource management systems are successful models that should be built upon innovatively in order to counter trends towards ill-informed planning, predatory accumulation, and mass-disenfranchisement.

(1) Economy & Energy Transformations [1]

Climate change, growth & renewables in Eastern Africa

Driven by concerns about the consequences of rapid climate change and ecological degradation,[1] energy questions receive increasing attention among policy makers, in academia and the wider public,[2] including in regard to Eastern Africa,[3] a region long associated with environmental hardship and crises,[4] high levels conflict[5] and deficiencies in energy generation.[6] Much hope is being placed in the development of renewable energies reducing dependency on fossil fuels, and drylands, long remote to international and state-level economic planning, have seen their importance as prospected value generation sites rising dramatically.* Not only do they often excel in solar irradiance and wind intensity; low-intensity usage patterns, low population densities and political marginality increase to their attractiveness for planners and investors.* The Omo-Turkana Region (OTR), including the Ateker region and the Omo-Turkana basin, has recently seen massive investment in hydro-power,* wind power* and bio-fuel production;[7] there is significant geothermal potential;[8] solar power is fast expanding and likely to become a booming industry in the near future.* Simultaneously, violent conflict is virulent; and while renewables development is credited with potential to decrease inequalities and promote social peace, concerns that it can do the opposite are already confirmed by reality.[9] A transition is needed and OTR is a prime site, but the question is how to implement it well.[a]

In this text, I will discuss the situation in the OTR from an energy perspective that builds on cultural ecology traditions to analyse flows that shape its socio-ecological system and their significance for planned and contingent future-making, where the direction of these flows is or can become a matter of conflict, what that means for the development of renewable sources of electricity generation and the opportunities arising from it. For brevity I will call them "renewables", yet not without admitting that energy sustainably captured from plants and animals in e.g. the pastoralist mode of production is, strictly speaking, also „renewable energy" and discussing why this should always be included in any calculation.

Society as energy metabolism

All live is based on energy transformation. Plants (autotrophs) bind solar energy into configurations of matter that spread their own patterns. Animals (heterotrophs) take the energy to do so from living matter, and humans gradually learned to use energy provided by fuel combustion, i.e. fire, to decrease the energetic costs of digestion, thus freeing capacity investible in complex brains with high energy consumption. These high-powered brains then opened up exponentially growing amounts of energy, matter and live for the collective metabolisms we call societies,[10] collective adaptations to natural and socio-political environments.

(2) Energy, Ecology & Conflict [2,5]

Energy & conflict in pastoralist systems

The socio-economic systems of this region's pastoralists evolved to use the scattered and periodically scarce resources of harsh arid and semi-arid lands (ASALs) thanks to the unique ability of their livestock to access energy bound in patchy and unpalatable biomass and transform nutriments[11] and materials at energy input-output ratios superior to many farming and industrial systems.[12]* It testifies to its efficiency that millions of people continue to pursue well-being through pastoralism, even as an expansive capitalist economy using an infinitely larger range of tools, techniques and resources competes for its resources, and although periods of extreme scarcity, drought, plagues and raids cause much pain and suffering.[13] Livestock raiding evolved as part of an adaptive packet that allows communities to both generate spaces of peace, cooperation and security, controlled by a collective moral order that regulates a competitive system of energy flows, especially in form livestock labour and cooperative action, and capture 'external' resources to cope with scarcity and uncertainty.* Yet while the link between scarcity and conflict is a popular meme among scholars and non-scholars alike, it is also subject of long-standing academic debate,[14]* including on East African pastoralists.[15]

Do climate & ecological crises cause conflict? Data & Factors.

Studies of conflict frequency in relation to degrees of resource scarcity among the region's pastoralists contradicted assumptions of simple correlations;[16] but they also revealed that the

[a] I am currently involved in a project with researchers from the Stockholm Environment Institute (SEI), Durham University, Kings College London and the Stockholm International Peace Research Institute (SIPRI) on these issues in the Omo-Turkana region (see SIPRI 2018).

value of statistical data on a few selected parameters and rather short time spans depends on contextualisation with ethnographic knowledge and long-term perspectives.[17] For OTR, such studies suggest a strong impact of environmental factors.[18] Insights of ethnological and historical analysis[19] allow for a holistic understanding, not least thanks to often close communication with the concerned people. Important work investigates the importance of other factors for raiding in the OTR, including the dialectics of the pastoralist disequilibrium system,[20] cultural adaptations to a violent environment,[21] allies, weapons and ammunition,[22] enemy and government force,[23] commercial interests[24], the availability of food and income[25], disempowerment and discrimination grievances,[26]* and modern politics[27].

Sometimes, however, a fashionable focus on change and modernisation phenomena[28] has led to problematic dichotomies, e.g. of once "redistributive" vs new forms of "predatory raiding"[a], promoted far-fetched imaginaries including supposed "warlords",[29] exaggerated the role of modern weaponry as "change agent" resonating concerns of the privileged[30], and produced 'grey' literature teeming with clichés, errors and half-baked conclusions that can nevertheless exercise significant influence on high-level decision making.[31]

To inform policies, governance, development and security practice adequately, the vast resources of available knowledge should be processed with sufficient understanding of the region to join the key dots. This should integrate analyses of individual motivations of typical actors, landscape-scale interrelations and global dynamics in regard to ecological, economic, social, cultural and symbolic capital, short- and long-term interests, but maintain clarity about what matters most to avoid getting bogged down in details of unclear relevance or waft away by flights of intellectual fancy.

Global fears, privileged narratives & policy-making

The stark contrast between how convinced policy makers and the wider public are that climate change and environmental pose severe threats and scholarly debates about whether they 'really', i.e. statistically demonstrably lead to increases in violent conflict has fed into accusations by critique-centred academic currents that global elites use imaginaries of fear featuring wars and mass migrations caused by environmental disasters that threaten the security, internal peace and wealth not only in the Global South but also of the Global North. Such memes are used to justify securitisation and intervention politics that cement and expand the very inequalities that breed these disasters in the first place and to militarise the relations between wealthy states fortifying their boundaries and the degrading domains of the have-nots who scramble for what they can grasp. They provide well-led narratives of self-inflicted Southern decay frustrating a compassionate North and its aid endeavours that roll of the Southerners' shoulders in their refusal to act responsibly, a narrative meant to absolve the chariteers of their own sins.[32]

Security fears can be misused, but the threats are real

While there is merit to these arguments, there is also a risk that their focus distracts from facts that are very costly to ignore. It is true that, in many cases, scarcity is not a sufficient condition for conflict. People might even die of hunger, but no violent conflict occurs.* For the Ateker region it is well established that in many of the devastating famine periods, not only did people often refrain from attacking neighbouring communities, the least far to seek opportunities to pursue survival at the expense of one's immediate neighbours and resort to coercion and

[a] A prominent early example that contaminated especially the grey literature was Hendrickson et al 1996; more nuanced pictures of real changes were given by Belshaw 1999, Krätli & Swift 2001; Akabwai et al 2007, Eaton 2010, 2008, Abbink 2009, Tornay 2009, Sagawa 2010, and others; interesting aspects such as changes in sentiment between social groups, especially generations, were thematised by Skoggard & Teferi 2010, though much more research on this is needed.

violence when expedient are hardly ever pursued.[a] Within Ateker pastoralist communities, people normally don't prey on each other even during extreme scarcity and even share what little food they have. Nevertheless, the global and local effects of unchained growth, combining massive population growth with steep increases in consumption, capitalist resource appropriation and production costs, including energy, materials, biodiversity and human effort, cannot accumulate endlessly without resulting in large-scale suffering, regardless of how much armed violence will be involved.

Population growth & productivity

Arguably, Turkana is the part of the Ateker region where the impact of the modern system has been strongest, where population growth has been most extreme (from 0.03 million at the dawn of colonisation to 1,5 million today, see figure 1),[33] and where that has already led to transfer-dependence for a majority (ibid.).

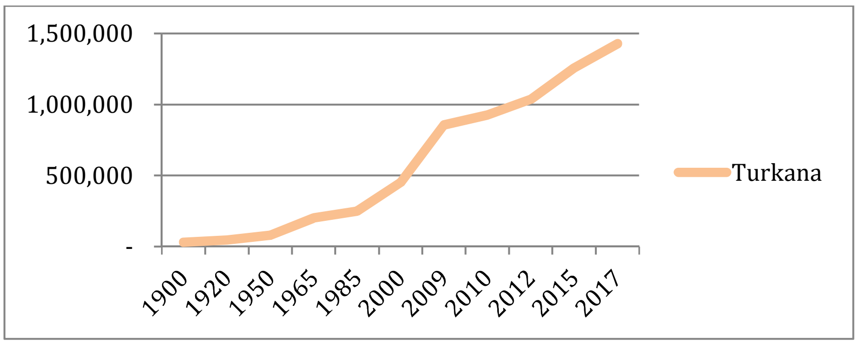


Figure 1 Turkana population growth between 1900 and 2017; Source: Compilation of the author based on census data, UN OCHA, ethnographic studies, and personal field inquiry.

Figure 2 shows the increasing mismatch between livestock and human population for Karamoja, with the livestock peak in 2008 partly related to raids on neighbouring groups and the subsequent drop to the military occupation.

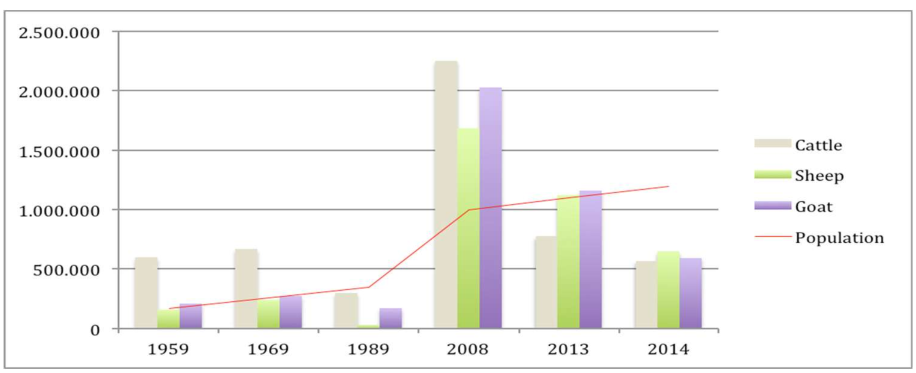


Figure 2 Livestock numbers and population growth, Karamoja, between 1959 and 2014

Figure 3 shows national dimensions and could be mirrored by graphs depicting parallel decline in forest cover, usable land or water available per capita. Planners' answer is usually intensification and industrialisation, as this was how most of the now wealthy nations gained the wealth and power everyone would like to achieve. While intensification is possible, its costs are often neglected, here as globally, and landscape-scale analyses show that often increases in one sector or one area are more than offset by decreases in others, and that what actually happens is a shift of resource benefits from groups with less to groups with more power. In the following sections, I will give examples from the Ateker region for this process.

[a] A change away from this pattern has been described for post-disarmament Karamoja by Stites & Howe 2019; Stites & Marshak 2016; Stites & Huisman 2010.

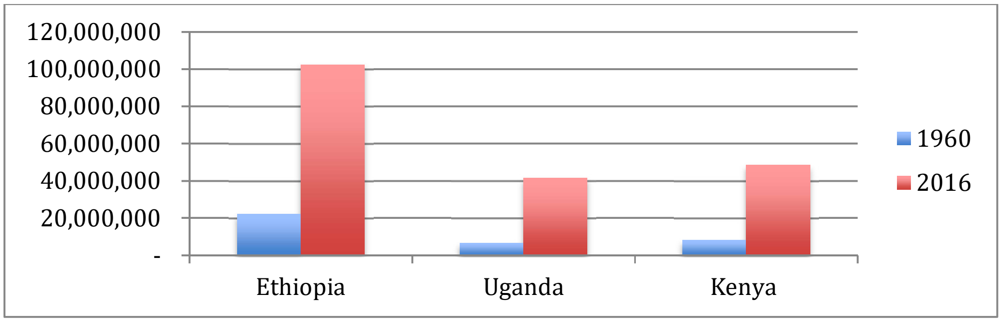


Figure 3 Population growth Ethiopia, Uganda and Kenya between 1960 and 2016; Source: World Bank 2017b

(3) Renewables & Development [5]

Thanks to Kenya's devolved government system, Turkana County is the entity with the strongest autochthonous agency in the Ateker region. Its government (TCG) has a far greater say in development planning and implementation and far more resources than comparable administrations in Karamoja, the Omo valley or South Sudan. In the 2015 5-years-development plan formulated with UNDP,[34] it sets the goal of connecting 200,000 households and public institutions, mainly health centres and schools, with electricity, including through solar generators, and to 'become a major producer and exporter of solar, wind and geothermal energy', mirroring the importance of renewables development in Kenya's national agenda, including the National Climate Change Action Plan (NCCAP)*. Though TCG has not gone very far on the way to a national top rank, the potential of the Ateker region is obvious and the projects discussed in the following sections may give a glimpse of the implications.

Hydro-Power & Irrigation

The Turkwel dam & irrigation in Turkana

The first significant hydro-power project in the region was the Turkwel Gorge dam, with 153 m Kenya's tallest, gathering waters from 5,900 km^2 of Mount Elgon, South-eastern Karamoja, West Pokot and the Cherangani Hills.[35] With French assistance, it was constructed between 1986 and 1991 GoK's Kerio Valley Development Authority (KVDA) at a cost of 20 billion Kenya Shillings, instead of c.4 billion initially calculated, where river leaves the West Pokot highlands and enters the dry Turkana plains. It was supposed to bring "hydro-power, agricultural, fisheries and tourism development"[36] to both communities. As with many large-scale projects of the Moi era, there is a wealth of plausible tales of corruption and ethnic favouritism girding its history. Some of Moi's closest allies were involved and the main local beneficiaries of the dam were Pokot, closely related to his 'Kalenjin block' and rapidly gaining power thanks to armament efforts of their political representatives in his party.[37] At 106 MW, Turkwel Hydroelectric Power Station (THPS) is Kenya's 3rd largest hydroelectric power plant. Run by KenGen and connected by a 230 km transmission line to the national grid at Lessos in the Kalenjin Highlands, it provides c.10% of the national electricity supply,[38] but it took over 25 years and the discovery of Kenya's only profitable oil deposits in Turkana County to bring power from the dam close to Lodwar. The construction was accompanied by the expansion of Pokot administration, business and raiding in the area, keeping it one of the most insecure zones of the Omo-Turkana region to this day.[39] "Tourism" is confined to a camp-like 'lodge' at the feet of the dam where at times meetings between Turkana and Pokot operatives take place and fishing has remained minimal. The most significant effect for Turkana, apart from Pokot pressure, was the conversion the Tùrkwel from a seasonal and otherwise underground stream into an almost permanent river that enabled the set-up of irrigation schemes along its lower reaches.

Irrigation in pastoralist drylands

Irrigation projects in Turkana have never been economically viable since they were introduced in the 1960s. Solid studies from the 1980s[40] show that participants are bound to depend on external inputs far higher than the costs of restocking, an option much preferred by pastoralists. Yet agency after agency rehabilitates them to uphold the idea that irrigating mainstream crops, especially maize, is the way to go. As this idea is shared by under-informed donors (and most are under-informed), the circle of rehabilitation and decay after external funding stops keeps on revolving, reproducing stark disproportions in agricultural investments. While crop production is undertaken by under 10% of Turkana's population on less than 10% of the area, it receives c.80% of investments, while pastoralism, feeding a many times higher population from the biomass of over 80% of the area, including by exchanging stock for plant products from areas where their production is far more efficient, receives less than 20%.

Reductionist perspectives, short-term gains & cost externalisation

In a time where constantly rising levels of consumption and population drive up demand to ever greater heights, people taking orientation from apparently globally successful models look especially to **irrigation** when confronted with the dilemma of massive growth-driven food insecurity. If their perspective is confined to a *local condition* –food production insufficient to sustain a local population– and a *local solution* –irrigated food crop cultivation to increase it– it seems to make sense. However, an analysis of the wider socio-ecological system reveals serious flaws in this apparent solution. Its costs are largely incurred by those who use almost 100% of land surface: mobile pastoralists. Where up to 80% of stock dies during droughts and animals depend on the 10 to 15% of land with enough water for survival, alienating such land for food or cash crop production impossible elsewhere is devastating for landscape-scale productivity. While experts have stressed this for decades, policies and public discourse are still held hostage by ignorance and self-serving indifference.

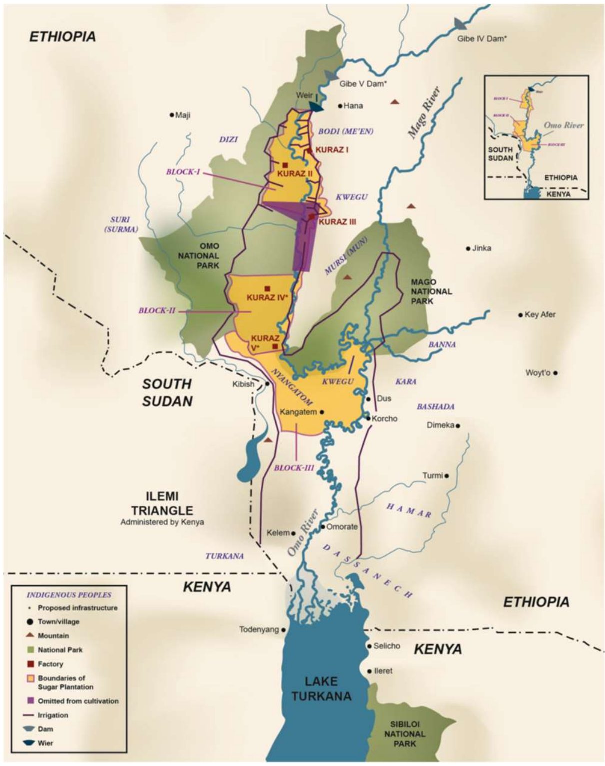
Pastoralism is more productive than cultivation when assessed at landscape scales

Mobile pastoralism can deal with erratic rainfall and biomass availability (1) because it can react very quickly, flexibly and inexpensively to rapid changed;* (2) the vegetation it uses does not require human energy input and is far more resilient;* (3) because its institutions of resource management and cooperation are strong and reliable,[41] allow for capital accumulation through careful operation, recovery of losses and livelihood recovery after disasters.[42] The portrayal of pastoralism as "outdated" and 'inferior to agriculture' in productivity is debunked as ideological by evidence. Though crop production might generate more calories per hectare, soil and water conditions allow it for only for a fraction of the region at viable costs. But taking these ecologically privileged areas away from the pastoralist economy reduces the total productivity of a far larger area, an area used by pastoralists.[43] The apparent productivity increase turns out to be a misleading mental construction based on the omission of the costs. This is demonstrated by the South Omo scheme in the Ethiopian part of OTR that threatens the entire region with disaster.

Gibe 3, Bio-fuel & the Lower Omo

Ethiopia's Omo Zone excels as surviving bio-diversity hotspot thanks to its unique indigenous socio-ecological systems that combine pastoralism with highly productive flood-retreat cultivation, beekeeping, fishery, foraging and exchange.[44]* The Omo river is the only major stream for hundreds of kilometres and source of c.90% of the water in Lake Turkana before the upstream Gibe III dam stopped the annual floods that created its main fish breeding grounds[45]. It is part of a larger socio-ecological system that connects its ca. 5 million pastoralists across the borders with Kenya and South Sudan.[46]

Figure: Map of the Lower Omo valley and surroundings (Hodbod et al 2019)



Gibe III, the first large dam on the Omo and Africa's tallest, is prospected to produce 1.870 MW (starting at 800 MW with 6 of 10 turbines in 2016) from a 200 sqkm reservoir with a storage capacity of 2,240.000 m^3 and to increase Ethiopia's capacity by 80% while selling 500 MW to Kenya, 200 MW to Sudan, and 200 MW to Djibouti[47]. Supposed to "redress inequalities (along with jobs and foreign revenue)"[48], its impact has been heavily and consistently criticised by experts for over a decade as ecologically, economically and socially worse than the Aral Sea disaster,[49] yet this is less related to the dam itself but by the use GoE plans to make of its water: irrigating 100.000 hectares of industrial sugar cane plantations for bio-fuel production in the state-owned Ethiopian Sugar Corporation's *Kuraz Sugar Development Project* (KSDP), as well as large-scale cotton and palm oil schemes would lead to the partial or total disappearance of the world's largest desert lake, its unique ecosystem, the highly productive valley agriculture and fisheries on which hundred thousands of locals rely, and a reduction of general humidity of unknown consequences for millions of pastoralists, many of whom now depend on food aid after losing their livelihoods to the project and associated "villagisation" schemes. Although GoE promised to prevent this by releasing artificial floods, observers still remain sceptical that it will make the necessary efforts.

Implementation problems, large-scale embezzlement (including by investors acquiring land from GoE at throwaway prices only to skim off associated credits invested elsewhere after destroying vegetation to fake activity), unsuitable soils, harsh international criticism of ecological damage and the violation of indigenous rights, resulting donor withdrawal, a drop in global sugar prices that turned KSDP into a loss-making business and other issues eventually compelled GoE to downscale the scheme from 1.75 to 1 k ha, but the main problems still remain.

Fortunately, the broad consensus of researchers, civil society and international organisations has gained new opportunities with the remarkable democratisation process initiated by Ethiopia's new president that kindles new hopes for a turn towards a more responsible, inclusive and productive approach. The size of irrigated areas could be further reduced and repurposed to correspond to local needs for food and dry-season fodder that could dramatically increase pastoralist productivity in a large cross-border region, initiate new forms of market integration for livestock producers and inter-community peace-building through resource sharing.* The problem of reduced flows to Lake Turkana can be further mitigated by using less water-intensive crops and techniques. Expert initiatives that have developed over the last decades have an important role to play in bringing together a coalition of actors to divert the available resources from the road to disaster towards sustainable and equitable landscape-scale productivity increases in close cross-sector cooperation.*

Geothermal Power

Geothermal power is especially attractive because it is far less land-intensive and largely immune against the strong fluctuations that plague especially hydro-, but also biofuel, solar and wind power. Kenya, the leading geothermal producer in Africa and number 9 worldwide, followed by Japan,[50] is working towards boosting geothermal production far beyond the current 530 MW (32%)[51] (630 MW[52]), which already leave thermal (c.250 MW, c. 15%) and wind power generation (before 2018 only 25 MW, 1,5%)[53] far behind, to 5530 MW in 2031 (out of the Great Rift Valley's c.10 GW potential)[54]. However, the projects in the Olkaria region (Nakuru* County), the current main site, face opposition from local communities.[55] Recent explorations in southern Turkana also led to conflicts[56] and the potential of the Kapedo and Silale regions at the Turkana-East Pokot frontier have long been reported to contribute to their extraordinarily high levels of inter-community violence through incitement, armament and competition of modern political elites, even though investors pushed for inclusive peaceful settlements.[57] Consequently, they were outstripped by a wind power mega-project in the immediate vicinity.

Wind power

Africa's largest wind park

Situated near Loyangaláni, where Marsabit borders Turkana county, the *Lake Turkana Wind Power Project* (LTWP) was conceived by companies specialising in green energy, construction and tourism in 2006 as largest African wind farm.[58] Daily temperature fluctuations between the lake and the plains generate strong predictable wind streams concentrating in a funnel between the Kulàl and Nyíro ranges reaching speeds of 11 m per second, a global top range translating into a vast extraction potential at quasi optimal conditions. As part of Kenya's ambitious and exemplary program of renewable energy development, an MoU with *Kenya Power & Lighting Company* (*KPLC* or *Kenya Power*) in 2008 made it a flagship project of the *Kenya Vision 2030* agenda, co-funded by a consortium of international development funding agencies with interest in renewable energy and carbon credit generating assets, most from Europe, especially Scandinavia, Germany and the Netherlands (Achiba 2019). With investments of over 700 m US$ it became the biggest public-private partnership (PPP) and largest private investment in Kenya's history and was built between October 2014 and January 2017 in only 2.3 years. 365 wind turbines on 40,000 acres of rangeland generated an ideal output of 310 MW, i.e. c.17% of Kenya's national capacity or "one million homes", bought at a fixed price by KPLC for 20 years (LTWP 2019), in addition to a previous total of only c.25 MW or 1,5% (KenGen 2018b). However, as the transmission line was completed only 21 months after production took off (October 2018) and 5 more passed until full operation while no power could be sold, Kenyan consumers have to pay the US$ 52.5 million debt GoK owes LTWP through KShs 0.96 extra per kWh for six years.

Problems, conflicts & prospects

LTWPs many impressive successes are further overshadowed by conflicts over land rights and benefits. While a funder reports it to have created 699 local jobs, projected carbon credit funds of € 2.3–6 million[59] illustrate the distribution of gains between local and non-local beneficiaries.[60] Already in 2014, communities in Laisamis Constituency appealed to Kenya's Environment and Land Court (ELC) for immediate cessation of project activities over illicit annexation of community land based on a biased Socio-Economic and Environmental Impact Assessment (SEIA). LTWP lawyers argued the land was "uninhabited", a claim used to justify dispossession of commons since colonial times, and that the project "benefitted the community immensely".[61] Those speaking for the Turkana, Samburu, Rendille and Gàbra communities, whose pastoralists use the area conjointly or alternatingly, disagreed, decrying exclusion from decision making and benefits.

It is worth noting, however, that this pursuit of access to benefits, including jobs corporate social investment and compensation payments, has, as for other mega-projects in Northern Kenya, including LAPSSET* or the pipeline that was to transport Ugandan oil through Turkana before excessive compensation scheming led Uganda and the donors to prefer a longer route through Tanzania,* become an important strategy for a school-educated minority that uses pastoralist land usage histories and a language of entitlement, advocacy and 'right to development' to stake their own claims in a competition not only with companies and the state but also with rival communities, often fuelling ethnic rivalry between pastoralists with exclusivist memes.[a]

The main problem for the area's pastoralist majority, apart from elite machinations, is the fencing of facilities that could have been minimised by integrating them in institutional security arrangements. When well-coordinated with local communities and set up at sufficient distance from sites of permanent settlement, wind power remains an option of prime importance and suitability for energy export development in the region that can offset the costs of growth-induced poverty and resource pressure.

Solar power potentials & uses

Local demand for electricity is very low so far & decentral solar covers it

Drylands like those of Australia or North-Eastern Africa have always required people to handle low density of resources and human population. In the age of electricity, connection of scattered populations to the national grid is challenging and often hardly cost-efficient, resulting in reliance on diesel engines for power generation in the centres, a situation still prevailing in most of the Ateker region. However, the rapid development of solar power technology and the resulting drop in its cost has made electricity available in most of its settlements. Remarkably enough, our research so far suggests that the demand for electricity among the majority is very low and largely confined to charging mobile phones and electric torches, though the latter often use batteries, including in permanent rural settlements. Even where electric light is available, it is often used very little. In most nights, the moonlight is very bright and fully sufficient outdoors, whereas cell phones, splints, torches, etc. provide spotlight indoors when needed. Some like small radios playing the regional mix of Gospel and Kiswahili with news, but most don't and people have enough social interaction not to be bored. Only a wealthy few afford TVs and fridges and there is little other use for electricity here, except for the solar-powered water supply systems that commonly pump water into large tanks from where it is distributed to a set of local taps where neighbourhood clusters access it. Nevertheless, solar energy is likely to become a key factor in the changing energy economy of the region, including for pastoralists, though probably not in the way it is commonly conceived at the moment.

Napuu Irrigation Scheme, a Turkana pilot for solar-powered irrigation

Solar-powered irrigated gardens are currently introduced in many parts of Turkana to cope with the lingering hunger and rampant joblessness. As their small scale seems more sustainable, especially when they extract water below replenishment levels, donors are generally positive

[a] Cormack & Kurewa 2018. Members of our project conducted extensive research on the LTWP case but the data still await processing.

about them. The Napuu Drip Irrigation Scheme on the outskirts of Lodwar, a showpiece project of Turkana's first County government, was acclaimed as providing "the first crop on land irrigated with water from an underground aquifer" […] to address the challenge of food insecurity in Turkana" on 150 acres by organised local farmers under the Kerio Valley Development Authority KVDA, with a prospect to "attract more State funding" to scale it up to another 1,000 acres for maize and sorghum, bananas, mangoes and oranges (Lutta 2016).

When we visited the site in 2018, we found a much smaller area surrounded by mesh wire worked by around 50 of Lodwar's ten thousands of families growing some kale, tomatoes or (clearly inferior) water melon to earn a couple of shillings with which they would then purchase maize flour from the highlands and other essential goods, as this was the most economical use, though they had the difficult choice to either invest in expensive pesticides or losing yield to pests. The PR aspect of the project became obvious from the contrast between its triumphant advertisement and the remarkable neglect of its sad reality: situated just a few metres away from the responsible offices, more than 10 of the c.40* massive water tanks were missing their valves and thousands of litres of water running non-stop unused into weed-skirted mosquito-breeding puddles. No one seemed to check or feel responsible. There was no lock at the gate to prevent thieves and goats from entering at night to feast, as the tenants* we talked to complained, nor a watchman to make sure they wouldn't because nobody tried to raise the 3k Shillings (c.30 US$) for a salary and keep the tax payer-funded KShs 70 million project viable. Although Lodwar is full of hungry people, many plots were unused and overgrown. It didn't look like the fulfilment of urgent desires of the local population but there was a lot of talk about massive amounts of water from the scheme being used by well-connected people for other purposes, as the Lodwar Water and Sewerage Company Ltd (LOWASCO) uses the same systems to pump water into town. And for those involved, the construction of the scheme was certainly good business. But while all this is sad and a telling tale of Turkana politics, as no local politician cared to mobilise resources and / or people to remedy the problems, a rather easy task, the main issue is the problematic overarching dryland development approach.

(4) Outlook: Shaping complex energy futures [2]

Global industrialism & pastoralist regions

Development avails vast energy sources – which makes it very dangerous.

The global industrial economy might easily appear less vulnerable to climatic variation than economies such as Ateker agro-pastoralism that depend directly on resources whose local availability varies as strongly as that of water in OTR. Powered by ever larger amounts of energy, it is geared to supply ever larger human populations with ever more products through ever more diverse strategies, ever larger resource transfers and trans-continental networks of cooperation. But the profit imperative of the economic system conflicts with the sustainability imperative of the social system; and the coping strategies humans have use for millennia – further expansion, intensification, and externalising costs to insufficiently powerful populations and species– are at the very core of the problem. Merely integrating pastoralists better and boosting their productivity with external resources does not solve it. But keeping landscape-scale ecosystem productivity, bio-diversity and the equitable distribution of benefits in focus is still likely to be the best guideline available.

Renewables development prospects

If we look at OTR from an energy perspective, we find that wind and solar power are distributed rather evenly while water, the medium of biological energy conversion, is highly concentrated and generally insufficient to boost biomass generation through intensified agriculture in conventional ways. Geothermal and wind energy extraction can contribute to the increase in green electricity production without exceeding difficulty even in ethnic frontier zones, given their elites cooperate in a spirit of win-win resource sharing and use their influence on pastoralists to promote the same among them, including by tending to their urgent needs. These needs continue to revolve around the well-being of their animals, making them the still most productive part of the population. While other fields of economy will certainly continue evolve in the region, it is likely to remain the most viable form of biomass utilisation and a key question is how emerging cooperative and technological opportunities, including green energy infusions, can help stabilising it at optimal productivity levels. Our project aims therefore, among other things, at calculating energy budgets for different local economies.

My research so far indicates that the main energy needs of the rural OTR majority –movement of and with animals, food, cooking fuel and access to water– can partly be covered by renewable energies, provided appropriate gadgets are provided and properly maintained. Solar pumps are already frequent, solar cookers still need improvement and popularisation, irrigated gardening can help somewhat to ease local needs, and rapid advances in solar and electro-mobility technology could convert the drylands into giant solar fuel production fields where a solar 4WD pickup truck carrying stock could run on locally produced solar power at minimal costs and thus cut down the animals' biomass energy consumption. However, while a mass expansion of solar generation would see the regions contributions to the GDP skyrocketing, experience suggests that, apart from ecological costs that have to be studied and remedied, the main lingering issues are the distribution of authority and benefits. Elites tend to use exclusive social capital in decision making arenas for an expansion of their economic and social power, often leading to inequality increases with detrimental effects on social cohesion and well-being, democratic space, economic and ecological sustainability, partly due to ignorance but largely due to indifference based on their exclusive opportunities to externalise the costs, i.e. to have others to suffer the consequences. Therefore, ownership and participation rights are key to ensure equitability and a careful resource management style that counters risk by diversification and small scale. There is no good reason why solar panels and wind turbines should not coexist with livestock and wildlife to extract high amounts of energy from the drylands. But the best way of ensuring equity seems to marry the existing complex system of ownership with green electricity production (except from biofuel, which does not make economic sense in the OTR in terms of optimal landscape productivity) with communal land owners and industrial actors working together in maintenance and sharing profits. Mega-project can displace and disenfranchise people to fill a few deep pockets, but, on the other hand, every house and compound can be solar-roofed and the savannah can be dotted with panels, power dripping into many smaller pockets by the minute and enable new strategies of livestock management. OTR could become a landscape of 'clean energy communities' as decentralized sub-structures of larger energy systems and markets.[62]

'Traditional' energy management, equitable modernisation & the role of research

Pastoralist neighbourhood organisations maintain remarkably tight control over the use of the pasture, water and other natural resources, but accommodate migrating herders normally at least for a time, as everyone can at some point depend on that.[63] The same management system is increasingly used for assets like fuel wood, charcoal, sand and stones (for construction), etc., realising *community ownership* ideals of development theorists without external assistance, though in a permanent struggle against profiteers. In spite of rampant destitution, joblessness and hunger, they largely manage to keep riverine forests, tree and shrub savannahs and other vital ecosystems intact and healthy.* Perceiving deviations from international standards as deficiencies, development actors still miss to see and integrate their potential.[64]* Global, national and local development discourses continue to ignore their economic achievements and social importance. Though often presented as "new" visions and emancipation efforts, they perpetuate colonial and post-colonial traditions of denial and nurture authoritarian imaginaries of large-scale 'modernisation' through 'productivity-enhancing technologies', veiling the accumulative and thus political character of technocratic dispossession with notions of cultural superiority and inexpensive promises of growing wealth.[65]

Tales of inadequacy of indigenous commons regimes legitimise accumulation by dispossession and abet destructive pursuit of short-term gain, but they also build on the actual ignorance of funders and decision makers of key facts and relationships. Though defining maximum sustainable yield is not only difficult to define for a particular resource but even more so for a complex socio-ecological system with competing actors, antagonistic and contrary strategies, trying to do so is a key task that can only be performed adequately if all pertinent actors cooperate. Researchers might be particularly well-placed to stimulate the necessary dialogue between locals, experts, practitioners and policy makers. Thanks to a lively culture of interaction, they are already a vanguard in the production of understanding across social boundaries.

(5) Endnotes

[1] See e.g. Barnett 2009; Barnett & Adger 2007; Bernauer et al 2012; Boyer 2014; Buhaug 2016; Buhaug et al 2014; Devereux & Edwards 2004; Devlin et al 2014; Grandcolas & Pellens 2016; Heinberg 2003; Hertsgaard 2013; Heshmati et al 2019; Homer-Dixon 1999; Love & Isenhour 2016; Pearson & Newman 2019; Raleigh & Urdal 2007; Reuveny 2007; Szeman & Boyer 2017; Theisen et al 2013; Vaske 2014; for the wider region see Abbink 2018; Adano et al 2012; Angassa et al 2012; Ayana et al 2016; Behnke & Kerven 2013; Blackwell 2010 ; Bryan et al 2009; Buhaug et al 2015; Busby et al 2014; Campbell et al 2009 ; Collier et al 2008; Davidson et al 2003; Detges 2017 ; Egeru 2016; Egeru et al 2014; Ellis & Galvin 1994; Fana & Asnake 2012; Flintan & Tamrat 2002; Gabbert 2018; Gartzke 2012; Ide et al 2014; Johnson & Anderson 1988; Kumssa & Jones 2010 ; Meier et al 2007; Mekonnen 2018; Notenbaert et al 2007; O'Loughlin et al 2012; Omondi 2012; Pantuliano & Pavanello 2009; Powers 2011; Raleigh & Kniveton 2012; Sabala 2013; Salih et al 2001; Sawas et al 2018; Schilling et al 2015, 2013; Theisen 2012; Tierney et al 2015; Uexküll 2014; Van Baalen & Mobjörk 2017; Waila et al 2018; Wandiga et al 2016; Yoshiko 2014;**

[2] See e.g. Adams 2009; Boyer 2014, 2011; Burke & Stephens 2018; Cash 2018; Cross 2013; Gui & MacGill 2018; Henning 2005; Hornborg 2018; IRENA 2018; Jasanoff 2018; King & Zhao 2016; Love & Isenhour 2016; REN21 2017; Sawas et al 2018 ; Smil 2017; Srivastava 1999; Szeman & Boyer 2017.

[3] See e.g. Alem et al 2016; Byrne et al 2018; Egeru et al 2014; Kombe & Muguthu 2018; Kumssa & Jones 2010 ; Lai et al 2017; Ochola et al 2014 ; Odhiambo 2015; Onyango & Varet 2016 ; Patel 2015 ; Patey 2014 ; Pschetz et al 2018 ; Sawas et al 2018 ; Schilling et al 2018, 2015 ; Van Baalen & Mobjörk 2017 ; Vasquez 2013 ; Winther et al 2018.

[4] Anderson & Bollig 2016; Avery & Tebbs 2018; Blackwell 2010 ; Bollig & Anderson 2018 ; Broch-Due 1999 ; Bryan et al 2009 ; Butler & Gates 2012; Butzer 1983 ; Catley, Lind & Scoones 2013; Chritz et al 2019 ; Detges 2017 ; Eulenberger et al 2019 ; EUTF 2016; Fana & Asnake 2012; Gowlett 1988; Hodbod et al 2019 ; Hogg 1987; Ide et al 2014; Johnson & Anderson 1988; Knaute 2009; Le Ster 2011; Lind & Sturman 2002; Little et al 2001; McPeak et al 2012; Mekonnen 2018; Schilling et al 2015; Stevenson 2018; Tierney et al 2015; Tornay, 1993, 1979; Waila et al 2018; Wandiga et al 2016

[5] See e.g. Adano et al 2012, Adem et al 2012; Anderson & Rolandsen 2014 ; Belshaw & Malinga 1999; Bollig 1990; Busby et al 2014; Butler & Gates 2012; Campbell et al 2009 ; Detges 2017, 2014 ; Donham & James 2002; Ember et al 2014, 2013, 2012; Eulenberger et al 2019 ; Fukui & Turton 1979; Galati 2005, 1991; Gray et al 2003 ; HSBA 2010 ; Ide et al 2014 ; Knighton 2006; Krätli & Swift 2001; Kurimoto & Simonse 1998; Lind 2003; Okumu et al 2017; Pike et al 2018, 2010 ; Rolandsen & Anderson 2015 ; Salih et al 2001 ; Schlee & Watson 2009; Smidt & Abraham 2007; Stites & Howe 2019; Stites, Fries & Akabwai 2010; Turton 1991; Van Baalen & Mobjörk 2017 ; Wandiga et al 2016.

[6] See e.g. Shakow 1981 ; Wakhungu 1993.

[7] See e.g. Avery & Tebbs 2018; Behnke & Kerven 2013; Buffavand 2016; Clack & Brittain 2018; Fana & Asnake 2012; Hodbod et al. 2019; Kamski 2016; Oakland Institute 2011; Stevenson 2018; Tewolde & Fana 2014; for a parallel Kenyan case, the Tana delta, see Pickmeier 2014.

[8] See e.g. Kombe & Muguthu 2018; Onyango & Varet 2016 ; Patel 2015 ;

[9] On hydropower development and biofuel production see e.g.**; on wind power development see e.g.

[10] Lucid analyses of these coherencies are Price 1995 and Harris & Johnson 2007:60ff.

[11] See Coppock et al 1986; Coughenour et al 1985; Little & Leslie 1999.

[12] See e.g. Behnke & Kerven 2013; Harris & Johnson 2007:60ff.; Hogg 1987, 1985; Little & Leslie 1999; Price 1995; Smil 2017; see also footnote 1 on the research project looking, among other things, on such energy budgets.*

[13] Gray et al 2003; Pike 2019; Pike et al 2018, 2010 study health costs of pastoralist violence.

[14] See e.g. Arnson & Zartman 2005; Ballentine 2003; Barnett 2009; Barnett & Adger 2007; Berdal & Malone 2000; Bernauer et al 2012; Brush 1996; Durham 1976; Ember & Ember 1992a+b; Ferguson 1990, 1984; Fukui & Turton 1979; Gleditsch 2012; Harris 1974, 1977; Heinberg 2003; Helbling 2006; Homer-Dixon 1999; Le Billon 2001; Lind & Sturman 2002; Myers 1992; Harris 1977; Raleigh & Urdal 2007; Rappaport 1968; Reuveny 2007; Scheffran et al 2012; Schlee 2008; Schnurr & Swatuk 2012; Sweet 1965; Suliman 1999; Swain & Öjendal 2018; Theisen et al 2013; Vayda 1976, 1969;

[15] See e.g. Adano et al 2012; Adem et al 2012; Ayana et al 2016; Bob & Bronkhorst 2014; Butler & Gates 2012; Campbell et al 2009 ; Detges 2017, 2014; Ember et al 2014, 2013, 2012; Fukui & Turton 1979; Ide et al 2014; O'Loughlin et al 2012; Omondi 2012; Raleigh & Kniveton 2012; Sabala 2013; Schilling et al 2014; Schlee 2008; Theisen 2012; Turton 1999; Van Baalen & Mobjörk 2017; Witsenburg & Adano 2012; Waila et al 2018; Yoshiko 2014;**

[16] Adano et al 2012; Adem et al 2012; Detges 2014; Ember 2014, 2013, 2012; Witsenburg & Adano 2012.

[17] See e.g. Vayda 2009.

[18] Almagor 1979; Bassi 2011; Fukui & Turton 1979; Kurimoto & Simonse 1998; Lamphear 1993, 1992, 1988; Tornay, 1993, 1979; Turton 1999, 1991

[19] See e.g. Almagor 1979; Anderson 2004; Dyson-Hudson, Abbink 2009; Adano et al 2012; Adem et al 2012; Akabwai et al 2007; Bollig & Österle 2007; Bollig 1990; Bollig & Anderson 2018; Donham & James 2002; Eaton 2010, 2008a; Eulenberger 2014, 2013; Fana & Asnake 2012; Fleisher 2002, 2000, 1998; Fukui & Turton 1979; Galaty 2005; Girke 2008; Gulliver 1951; Johnson & Anderson 1988; Knaute 2009; Knighton 2010, 2006a, 2003; Krätli & Swift 2001; Kurimoto & Simonse 1998; Lamphear 1993, 1992, 1988; Lind 2017, 2015, 2003; Lokiyo 2014; McCabe 2004; Meinert & Reynolds Whyte 2017; Mkutu 2017, 2014; Mulugeta 2016, 2015, 2014; Schlee 2008; Schlee & Watson 2009; Smidt & Abraham 2007; Stites & Howe 2019; Stites & Marshak 2016; Stites, Fries & Akabwai 2010; Stites & Akabwai 2010, 2009; Stites & Huisman 2010; Straight 2009; Tornay 2009, 1993, 1979; Turton 1999, 1991

[20] Coppock et al 1986; Coughenour et al 1985; Little & Leslie 1999; McCabe 2004; Wandiga et al 2016.

[21] Eulenberger 2018, 2015, 2013; Glowacki & Wrangham 2015; Helbling 2006; Lind 2003; Lind & Sturman 2002;

[22] Abbink 2009; Bevan 2007; Buchanan-Smith & Lind 2005; Butler & Gates 2012; Eulenberger 2018, 2015, 2013; Gartrell 1985; Knighton 2007, 2006; Kurimoto & Simonse 1998; Mirzeler & Young 2000; Mulugeta 2016, 2015; Sagawa 2010; Schlee 2008; Tornay 2009, 1993.

[23] Abbink 2009; Buchanan-Smith & Lind 2005; Eaton 2010, 2008; Eulenberger 2015, 2013; Helbling*; Lamphear 1993, 1992; Schlee 2008; Tornay 2009, 1993.

[24] Akabwai et al 2007; Eaton 2010, 2008; Fleisher 2002, 2000, 1998; Menkhaus 2015 ; Mkutu 2017, 2010;

[25] Galaty 2005; Johnson & Anderson 1988; Mkutu 2017, 2010; Stites & Howe 2019; Stites & Marshak 2016; Stites & Huisman 2010; Stites et al 2010; Wood 2014;*

[26] See e.g. Krätli & Swift 2001; Mkutu 2917; Schilling et al 2012; on Africa in general Detges 2017; Berdal & Malone 2000; Ballentine 2003.

[27] Anderson & Rolandsen 2014 ; Bainomugisha et al 2007; Berhane & Tefera 2018; Beyene 2017; Bollig 1990; Bollig & Österle 2007; Eulenberger 2018, 2015, 2013; Greiner 2013, Menkhaus 2015 ; Lind 2003; Okumu et al 2017; Schlee & Shongolo 2012; Schlee & Watson 2009; Straight 2009.

[28] Change is foregrounded in a large number of (sometimes thorough, sometimes more shallow) studies, including Buchanan-Smith & Lind 2005, Meier et al 2007, Greiner 2013, Schilling et al 2015, 2012, etc.

[29] See Knighton 2007, 2006 for a critical review, Simala & Amutabi 2005 for a flight of academic fancy.

[30] See e.g. Hendrickson et al 1996, 1998; Meier et al 2007 ; Menkhaus 2015 ; Simala & Amutabi. Good replies to these theses were given by Knighton 2007, 2006, Eaton 2008, Sagawa 2010, Mulugeta 2016, 2015 and others.

[31] I want to cite here only one (Powers 2011) of special thematic relevance, published by a UN Intergovernmental Committee of Experts.
[32] See e.g. Barnett 2009; Duffield 2005; Gartzke 2012; Mirumachi et al 2019*
[33] All three figures are from Eulenberger et al 2018.
[34] Turkana County Government (2015) Turkana County Investment Plan 2016-2020. http://www.ke.undp.org/content/dam/kenya/docs/Democratic%20Governance/TURKANA%20COUNTY%20INVESTMENT%20PLAN%20-%2027TH%20NOVEMBER%202015.pdf
[35] Adams 1989; KVDA 2018
[36] KenGen 2018a
[37] See Bollig 1990*; Lokiyo 2014*; interviews 2008-2018.
[38] KenGen 2018a
[39] See e.g. Lokiyo 2014, Mkutu+ Wandera 2016
[40] See Hogg 1987a+b, 1985.*
[41] See e.g. Dyson-Hudson 1966:81ff.; Dyson-Hudson & Dyson-Hudson 1999; Gulliver 1951, 1955; Homewood et al. 2012:16; Johnson 1999; Khazanov & Schlee, eds. 2012; Little & Leslie, eds. 1999; McCabe 2007:57f.;
[42] See e.g. (by date) Eulenberger 2015; Krätli 2015; Abbink et al 2014; Galaty 2014, 2013a+b; Little & McPeak 2014; Mulugeta 2014; Behnke & Kerven 2013; Catley, Lind & Scoones 2013; Schlee 2013, 2010; Fana & Asnake 2012; Levine 2010; Stites & Huisman 2010; Knaute (ed.) 2009; Tornay 2009, 1981; Bollig & Österle 2008; Galvin et al 2008; Knaute & Kagan 2008; Wolputte & Verswijver 2004; Barrow & Mlenge 2003; Little et al 2001; Anderson & Broch-Due 1999; Fratkin & McCabe 1999; Little & Leslie 1999; Hogg, ed. 1997; Schultz 1997, 1996; Little 1996; Scoones 1995; Behnke, Scoones & Kerven 1993; Galaty & Johnson 1990; Odegi-Awuondo 1990; Barrow 1988; Johnson & Anderson 1988; Hogg 1987, 1985; Galaty et al 1981; Dyson-Hudson 1966.
[43] See also Abbink et al 2014; Behnke & Kerven 2013a; Catley, Lind & Scoones 2013*; Galaty 2013; Krätli et al (IIED) 2015:11f.; Schlee 2015:121f.,134f., passim, 2013.
[44] See Clack & Brittain 2018; Carr 2016 ; Bassi 2011; Gabbert & Thubauville 2010; the zone covers c.24,000 sqkm with over 0.8m inhabitants (EUTF [Fana & Tefera] 2016).
[45] See e.g. Avery & Tebbs 2019; Butzer 1970; Hodbod et al 2019; Gownaris et al 2016.*
[46] See e.g. Bassi 2011; Carr 2016 ; Eulenberger et al 2019, 2018; EUTF [Fana & Tefera] 2016; Gabbert & Thubauville 2010; Hodbod et al 2019.
[47] Salini Impregilo 2016, cit. Hodbod et al 2019.
[48] Hodbod et al 2019.
[49] Abbink et al 2014; Africa Confidential 2017; Allibhai 2015; Arnold 2013; Avery & Tebbs 2018; Behnke & Kerven 2013; Buffavand 2016; Carr 2016 ; Cohen et al 2015; Fana & Asnake 2012; Fong 2015; Gownaris 2016; Hodbod et al 2019 ; HRW 2015, 2012; Kelley 2015; Mosley & Watson 2016; Oakland Institute 2011; Oluoch 2015; Regassa et al 2018; Stevenson 2018; Stevenson & Buffavand 2018; Tewolde & Fana 2014; UNEP 2013.
[50] REN21 2017.
[51] KenGen 2018b;*
[52] Otuki 2018; Patel 2015 writes of 579 MW.
[53] KenGen 2018b;*
[54] Patel 2015
[55] Exploration here started in 1955. In 1970 KenGen and UNDP started systematic development and commercial electricity generation (15 MW) began in 1981. A second 15 MW turbine came online in December 1982 and a third in March 1985, bringing total output up to 45 MW of which 3.3MW is used to power the station itself. Currently, KenGen runs the Olkaria I (185 MW) and Olkaria II (105 MW) power plants (KenGen 2018; Otieno & Awange 2006:49f.; Otuki 2018; Patel 2015; REW 2012; Sack 2006). It uses funds from the Japan International Cooperation Agency (JICA) and the European Investment Bank (EIB) to increasing their capacity and building Olkaria IV, adding 280 MW (Bungane 2016; EIB 2010; Otuki 2018; Patel 2015; Sack 2006) and Olkaria V (140MW, s.Crichton 2016). Olkaria III (48 MW) is privately owned capacity, set to be upgraded to 100 MW and will likely qualify for carbon credits under the Kyoto Protocol's Clean Development Mechanism (s. op cit.). However, there is conflict, especially with resident Maasai communities, over land rights, socio-economic and ecological costs.** After full operationalization of Olkaria IV, Kenya is expected to produce c. 47% geothermal, 39% hydro, 13% thermal and 1% wind power (KenGen 2018b, Sack 2006)*.
[56] Interviews July-August 2018.
[57] Greiner 2016, 2013: 226, 233; Lokiyo 2014; Mkutu & Wandera 2016:20; on the history of the inter-ethnic conflict see e.g. Bollig 1990; Bollig & Österle 2007.
[58] See Achiba 2019; Cormack & Kurewa 2018; Kazimierczuk 2019; Schilling et al 2018.

[59] African Development Bank Group 2017

[60] Muchira 2018.

[61] Achiba 2019; Republic of Kenya 2014, 2016.

[62] Gui & MacGill 2018, Hertsgaard 2013.

[63] I did extensive interviews on this in 2015. See e.g. Barrow & Mlenge 2003; Barrow 1988; Eulenberger 2018; Dyson-Hudson 1966; Gulliver 1951.

[64] Catley, Lind & Scoones 2013:2; Eulenberger 2018;**

[65] See e.g. Abbink et al 2014; Achiba 2019; Anderson 2002; Anderson & Bollig 2018; Buffavand 2016; Catley, Lind & Scoones 2013; Ferguson 2003 (1994); Galaty 2013; Hogg 1987b; Makki 2014; Mosley & Watson 2016; Robinson 2009; Salih et al 2001; Schlee 2013; Stevenson 2018.*