Persistence and changes in the peripheral Beles basin of Ethiopia

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Abstract

We have investigated the relevance of the notion of "peripheralism" in the Beles basin. In this lowland border area of Ethiopia, important investments require an evaluation of their socio-economic and ecological impacts in the light of Ethiopia's Climate-Resilient Green Economy (CRGE) strategy. We contrasted literature of different periods with field observations. In the middle and lower basin, the Gumuz people traditionally practiced shifting cultivation. Resettlement of highlanders is particularly linked to water and land resources. A large irrigation project was initiated in the 1980s, but vegetables and fruits face post-harvest losses. Large water transfers from Lake Tana since 2010 affect the movement of people, the hydrogeomorphology and ecology of the river. In several parts of the basin, the settlers' economy now dominates. Many Gumuz became sedentary but maintained their agricultural system, particularly in the south of the lower basin. Land titling allowed allocation of "vacant" areas to transnational or domestic investors. As a result, the semi-natural vegetation is frequently replaced by open cropland, leading to decreased carbon storage and increased soil erosion. This, and water abstraction for irrigation jeopardises hydropower production, in contradiction with the CRGE objectives. Despite the recent developments, the contrasts in economic activity make the core-periphery dichotomy to remain actual in the Beles basin. The resettlements and permanent cropping tend to make the upper basin part of the core. However, the installation of a transit road and commercial farms in the lower basin do not allow to consider that a non-peripheral integration has taken place.

Keywords Africa South of the Sahara, peripheralisation, non-peripheral integration, Gumuz, sustainable development, water, internal migration

Number of words: 8054

Introduction

When the spatial structure of an area is cast in terms of uneven development, it is often conceptualised by means of a "core-periphery model" (Brown et al. 2010). The "core" area consists of those places that wield the greatest economic power and have accumulated the highest levels of affluence. These are the places and regions *for which* the system creates development. The "periphery" lacks a stable power base, is characterised by a lack of wealth, and serves as supplier of capital, labour or commodities to the core. These are regions *through which* the system creates development. Although most concepts or measures of uneven development would identify a continuum rather than a dichotomy (Scott 2012), the very core-periphery thinking provides geographers with a useful analytical framework, as it highlights that uneven development needs to be understood from a relational point of view (Brown et al. 2010). Indeed, the crux of the core-periphery model is that it seeks to explicitly grasp the vicious cycle of the 'development of underdevelopment' characterising peripheries (Frank 1971).

This conceptualisation contrasts with the more traditional regional-geographical concept of a "periphery", which is used to identify places or regions that are distant from a centre or situated on the fringes of a city, region or country. The use of the term periphery in a core-periphery model points to on-going *processes* of "peripheralisation"; the production an accumulation base through uneven socio-economic relations across space (Kühn 2015).

Core and periphery very often remain in place, in spite of major changes in socio-economic activities. The resources being extracted and the low value-added commodities provided by the periphery may change over time. However, this does not herald a fundamental change in a region's peripheral status. Rather than specific socio-economic activities and processes, therefore, both core and periphery are defined by persisting, uneven *exchanges*. Although the core-periphery model is most commonly marshalled to conceptualize uneven development in the world (Knox et al. 2014) it has been deployed at various scales to grasp persisting patterns of uneven development (Friedmann 1966; Hoggart and Buller 2015; Labrianidis 2017). It can also be treated as a hypothesis to be tested (Arrighi and Drangel 1986), by examining whether core-periphery contrasts increase through time, or are rather being subdued, leading to "deperipheralisation" (Colmeiro 2018) or "non-peripheral integration" (Arrighi 1979). It is in this framework that, in this paper, we adopt the notion of peripheralisation to conceptualise and empirically document persistence and changes in the Beles basin of Ethiopia.

Ethiopia presents an interesting case in this regard, as the agriculture-based civilisation that developed in the northern highlands (McCann 1995) could use its topographic and socio-economic advantages to develop a state that remained independent (Scaetta 1935). As the only African country that was never colonised, Ethiopia could incorporate besides the northern highlands, the southern highlands, and lowland areas located at its eastern, southern and western margins through the 18th and 19th century (Bahru Zewde 2002). It has often been claimed that especially the lowland areas of Ethiopia have remained peripheral in both senses of Kühn's concept (2014): both in terms of topography and distance, as well as in terms of how its development, its economic and human rights have been defined in unequal power relations. Markakis (2011) for instance considers two partly overlapping concepts: the dichotomy between highlands and lowlands, and a more politically defined concept of concentration of power in the hands of central, highland elites that rule with the help of dominated peripheral elites and migrations of highlanders to the lowlands.

At the onset of the 21st Century, the Climate Resilient Green Economy (CRGE) strategy has become the framework of Ethiopia's developmental activities (Death 2015; Jones and Carabine 2013). The CRGE is based on four pillars: (i) crop and livestock for food security and farmer income while reducing emissions; (ii) forests for their economic and ecosystem services, including carbon stocks; (iii) electricity generation from renewable sources of energy; and (iv) energy-efficient technologies in transport, building and industrial sectors (FDRE 2011).

Here we investigate the relevance of the notions of "core" and "periphery" in the geographically peripheral Beles basin, a region situated at the western margin of the Ethiopian highlands which is characterised by a very different environment and indigenous culture, and where recent important investments have taken place in the framework of the CRGE. Hence, we explored the regional human-environment interactions in this basin, as well as the important changes that occurred over the last fifty years. In recent decades, important changes have occurred in relation to road building, resettlement, international land deals, irrigation and water transfers, which makes the region exemplary for remote area development (Pelican 2009; Saugestad 2001) in Africa South of the Sahara. After introducing the Beles catchment, we review the existing literature. First, the scene is set through a detailed presentation of the abiotic, biotic, historical, social and cultural characteristics of the study area. Then, the processes of change (and persistence), particularly in relation to water, migration, infrastructure and socio-cultural relations are reviewed starting from the first account by Emperor Sertse Dengel's chronicler (ca. 1590). Notably, we compare the current situation with that of around 1960, as described in "Land, economy and settlement of the Gumuz" (Kuls 1962). Based on the observed human, climatic, geological and agricultural characteristics, we (i) propose a regionalisation of the Beles basin; (ii) identify knowledge gaps; (iii) investigate to what extent persistence and changes align with the CRGE strategy, and (iv) assess the emerging or likely implications for land, water, biodiversity, cropping and livelihood; to finally (v) analyse whether the changing conditions of the Beles basin at the beginning of the 21^{st} C are translated into deperipheralisation.

Research methodology

We compiled an extensive review based on existing scientific papers (using Web of Science) as well as grey literature (reports, master theses, etc.) regarding the Beles basin. The latter were retrieved from the different co-authors' thematical archives as well as through visits to district offices in the basin.

In addition to disciplinary investigations, multidisciplinary field visits were undertaken along the route Guba – Gublack – Manbuk – Gilgel Beles – Mandura – Chagni (Fig. 1), with lateral incursions at many places, including Gumuz settlements and commercial farms west of Gublack, the middle Beles basin around Pawe, and the slopes of Belaya Mountain. Additional visits were made to the upper part of the Beles basin which could be accessed through service roads prepared for the Tana-Beles hydropower installation, and further on foot.

To integrate and conceptualise the disciplinary and interdisciplinary information collected, three brainstorming workshops among co-authors took place on 25-29/1/2016 in Brussels, on 11-14/11/2016 in Dangur, and on 18-20/1/2017 in Bahir Dar and the Beles basin.

The Beles basin in northwest Ethiopia

Study area

The Beles basin (Fig. 1) drains 13 571 km² of the Western Ethiopian escarpment and its foot slopes towards the Blue Nile. The basin, with elevations ranging between 577 and 2755 m a.s.l. is mainly inhabited by Gumuz people (Simons and Fennig 2017; Fig. 2), who are also the least defensible and resilient population group of the basin (González-Ruibal et al. 2007; Swedesurvey 2010). Until not so long ago (Kuls 1962), the edge of the escarpment marked the beginning of an entirely different world that was largely inaccessible, inhabited by the

Gumuz people with very different culture as compared to the highlanders, and also a totally different agroecology and agricultural system.

Physical geography

The geology of the Beles basin comprises extensive Tertiary trap basalts and strongly folded and faulted Precambrian rocks (Fig. S1, Fig. S2). Mesozoic sedimentary rocks make up thin intercalations between both major formations.

Annual rainfall shows a unimodal distribution and is well over 1000 mm yr^{-1} (Fig. S3). Maximum temperatures rise high, up to 40 °C in early afternoon in the lower parts of the basin, with a daily contrast that is stronger than the seasonal contrast. Global warming tends to lead to slightly increased rainfall over the basin by the end of the 21st Century (Barnes 2017).

The Beles River, originating from the south-western escarpment of Lake Tana water divide, is a perennial river flowing towards the Blue Nile. At the foot of the escarpments of the highlands and also of inselbergs, it is quite common to observe springs (Fig. S4). Few studies attempted to estimate flows at various points in the basin using rainfall-runoff models, whereby results indicate that the total runoff generated in the Beles basin would be approx. 5,690 10^6 m^3 yr^{-1} what corresponds to a runoff depth of 407 mm yr^{-1} (World Bank 2008).

Groundwater occurs in Quaternary unconsolidated deposits (within the upper few tens of metres) in the relatively flat lands, and in fractured rocks or along major regional faults at shallow to intermediate depth. The general groundwater flow is from elevated recharge areas to low-lying discharge areas (Seifu Kebede 2013). The presence of deep-seated geological structures, as well as that of ancient fluviatile deposits and several episodes of volcanism in the Tana area (Hautot et al. 2006; Prave et al. 2016) may favour inter-basin groundwater flow from Tana basin to Beles basin, which needs a critical investigation.

The larger part of the Beles basin consists of "dry combretum wooded grassland" (Friis et al. 2010). Characteristic species are different Combretaceae; further, and particularly close to the step to the highlands, very often *Syzygium guineense*, *Gardenia* (a sacred tree for the Gumuz who call it 'kota') and *Protea* are found. The understorey is a combination of herbs and up to 3 m high grasses. Many of the species have developed under the influence of recurring fire and as a result the trees have evolved very thick bark while most herbs developed perennial bulbs (IBC 2005). The Beles River is accompanied by narrow riparian forest strips (dominated by *Syzygium guineense*), and on its extensive gravel fields *Tamarix* sp. settles easily. Extensive lowland bamboo stands (*Oxytenanthera*) accompany the entire western edge of Ethiopian highlands and also penetrate into the larger westbound valleys (Kassahun Embaye 2000). On the Wombera, Dangur and Belaya Mountains, the natural vegetation is a moisture-loving mountain forest, composed of *Hagenia abyssinica* and *Podocarpus gracilior*. The biophysical environment of the Beles basin is further described with much detail in the Electronic Supplementary Material (https://link.springer.com/xxx)

Settlement and resettlement

The Gumuz used to live in the highlands but were through the centuries pushed towards the less accessible yet fertile bush-savanna lowland environment through the expansion of the Amhara and Agaw (James 1986; Swedesurvey 2010). They were also exposed to perpetual slave raids by highlanders and Sudanese, both for their own use and for sale to the Arab world (Ahmad 1999; González-Ruibal et al. 2007; Markakis 2011; Pankhurst 1977). Slavery only disappeared from Ethiopia in the 1930s-1940s (Edwards 1982; Miers 1997). The Gumuz of today still have vivid memories of the slave raids, which occurred as recently as the 1930s (Ahmad 1999; Swedesurvey 2010). Crop production in Beles basin took already place in 1586, as Emperor Sertse Dengel's chronicler (ca. 1590) reported that after "taking lots of cattle and slaves" in a hot plain near a large water (presumably Beles River), "the king sent out his troops to pillage grain and burn houses" on the slopes of Mount Belaya.

Neighbouring ancient population groups within the Beles basin are living in higher elevated places: Agaw on Mt. Belaya and the upper catchment, Amhara in the headwaters, and Shinasha on Mt. Dangur and around Wombera (Fig. 2). According to oral transmission, the Agaw would have come to Mt. Belaya around 1600 CE. The Beles basin roughly comprises the districts of Metekel zone in Benishangul-Gumuz region, as well as parts of three districts of the neighbouring Amhara region. For an analysis of the complex historical relations between different population groups in the region and its neighbours, the reader is further referred to González-Ruibal et al. (2007), Wolde-Selassie Abbute (2002), Markakis (2011) and Temesgen Gebeyehu (2018).

Resettlement to the Beles basin lowlands, which lie in the Benishangul-Gumuz region, is particularly linked to its land and water resources. The potential for irrigated agriculture is estimated at 115 000 ha (World Bank 2008). The establishment of roads and large commercial farms as of the year 2000 enhanced changes in many places in the basin. In 2010, a drastic change came with the operation of the Tana-Beles hydropower scheme that transfers large volumes of water from Lake Tana directly to the Beles River via a 12-km long tunnel to generate 460 MW hydroelectric power (Clark et al. 2013). Since the 1920s and 1930s such a hydropower scheme had been considered (Grabham and Black 1925; Hårsmar et al. 2016), and anticipating on large inter-basin water transfers, the Ethiopian Government organized infrastructure works and population resettlement to the middle Beles basin in the 1980s. The most recent change is the construction of the Grand Ethiopian Renaissance Dam (GERD, or *hidase* in Amharic) that will eventually lead to flooding of lower stretches of the Beles basin (Fig. 1).

Results

Persistence and changes in the Gumuz society

Gumuz is one of the ethnic groups in the northwestern part of Ethiopia, with ten clans, each having their own territory. The Gumuz language belongs to the Nilo-Saharan family (Ahland 2012). At the last census, the total population of Gumuz in Ethiopia was 179,348 (CSA 2008), as well as approx. 40,000 in Sudan (Simons and Fennig 2017). Kuls (1962) estimated that there were around 20,000 Gumuz in the Beles basin. Currently, an estimate of 80,000 Gumuz people residing in the Beles basin seems reasonable. The pressure of the more powerful Afroasiatic (Amhara and Agaw) people on the Gumuz territory continues in the 21st century (Wolde-Selassie Abbute 2002). The Gumuz practice shifting cultivation, collect wild fruits, roots, seeds and honey. Hunting (Fig. S7) and fishing complement the diet. Fishing takes place with nets as mentioned by Kuls (1962) but also increasingly through the use of poisons such as *Millettia ferruginea* seed, bark, and agrochemicals that are dangerous for the whole aquatic ecosystem. These fishers aim at harvesting all fish from a water body at a time for the dry fish market. Such poisoning with agricultural chemicals is seasonal and occurs mostly during Orthodox fasting seasons.

Traditionally, and nowadays still in the majority, the shifting cultivation also involves frequent shifting of villages that are constructed in light materials (Fig. 3). Permanent Gumuz settlements now have come into existence, which do not differ much from the ‘mobile’ settlements described and mapped by Kuls, with the notable exception of ‘home gardens’ that have become squared in relation to more densely populated settlements. Granaries are decorated with male and female genitals (Fig. S8); Kuls (1962) mentioned and illustrated other decorations such as gift bowls or breasts. Either there has been an evolution in decorations, or most probably decorations (always related to fertility) vary among clans.

In addition, the Gumuz depend on other subsidiary livelihood sources such as traditional gold mining, firewood collection, charcoal preparation and handicrafts (Tsegaye Moreda 2015). The Gumuz people also nurture traditional medicinal plants to solve health-related problems. The livelihood of Gumuz communities depends mostly on nature because of marginalisation and low orientation to technology. The Gumuz practice polygamy and exchange marriage, i.e. the man proposes a female relative (generally a sister), as wife to the brother of his bride (James 1986; Meron Zeleke 2010). Girls marry early and move to the homestead of their husband; as marriage is not allowed within the same clan, they generally move to a place that is quite far away. Going to stay with their husband means having to get to know his relatives, his clan, and a new environment. “This makes young wives shy, often scared” (Swedesurvey 2010). An in-depth study of gender issues among the Gumuz of the Beles basin was carried out by Meron Zeleke (2010).

Male elders exercise traditional administrative and judicial responsibilities for all clan members (Swedesurvey 2010). In recent years these elders, *obusuma* in Gumuz language, have also taken up government responsibilities, what has led locally to loss of legitimacy.

In remote places in the northern part of the lower Beles basin, and especially in its less accessible southern part, the ancient Gumuz shifting cultivation farming system has persisted. Currently, the customary land tenure system co-exists with the formal land policy formulated by the regional government, since land registration and certification is at its early stage. The Gumuz usually have large areas of communal land which is used as grazing field, for collection of firewood, honey, and wild fruits, or for slash and burn agriculture (Yntiso Gebre 2003). There are two traditional types of land ownership: (i) community ownership and (ii) lineage groups' ownership. In the case of the community ownership, all members of the community of a given area have the right of ownership on cultivable virgin lands, forests, grazing lands and river banks, whereas under the lineage groups' ownership clan members and their descendants have the right of possession as well as passing to their family members. In the Gumuz community, this right is applicable as long as they live in the lineage group. If they leave the group, whatever the case, their possession right ceases (Mekuria Jira 2008). Collective land ownership rights are administered by the clan system (Ahmad 1999). The clan is considered the owner of the natural resources; individual members are accorded only usufruct rights. Therefore, the resources cannot be possessed or controlled by single members of the community. Elders select the appropriate location for a hamlet based on both vegetation and soil types. Inter-clan relations require recognition of each other's territories and rights. Natural landmarks such as rivers, hills, big trees, rocks, roads or footpaths mark the territory of a clan.

Gumuz and settlers' agricultural systems and commercial farming

Patchwise, the centuries-old Gumuz agricultural system which was described in much detail by Kuls (1962) has been maintained till now. It involves shifting cultivation, and the main tool used for land clearing and preparation are fire (Fig. S9) and the *tiba*, a hoe of which the blade is inserted approx. at a 45° angle (Fig. S10), which must be unique worldwide.

Direct sowing of crops in a zero-tillage system is implemented, in which planting holes are made using a planting stick fitted with a sharp iron tip. Use of oxen-plough is difficult in the traditional farming system because many trees and roots remain after land clearing. "The irregularly limited farm plots are mostly quite far away from the settlements, and most of them are cultivated for only one or two years. After that, the land remains for a longer time as bush fallow" (Kuls 1962), locally called *bukuna*. Dominant crops in this agroecosystem include sorghum and sesame. Ginger, finger millet, teff and maize are grown especially around Mandura. Sorghum is the main food crop of the Gumuz people, and it is largely grown nearby settlements, because it needs protection. The fires that widely burn the Gumuz lands in the dry season is not to be considered as “deforestation”, as stated for instance by (Girma Adisu 2010) and many others, rather they are considered as a natural process, related to the large buildup of dry biomass. van Breugel et al. (2016) showed that 64% of the area was burnt at least once in the period 2003-2013. Adaptation to fire occurs in grasses, shrubs, and trees, so natural fires must have occurred long before now (Menassie Gashaw et al. 2002). Currently fire is also used as a land management technique, aiming at the removal of stover and dry grasses and provoking the emergence of shoots of fire-resistent species in the woodlands (Fig. S9). Settlers and some commercial farms have adopted the same technique of land clearing, even on permanently cultivated land. On the other hand, such practices are known to lead to decreased flora and (pedo)fauna biodiversity (Platt et al. 2012, and many others). In many tropical regions, debates are ongoing regarding pros and cons of wildfire. Indeed, the Gumuz have been encouraged to change from shifting to permanent cultivation and to establish in permanently settled villages. Land ownership became an important issue, particularly after the resettlement of highlanders, starting in the 1980s. The introduction and emergence of a modern ruling structure of the central government, made the Gumuz to own land individually. The shift of communal land ownership to the individual ownership was high in the areas that bordered non-Gumuz people and settlers (Mekuria Jira 2008). Parts of the lands that were under shifting cultivation appeared then as vacant and thus considered as potential land that was allocated for transnational or domestic investments without correct compensation to the community (Crewett et al. 2008). Starting from 2007 and following the ‘invest in Ethiopia’ call of the Ethiopian government, forests and woodlands were occupied by commercialised agriculture (Table S1). The deforestation, in turn, resulted in the declining and disappearance of wild animals, roots, and wild fruits, which are important components of the Gumuz diet (Berihun Mebratie 2004). Anticipating on such major land seizures, the Gumuz individually and increasingly rent out part of their land to settlers from the highlands without the consent of the elders (Crewett et al. 2008; Dereje Teklemariam et al. 2016). Particularly along the roads, such farmlands are increasingly cultivated using oxen-plough or informally rented tractors. For instance, in the upper Aymela catchment (Fig. S11), the part along the road was recently deforested and ploughed by tractor. At catchment scale, such tractor cultivation leads to 50% higher peak discharge (hence flooding risks) and more than doubling of sediment load (Dereje Teklemariam et al. 2017a) (Fig. S12). The traditional agricultural system of the Gumuz protects the land relatively better from erosion than commercial farming, which is explained by the smaller share of cropped area and absence of ploughing what protects the root mat (Dereje Teklemariam et al. 2017a). Wherever possible, settlers try to establish small-scale irrigation using pumped water from Beles River and its tributaries. A major problem here is the difficulty to store tomato and onion produces, particularly given the high temperatures, what leads to strong price drops at peak harvesting time compared to that at early harvests (from 25 ETB in October and November, down to 5 or even 1 ETB per kg for tomatoes, in January to early May – 1 ETB was 0.03 € on 28/2/2018). Here, tomatoes need to be marketed immediately after harvesting. Early growing and harvest incur additional costs by spraying fungicides against late and early blight diseases which are favoured by high humidity in the summer rainfall season (Melkamu Alemayehu and Getachew Alemayehu 2017).

As mentioned above, large tractor schemes have been developed since around 2000, on which crops such as cotton, sesame, maize or the biofuel tree pongamia (*Millettia pinnata*) are grown. Major companies in the lower Beles basin include S&P Energy Solutions (Dereje Teklemariam et al. 2017b). Large sugar estates were also established in the upper

Beles basin around Jawi (using irrigation water) (Clark et al. 2013), Fantini et al. 2018). Maintaining the original vegetation in 50-meter wide strips on both sides of drainage lines is compulsory in such land rental contracts, but it could only be observed in few cases (Fig. S13).

The agricultural system of the Shinasha and Agaw, as well as that of more recent settlers, is one with permanently farmed fields, very similar to that of the highlands (qualified as "permanent upland system" by Ruthenberg (1980), and as "grain-plough complex" by Westphal (1975)). On most of these lands, including the lower and middle slopes of the mountains, no soil and water conservation activities are done; the perception that there is still "enough land" leads to less care for the land. In contrast, on the most elevated places, where there is a shortage of land, stone terracing is done.

Along the escarpment a rare insight is given in environmental changes, when comparing Kuls' photographs that were taken around 1960 with repeat photographs illustrating the current situation (Fig. S14). While Girma Adisu (2010) shows a photograph of this area after burning and qualifies the annual fires as deforestation, the tree cover seems in reality to have increased over time.

From Kusa to regulated Beles River

In terms of hydrology, the Kusa (as the Beles River is called in local Gumuz language) has strongly changed: a large "Tana-Beles" irrigation project was initiated in the 1980s, and a diversion dam was built (Fig. S15), but the planned tunnel that ought to bring the water from Lake Tana was not constructed (Eguavoen 2009). The irrigation scheme itself, intended for growing rice, was never formally implemented though locally pumping irrigation is done, and vegetables, as well as tropical fruits are grown. Concomitantly with the works for the irrigation scheme, numerous numbered villages were established. For instance, the original name of the town of Pawe is “Village 7”. The idea of formally irrigating the area was put on hold till the water tunnel was ultimately opened in 2010 (Eguavoen 2009). At that time, priority was given to irrigation of sugar cane around Jawi (Fantini et al. 2018). The integrated planning and management (including the impacts on the downstream projects in Ethiopia and downstream countries that depend on the flows of the Nile) of water resources in the Beles basin is one of the researchable matters. To give a clue about the issues at stake in relation to GERD hydropower dam, which is partly fed by the Beles River: the planned command area of Tana-Beles project could be estimated at 115 000 ha. Considering that the required irrigation water has a depth of about 1.4 m per year (Sileshi Bekele et al. 2009), a corresponding annual volume of 1.6 10^9 m^3 would be abstracted from the discharge entering the GERD, which is about 3.3% of the average annual flow (49.4 10^9 m^3) used for modelling the reservoir filling strategies (Wheeler et al. 2016). If confirmed, using such an amount of water for irrigation may negatively impact the hydropower production of the GERD.

Since May 2010, the Tana-Beles project has become operational after which 55% of the Lake Tana water outflow is transferred directly through Beles River, rather than following the Blue Nile gorge (Mekete Dessie et al. 2015). Consequently, the average additional discharge of 84 m^3 s^{-1} in Beles throughout the year (Mekete Dessie et al. 2015), is a stimulus for the creation of irrigation schemes, as was already done with the establishment of 20,000 ha sugar estates at Jawi (Fantini et al., 2018). It has also become difficult and in many places impossible to cross the river, leading to problems in reaching relatives and farmlands across the river; more than 250 people have been taken by floods after the hydropower operation started (Annys et al. 2018). Another effect relates to the changed hydrogeomorphology; changing a river from highly seasonal to permanently strong discharges has consequences on its planimetric morphology (meander wavelength, river width), and on its depth. The releases from the Tana-

Beles hydropower tunnel are passed downstream along the Jehana River, a tributary of the Abat Beles, significantly changing its hydrological regime and morphology (Bewuketu Abebe 2016); in places where the river is not confined, its morphology changes from a braided to a largely meandering river. In the plains around Pawe, indicators on bridge foundations and embankments clearly show an incision (sediment scouring) by several metres (Fig. S16).

Towns get their water from springs such as the Ligitcha spring for Mandura and from boreholes (groundwater). In rural places, there are hand pumps, but springs and surface water (rivers) are also frequently used. The water supply and sanitation coverage in the region is very low. In 2004, it was only about 35% of the population that got potable water (Assefa Delesho 2006). Hence, besides the use of the land, water consumption is also a continuous source of conflict. For instance, the Gumuz people in Kota do not allow the settlers along the road to come and take water from their wells; on the other hand, companies that allow local people to take water from their installations are better accepted (Dereje Teklemariam et al. 2017b).

Migration

Whereas Kuls (1962) and Swedesurvey (2010) mention occasional migrations of highlanders to larger settlements in the Beles basin as of the 1950s, more than 100,000 people have migrated here from Wollo (N Ethiopia), Kembata (S Ethiopia) and other highland areas in the early 1980s as part of (forced) resettlement programmes (Wolde-Selassie Abbute 2002; Zanardi 2011). Some 18,000 Gumuz were displaced (Wolde-Selassie Abbute 2002). In absence of the necessary medical services the settlers suffered heavily from diseases such as schistosomiasis and malaria (Awash Teklehaimanot and Fletcher 1990; Fletcher and Awash Teklehaimanot 1989); many died or have gone back to their region of origin. Violent clashes with Gumuz at the time of overthrow of the military Derg regime around 1989-1993 also contributed to the return of settlers to the highlands (Markakis 2011). The current and ongoing wave of immigration is quite spontaneous, following the establishment of roads, agricultural investments, and towns. Employees of agricultural investment companies commonly try to obtain some cropland for themselves, for instance by renting it from Gumuz people. Several studies showed negative impacts of these resettlements on the host community (Agneta et al. 1993; Yntiso Gebre 2003). In the densely populated Pawe district, there are no more Gumuz. The settlers now recently started to cultivate the slopes, which gives them a typical 'Wollo' aspect (Fig. S17). As a response, the Agaw came down from Belaya mountain to establish homesteads, in order to secure the space.

In recent years, the GERD dam building works have also attracted an important workforce as well as petty trade near the site and along the main roads. This has attracted more settlers to the region, and along roads, the population becomes increasingly mixed. In addition, an estimated 20,000 Gumuz who were living in the impounded area and five-km buffer strip (both along Beles and Blue Nile) are being relocated to villages along roads (Veilleux 2014), which led to the expansion of towns such as Aycid.

Environmental changes

The most dramatic change is the clearance of the semi-natural vegetation and its replacement by artificial vegetation (cropland) as can be easily observed when comparing historical imagery over a few years (Fig. 4). The traditionally protected *kota* trees (*Gardenia ternifolia*) are the last ones to remain on the farmlands, but also these are frequently removed, among others through debarking.

In Benishangul-Gumuz region alone, the lowland bamboo covers an estimated area of 440,000 hectares, though gradually it is disappearing from the landscape (INBAR 2010). In contrast to a 50/50 share of woodland and bamboo mentioned by Kuls (1962), a sampling of 12 traditionally managed landscapes (between 0.5 and 15 ha each) shows that bamboo occupies 4%, woodland and forest 65% and cropland 17% and fallow 4% (Dereje Teklemariam et al. 2017a). In eight catchments under agricultural investment, there is only 3% bamboo coverage. Admittedly, Kuls' (1962) observations were mainly done in the Mandura district, which is better endowed with springs and has a somewhat milder climate, but also there, bamboo is nowadays quite rare to be observed. Pressure on bamboo stands stems from intensive use as cash income and for construction purposes, and poor regeneration due to livestock feeding, in that order (Yeshambel Mekuriaw et al. 2011). The lowland bamboo of this area has been shown to have a high potential as ruminant feed (Yeshambel Mekuriaw et al. 2012). Excavation of shoots, which are used for human food, does have less effect on the overall bamboo stands.

Discussion

Regionalisation of the landscapes in the Beles basin in terms of core and periphery

As Kuls (1962) rightly mentioned, the escarpment of the Gojjam plateau forms a striking boundary between the Ethiopian highlands and the lowlands, both with regard to the natural environment and population groups, what fits with Markakis' (2011) dual frontiers. Our findings show that the contrast between Ethiopian core and periphery demonstrated by Markakis (2011) has remained very actual in the Beles basin. The resettlements (Agneta et al. 1993; Yntiso Gebre 2003) and sugar plantations (Fantini 2018) tend to make the upper part of the Beles basin part of the core as a result of the continued crowding out of the Gumuz. The further installation of a transit road and a few (largely failed) commercial farms in the lower half of the basin do not allow to consider it as not peripheral. Hence, within the Beles basin, there are strong contrasts in population groups, infrastructure development, and agricultural systems. Changes in these variables spatially often coincide, so that more or less sharp boundaries fitting with topography and river systems can be drawn between the different geographical regions of the Beles basin. Such regional units are only meant for research purpose and not aimed at replacing, or even interfering with political or administrative boundaries which have their own rationale. The regional geographical units (Fig. 5) include:

A The uplands, sometimes with sharp boundaries corresponding to escarpments, sometimes more gradually like in the upper Beles basin. The uplands are typically inhabited by Agaw, Shinasha, and Amhara; there is a permanent cereal-based cropping system. The northern and eastern areas of these uplands are part of Amhara region. The upper Beles valley has been virtually cut into two parts, and numerous people lost their lives, due to permanent high flows in Abat Beles (Annys et al. 2018).

B The Mandura escarpment and footslopes inhabited mainly by Gumuz, Agaw, but also settlers. Gumuz have settled in permanent villages, and the permanent cereal-based cropping system prevails throughout, though the land is still burnt yearly.

C The Tana-Beles resettlement area from where the Gumuz who were still present in the 1980s (Awash Teklehaimanot and Fletcher 1990) have outmigrated over the last decades. The valley bottom is formally irrigated around Jawi, a lot of small scale irrigation elsewhere and permanent cropping expands towards the slopes. It includes the major towns Pawe and Gilgel Beles. The upstream part of these plains is part of the Amhara Region.

D The northern part of the lower Beles valley. This includes the districts Dangur and Guba, and is crossed by a major road towards Sudan and the Renaissance dam. Here numerous agricultural investment companies have been established, and many Gumuz have settled in permanent villages.

E The southern part of the lower Beles valley. It is separated from the previous region by the Beles River that can only be passed by wading, which has become increasingly difficult since even in the dry season the Beles flow is maintained at high levels. As the area is difficult of access, no major roads have been established and only a few domestic agricultural investments took place (Table S1); the Gumuz live their traditional lifestyle. This geographical unit comprises the northern lower parts of the Wombera and Bullen districts. Changes concern basic health and education infrastructure that the Ethiopian government established at numerous places, and some rural access roads, as well as potential conflicts for land with Shinasha living in the Wombera highlands. The local perception is that the Gumuz in this more isolated region with less pressure are "better off" than those in the more developed northern part of the basin. This hypothesis needs to be verified.

The modified hydrology and hydrogeology

There is a strong push to use the available water resources in the basin, mainly for irrigation, triggered by the inter-basin water transfers from Lake Tana to Beles basin, and development of commercialized agriculture including sugar cane (Fantini et al., 2018). Besides a study by the World Bank (2008), that estimated the total runoff in the Beles basin before the inter-basin transfers from Lake Tana, no studies are known that address the Beles' basins water balance, what is crucial for the Tana-Beles water contribution to the GERD hydropower scheme, hence to the CRGE. In addition, a catchment-level study (Dereje Teklemariam et al. 2017a) shows that tractor cultivation leads to 50% higher peak discharges (hence flooding risks). Sustainable water resources use and development largely depend on a profound understanding of the different water balance terms (runoff, river discharges, evapotranspiration, rainfall, groundwater, etc.), which is nearly absent in the basin.

In response to the increasing number of towns and villages, more water supply schemes are sought. Groundwater of Beles basin is the least studied and the least understood. The general hypothesis is that there is good groundwater potential in Beles basin, but the surface/ groundwater interactions and inter-basin groundwater flows need to be studied in detail. An emerging researchable, trans-border groundwater security needs also to be considered (Albrecht et al. 2017).

Land changes and environmental services

Few baseline studies have been carried out regarding forests and soils of the basin, their landscape relations, nutrient recycling processes and how they are impacted by wildfire. Also, the isolation of Mount Belaya and Mount Dangur at the edge of the Beles basin might have affected gene exchange from the montane vegetation of the highlands; the extent to which this has already affected metacommunity dynamics needs to be investigated.

The impacts of the Beles basin becoming an investment and settlement hotspot for the last 30 years, should be studied with regard to land use and cover, biodiversity and ecosystem integrity. So far only one impact study is known: it dealt with assessing the impacts of land-use changes on flooding and sediment transport (Dereje Teklemariam et al. 2017a), but land management issues have not been addressed in detail. These include direct sowing using a planting stick, and planting of lowland bamboo on critical slopes, which serves with its dense roots and rhizomes as soil and water conservation technique (Kassahun Embaye 1998). As part of the CRGE, indigenous environmental conservation practices and their nexus with 'modern' policy-based conservation measures, as well as the determinants of the adoption and sustained use of soil and water conservation measures must be explored. Furthermore, research should be done into the possibilities of linking environmental conservation in the Beles catchment with the life expectancy of the GERD hydropower reservoir at its outlet, devising of instruments such as payment of environmental services (PES) schemes (Engel et al. 2008) to be arranged between communities and the Ethiopian Hydropower Corporation. Advantages and loopholes of the production, certification, carbon storage effects and marketing of timber and non-timber forest products need also to be investigated (Burivalova et al. 2017; DeFries et al. 2017).

In addition, particular changes occurred due to strong increases in river discharge, and the change of the Beles River from a seasonal to a permanent regime; the hydrogeomorphology, particularly width, incision/ aggradation and meandering patterns as well as riverine forest ecology need to be studied.

Biodiversity and aquatic ecology

Whereas baseline studies on aquatic biodiversity exist at least for fish (Zeleke Berie 2007), the collection of baseline biological and environmental data is of paramount importance for a better understanding of the aquatic resources of the region. In addition, further study is needed to assess the impact of the water transfers from Lake Tana on the aquatic ecology of Beles River. Before the construction of the tunnel from Lake Tana, Beles was a seasonal river. However, as a result of the continuous supply of water, the river changed to a perennial one, carrying about 2.6 times the previous flow in upper Beles and 2.2 times the previous flow in the lower basin (Bewuketu Abebe 2016). These changes have likely impacted on the downstream biophysical environment. Ecological risks associated with such water transfers are manifold. First, the increased flow already had major implications for channel integrity, which in turn might have affected the ecological functioning of the river banks, leading to a potential loss of the benthic biodiversity. Second, the physical and chemical properties of the river water have changed which might have impacted on components of both the pelagic and benthic aquatic food web. Third, the direct connection of the river with Lake Tana has likely resulted in the spread of alien fish species, floating aquatic plants, and invertebrate and microbial communities, including animal diseases and their vectors (Comrie-Greig 1986; Davies et al. 1992; Day et al. 1982; Herrmann 1983; Rasmussen et al. 2014; Sible et al. 2015). Reversely, the inter-basin water transfer may increase the supply of surface water and the water content of soils near the riverbanks, which might eventually lead to the formation of local wetlands. Such wetlands can in turn mitigate ecological water deficiency, regulate the water volume of rivers as well as provide new habitats for fauna and flora (Chen et al. 2008).

We call for research on the biotic and abiotic characteristics of Beles and its affluents (not affected by the water transfers) and propose to develop comparative studies of the aquatic communities as well as the physicochemical parameters of the Abat Beles (which receives the Tana water) and Gilgel Beles river. Also, the potential for the development of aquaculture for fish and the benefits and threats related to these activities should be explored.

Sustainability of crop production systems

The agricultural systems that are briefly described in this paper should be further investigated, so that the multifaceted indigenous knowledge is thoroughly understood including its potential contribution to the CRGE. Stable shifting cultivation with the help of slash and burning is in ecological balance with the environment and does not irreversibly degrade the soil and vegetative resources, provided a sufficient length of fallow is allowed for soil and vegetation restoration (Okigbo 1984). But, an increasing population density necessitates a more intensive use of land. The consequence is extended cropping periods and shortened fallows that are no longer adequate to restore the productive capacity of soils (Erni 2015; Keck et al. 1994; Ribeiro Filho et al. 2013). Permanent cultivation systems run by settlers, Shinasha and Agaw, and by investors are also not conservation-oriented. High postharvest losses and limited demand during the peak of the harvesting season discourage farmers to engage in vegetable production. Crop production systems can be sustainable when they generate economic profit, social benefits to the farm family and the community, and environmental conservation, simultaneously (Dobermann and Nelson 2013; Sullivan 2003). Particularly, before recommending best technologies and practices ensuring sustainable crop production systems for the basin, research is needed on reducing the large postharvest crop losses that are caused by improper harvesting, threshing, transportation and storage management; and optimizing the value chain of the major crops grown in the basin. Further research should also be done into the domestication of wild edible plant species commonly used by the Gumuz (Tesfaye Awas et al. 2010), as well as modern propagation techniques for bamboo in order to control dieback (Kassahun Embaye 1998; Poppens et al. 2013).

Land tenure and ownership; socio-economic development

Currently, in Gumuz society, if the lineage groups' ownership is quite well respected, there is a shift from communal land ownership to individual ownership and commercialisation of land to investors. Particularly, lands that are only used periodically have been considered as vacant and were commercialised (Crewett et al. 2008). The indigenous life and the environment of the communities have further been affected by the continuous resettlement programmes from central Ethiopia as well as by internal developments that led to the conversion of forests to sedentary agriculture. All this calls for research on how the Gumuz people have adapted their indigenous life styles to such changed ecological, cultural and socio-economic environments.

In addition, the water transfers from Lake Tana to Beles have major implications for the agricultural systems along the river. As in many dam-impacted areas, the traditional agricultural rainfed system undergoes a shift towards small-scale pump or river diversion irrigation and commercial agriculture, with an increased number of cropping seasons (Thomas and Adams 1999). This mostly contributes to higher household incomes, but inefficient water use can lead to the impoverishment of farmers (WCD 2000). A discrepancy exists in literature on which of both systems is most beneficial (Thomas and Adams 1999; WCD 2000). In addition, large scale irrigation projects often transfer money to government workers, to new settlers (Kloos and Worku Legesse 2010) or to investors in commercial agriculture (Bazin et al. 2011) and are not exclusively beneficial for indigenous people. While mainly the resettled highlanders practice irrigation agriculture in the area, the Gumuz ethnic group has no prior experience with this type of agriculture. Hence, there is a need to study the dam-induced impacts on agricultural systems and people's livelihoods in the Beles basin. A distinction between the impact on the indigenous Gumuz people and the resettled highlanders will be made. To study these impacts, crop and hedonic pricing modelling will be done. While crop models estimate crop production by taking soil-plant-water components into account (Gitelson et al. 2012), hedonic pricing models take human capital limitation and economic considerations into account and estimate long-term impacts of dam-induced water availabilities on net household revenues (Seo et al. 2009). The results of both models will be empirically compared and will provide insights to further develop economic valuation methods.

With regard to private land renting between Gumuz and settlers, as well as larger land deals, investigating the institutional mechanisms that could allow win-win land deals is essential (Dereje Teklemariam et al. 2015). Trends in the natural resource valuation (e.g. land lease price determination, disparities between the formal and informal land rental prices, and the way forward to ensure agro-ecologically and economically viable land market) are also vital areas of research.

Finally, a true non-peripheral integration of the Gumuz, who live astride the Ethio-Sudanese border, needs to be investigated in relation to their empowerment to use their knowledge of both countries to develop trans-border commercial and societal relations (Arter 2001; Markusse 2004). The scope for cross-border institutions needs also to be investigated, both traditional such as in Nigerian borderlands (Kehinde 2010; Mortimore et al. 2006) or formal, in line with the emerging Convention on Cross-Border Cooperation (Niamey Convention) (African Union 2014).

Conclusions

Based on literature and field observations, this scoping study of the Beles basin balanced social, ecological and economic considerations; we searched for persistence and changes in peripheralism, as well as the likely implications for the population of the basin, and for Ethiopia's Climate Resilient Green Economy (CRGE) strategy (Death 2015; Jones and Carabine 2013).

We found that changes affect mainly the central Beles valley bottom (unit C on Fig. 5) with immigration of highlanders and ongoing agro-industrial development. The upper Beles basin is affected by the permanent high discharges of the river where crossing can only occur at the peril of one's life. In the northern part of the lower Beles basin, many large commercial farms have developed ("land grabbing"; unit D). In the less accessible southern Beles basin (unit E), many Gumuz have continued their traditional lifestyle.

Development of hydrology, hydropower, agriculture-based industrialization, biodiversity, and carbon sequestration are centre-pieces of the CRGE development activities in Beles basin, which should be undertaken in respect of local culture and land rights. Particular knowledge gaps identified are water balances at broader scale; local biodiversity and ecosystem functions; the land and its ecosystem services, related to agricultural production, but also biodiversity; the reduction of post-harvest losses and increased shelf life of vegetables and fruits while water and land are well managed; and local peoples' and farmers' empowerment, in the perspective of improved agricultural production and biodiversity.

We also investigated to what extent persistence and changes in the basin align with the CRGE strategy. The changed hydrology of the basin, as a result of hydropower development, has further favoured the development of irrigation and sugar cane plantation, which will lead to water abstraction affecting hydropower production at the GERD. The establishment of commercial farms in the Beles basin leads to sediment production and siltation of the GERD reservoir, and to wide deforestation (Fig. 4), also in contradiction with the CRGE strategy, while the farms are generally not productive. A reasoned sustainable development and intensification of the Gumuz agrosylvopastoral system should be investigated as an alternative for commercial farming, taking the CRGE criteria as standards for evaluation.

We conclude that the conditions of the Beles basin at the beginning of the 21st C still align with the concepts of core and periphery. Particularly in the lower part of the basin, where the Gumuz live, we found no empirical evidence of "deperipheralisation" in the sense of "non-peripheral integration" (Arrighi 1979). The central part of the basin has become more integrated with the highlands' economy, as a consequence of large settlement of highlanders. But for most of the Gumuz, we suggest that a non-peripheral integration requires their empowerment and the development of trans-border commercial and societal relations.

Acknowledgments

The authors acknowledge the numerous local inhabitants and authorities who shared their knowledge with us, particularly in Pawe and Dangur districts. All participants in group discussions and group excursions to the Beles basin, are thanked for sharing ideas. The Institutional University Cooperation with Bahir Dar University (BDU-IUC), funded by the Belgian authorities, through the Flemish Interuniversity Council – University Development Cooperation, hosted the research activities. Lutgart Lenaerts (Norwegian University of Life Sciences) shared inspiring thoughts and Daniel Mège (Polish Academy of Sciences) provided useful documentation. Daniel Mège, as well as Eric Movet (www.mydriase.fr) gave permission to use illustrations. The constructive comments on an earlier version of this paper by two anonymous reviewers and the editor are greatly acknowledged.

References

The authors have conventionally cited names of Ethiopian authors in direct order, i.e., the first name followed by the father's name.

African Union (2014) African Union Convention on Cross-Border Cooperation (Niamey Convention). http://www.peaceau.org/uploads/au-niamey-convention-eng.pdf.

Agneta F, Berterame S, Capirci M, Magni L, Tomassoli M (1993) The Dynamics of Social and Economic Adaptation during Resettlement: The Case of the Beles Valley in Ethiopia. In: Cernea MM, Guggenheim SE (eds) Anthropological Approaches to Resettlement. Oxford University Press, Oxford, pp 251-282

Ahland C (2012) A grammar of Northern and Southern Gumuz. PhD dissertation. University of Oregon.

Ahmad AH (1999) Trading in slaves in Bela-Shangul and Gumuz, Ethiopia: Border enclaves in history, 1897–1938 The Journal of African History 40:433-446

Albrecht T, Varady R, Gerlak A, Staddon C (2017) Governing a shared hidden resource: A review of governance mechanisms for transboundary groundwater security Water Security 2:43-56 doi:10.1016/j.wasec.2017.11.002

Annys S, Enyew Adgo, Tesfaalem Ghebreyohannes, Van Passel S, Dessein J, Nyssen J (2018) Downsides for downstream living communities – the case of the Tana-Beles hydropower project. 20th International Conference of Ethiopian Studies (ICES20), Mekelle, Ethiopia.,

Arrighi G (1979) Peripheralization of Southern Africa, I: Changes in Production Processes Review (Fernand Braudel Center) 3:161-191
Arrighi G, Drangel J (1986) The stratification of the world-economy: an exploration of the semiperipheral zone Review (Fernand Braudel Center) 10:9-74
Arter D (2001) Regionalization in the European Peripheries: The Cases of Northern Norway and Finnish Lapland Regional & Federal Studies 11:94-114 doi:10.1080/714004693
Assefa Delesho (2006) Urban water supply, the case of Assosa town, MSc thesis, Addis Ababa University, Ethiopia.
Awash Teklehaimanot, Fletcher M (1990) A parasitological and malacological survey of schistosomiasis mansoni in the Beles Valley, northwestern Ethiopia The Journal of Tropical Medicine and Hygiene 93:12-21
Bahru Zewde (2002) A history of modern Ethiopia, 1855–1991. Ohio University Press,
Barnes J (2017) The future of the Nile: climate change, land use, infrastructure management, and treaty negotiations in a transboundary river basin Wiley Interdisciplinary Reviews: Climate Change 8:e449 doi:10.1002/wcc.449
Bazin F, Skinner J, Koundouno J (2011) Sharing the Water, Sharing the Benefits: Lessons from Six Large Dams in West Africa. IIED, London, UK
Berihun Mebratie (2004) The past in the present: the dynamics of identity and otherness among the Gumuz of Ethiopia. Department of Social Anthropology, Norwegian University of Science and Technology,
Bewuketu Abebe (2016) Optimize Operations and Future Development on Multi-Purpose Tana Beles Hydropower Project. MSc Thesis, Norwegian University of Science and Technology, Norway.
Brown E, Derudder B, Parnreiter C, Pelupessy W, Taylor PJ, Witlox F (2010) World City Networks and Global Commodity Chains: towards a world-systems' integration Global Networks 10:12-34 doi:10.1111/j.1471-0374.2010.00272.x
Burivalova Z, Hua F, Koh LP, Garcia C, Putz F (2017) A Critical Comparison of Conventional, Certified, and Community Management of Tropical Forests for Timber in Terms of Environmental, Economic, and Social Variables Conservation Letters 10:4-14 doi:10.1111/conl.12244
Chen Y et al. (2008) Response of riparian vegetation to water-table changes in the lower reaches of Tarim River, Xinjiang Uygur, China Hydrogeology Journal 16:1371-1379 doi:10.1007/s10040-008-0306-1
Clark AK, Ratsey J, Wood RP (2013) Feasibility studies for irrigation development in Ethiopia Proceedings of the Institution of Civil Engineers-Water Management 166:219-230 doi:10.1680/wama.12.00067
Colmeiro J (2018) Peripheral Visions/ Global Sounds: From Galicia to the World. Oxford University Press,
Comrie-Greig J (1986) The ENWC,"killer canal" or life-giving artery, or both? African Wildlife 40:68-73
Crewett W, Ayalneh Bogale, Korf B (2008) Land Tenure in Ethiopia: Continuity and change, shifting rulers, and the quest for state control. CAPRi Working Paper vol 91. International Food Policy Research Institute, Washington DC
CSA (2008) Central Statistical Agency F.D.R. of Ethiopia Population Census Commission, Summary and statistical report of the 2007 population and housing census. Addis Ababa
Davies BR, Thoms M, Meador M (1992) An assessment of the ecological impacts of inter-basin water transfers, and their threats to river basin integrity and conservation Aquatic conservation: Marine and freshwater ecosystems 2:325-349 doi:10.1002/aqc.3270020404
Day J, Bridger K, Peet S, Friesen B (1982) Northwestern Ontario river dimensions J Am Water Resour Assoc 18:297-305 doi:10.1111/j.1752-1688.1982.tb03974.x
Death C (2015) Four discourses of the green economy in the global South Third World Quarterly 36:2207-2224 doi:10.1080/01436597.2015.1068110
DeFries RS, Fanzo J, Mondal P, Remans R, Wood SA (2017) Is voluntary certification of tropical agricultural commodities achieving sustainability goals for small-scale producers? A review of the evidence Environmental Research Letters 12:033001 doi:10.1088/1748-9326/aa625e

Dereje Teklemariam, Azadi H, Nyssen J, Mitiku Haile, Witlox F (2015) Transnational land deals: Towards an inclusive land governance framework Land Use Policy 42:781-789 doi:10.1016/j.landusepol.2014.09.021

Dereje Teklemariam, Azadi H, Nyssen J, Mitiku Haile, Witlox F (2016) How Sustainable Is Transnational Farmland Acquisition in Ethiopia? Lessons Learned from the Benishangul-Gumuz Region Sustainability 8:213 doi:10.3390/su8030213

Dereje Teklemariam, Lanckriet S, Azadi H, Tesfaalem Ghebreyohannes, Mitiku Haile, Witlox F, Nyssen J (2017a) Effects of Land Deals on Peak Discharge and Sediment Transport in The Catchments Around the Grand Ethiopian Renaissance Dam Land Degradation & Development 28:1852-1861 doi:10.1002/ldr.2654

Dereje Teklemariam, Nyssen J, Azadi H, Mitiku Haile, Lanckriet S, Taheri F, Witlox F (2017b) Commercial land deals and the interactions between investors and local people: Evidence from western Ethiopia Land Use Policy 63:312-323 doi:10.1016/j.landusepol.2017.01.019

Dobermann A, Nelson R (2013) Opportunities and solutions for sustainable food production. Sustainable Development Solutions Network,

Edwards JR (1982) Slavery, the slave trade and the economic reorganization of Ethiopia 1916-1935 African Economic History:3-14 doi:10.2307/3601214

Eguavoen I (2009) The acquisition of water storage facilities in the Abay River Basin, Ethiopia. ZEF Working Paper Series vol 38. Center for Development Research (ZEF), University of Bonn, Bonn

Emperor Sertse Dengel's chronicler (ca. 1590) Historia regis Sarsa Dengel (Malak Sagad) [in Ge'ez]. Translated to French by K. Conti Rossini (1907). vol 20-21. Corpus Scriptorum Christianorum Orientalium, Scriptores Aethiopici, Series Altera, Tomus III. Typographeo Reipublicae & Harrassowitz, Paris & Leipzig

Engel S, Pagiola S, Wunder S (2008) Designing payments for environmental services in theory and practice: An overview of the issues Ecological economics 65:663-674 doi:10.1016/j.ecolecon.2008.03.011

Erni C (2015) Shifting cultivation, livelihood and food security: New and old challenges for indigenous peoples in Asia. FAO, International Work Group For Indigenous Affairs, Asia Indigenous Peoples Pact, Bangkok

FDRE (2011) Ethiopia's Climate-Resilient Green Economy, Green Economy Strategy. Government of the Federal Democratic Republic of Ethiopia, Addis Ababa

Fletcher M, Awash Teklehaimanot (1989) Schistosoma mansoni infection in a new settlement in Metekel district, north-western Ethiopia: morbidity and side effects of treatment with Praziquantel in relation to intensity of infection Transactions of the Royal Society of Tropical Medicine and Hygiene 83:793-797 doi:10.1016/0035-9203(89)90332-5

Frank AG (1971) Latin America: Underdevelopment or Revolution Science and Society 35:357-360

Friedmann J (1966) Regional development policy: a case study of Venezuela. M.I.T. Press, Cambridge, Mass. (USA)

Friis I, Sebsebe Demissew, van Breugel P (2010) Atlas of the potential vegetation of Ethiopia. Det Kongelige Danske Videnskabernes Selskab,

Girma Adisu (2010) Hydrogeological and hydrogeochemical characterisation of Beles river basin, northwestern Ethiopia. MSc thesis, Department of Earth Sciences, Addis Ababa University. doi:10.1007/s00254-007-0937-x

Gitelson AA et al. (2012) Remote estimation of crop gross primary production with Landsat data Remote Sensing of Environment 121:404-414 doi:10.1016/j.rse.2012.02.017

González-Ruibal A, Fernández VM, Martínez VMF (2007) Exhibiting cultures of contact: A museum for Benishangul-Gumuz, Ethiopia Stanford Journal of Archaeology 5:61-90

Grabham GW, Black RP (1925) Report of the mission to Lake Tana 1920-1921. Public Works Department, Cairo, Egypt

Hårsmar M, Sandström E, Atakilte Beyene (2016) Lake Tana: source of disputes or collaboration over the Blue Nile? In: Sandstrom E, Jagerskog A, Oestigaard T (eds) Land and Hydropolitics in the Nile River Basin: Challenges and New Investments. Routledge, Albingdon, UK, pp 189-210

Hautot S, Whaler K, Workneh Gebru, Mohammednur Desissa (2006) The structure of a Mesozoic basin beneath the Lake Tana area, Ethiopia, revealed by magnetotelluric imaging Journal of African Earth Sciences 44:331-338 doi:10.1016/j.jafrearsci.2005.11.027

Herrmann R (1983) Environmental implications of water transfer. In: Biswas A, Zuo D, Nickum J, Liu C (eds) Long Distance Water Transfer: A Chinese Case Study and International Experiences. Tycooly, Dublin,

Hoggart K, Buller H (2015) Rural development: a geographical perspective. Routledge Library Editions: Human Geography. Routledge, London & New York

IBC (2005) National Biodiversity Strategy and Action Plan. Government of the Federal Democratic Republic of Ethiopia, Institute of Biodiversity Conservation, Addis Ababa

INBAR (2010) Study on utilization of lowland bamboo in Benishangul-Gumuz Region, Ethiopia. International Network for Bamboo and Rattan,

James W (1986) Lifelines: Exchange marriage among the Gumuz. In: Donham D, James W (eds) The Southern Marches of Imperial Ethiopia: Essays in History and Social Anthropology. Cambridge University Press, Cambridge, Great Britain, pp 119-147

Jones L, Carabine E (2013) Exploring Political and Socio-Economic Drivers of Transformational Climate Policy: Early Insights from the Design of Ethiopia's Climate Resilient Green Economy Strategy. Working Paper. Overseas Development Institute. doi:10.2139/ssrn.2646522

Kassahun Embaye (1998) Indigenous bamboos of Ethiopia: A call for attention and action Walia 20:3-9 doi:10.1579/0044-7447-29.8.518

Kassahun Embaye (2000) The indigenous bamboo forests of Ethiopia: an overview Ambio 29:518-521 doi:10.1579/0044-7447-29.8.518

Keck A, Sharma NP, Feder G (1994) Population growth, shifting cultivation, and unsustainable agricultural development: a case study in Madagascar vol 234. World Bank Publications,

Kehinde M (2010) Implications of Colonially Determined Boundaries in (West) Africa: the Yoruba of Nigeria and Benin in Perspective. PhD thesis. Durham University, Durham (UK)

Kloos H, Worku Legesse (2010) Water resources management in Ethiopia: implications for the Nile basin. Cambria Press, Amherst, NY

Knox P, Agnew JA, McCarthy L (2014) The geography of the world economy. Routledge, London & New York

Kühn M (2015) Peripheralization: theoretical concepts explaining socio-spatial inequalities European Planning Studies 23:367-378 doi:10.1080/09654313.2013.862518

Kuls W (1962) Land, Wirtschaft und Siedlung der Gumuz im Westen von Godjam (Äthiopien) Paideuma 8: 45-61

Labrianidis L (2017) The future of Europe's rural peripheries. Routledge, London & New York

Markakis J (2011) Ethiopia: The last two frontiers. Boydell & Brewer Ltd, Woodbridge (UK) & Rochester (USA)

Markusse J (2004) Transborder regional alliances in Europe: Chances for ethnic Euroregions? Geopolitics 9:649-673 doi:10.1080/14650040490478729

McCann JC (1995) People of the plow: an agricultural history of Ethiopia, 1800–1990. Univ of Wisconsin Press, Madison (USA)

Mekete Dessie, Verhoest NE, Pauwels VR, Enyew Adgo, Deckers J, Poesen J, Nyssen J (2015) Water balance of a lake with floodplain buffering: Lake Tana, Blue Nile Basin, Ethiopia Journal of Hydrology 522:174-186 doi:10.1016/j.jhydrol.2014.12.049

Mekuria Jira (2008) A History of the Gumuz People of Metekel, 1941-91. MA Thesis, Addis Ababa University.

Melkamu Alemayehu, Getachew Alemayehu (2017) Study on alternative technologies for the production of tomato during the rainy season in subhumid climate of Bahir Dar, Ethiopia Ethiopian Journal of Science and Technology 10:1-16 doi:10.4314/ejst.v10i1.1

Menassie Gashaw, Michelsen A, Friis I, Jensen M, Sebsebe Demissew, Zerihun Woldu (2002) Post-fire regeneration strategies and tree bark resistance to heating in frequently burning tropical savanna woodlands and grasslands in Ethiopia Nordic Journal of Botany 22:19-33 doi:10.1111/j.1756-1051.2002.tb01615.x

Meron Zeleke (2010) The mother and the bread winner: the socio-economic role and status of Gumuz women. Spektrum, vol 103. LIT Verlag Münster

Miers S (1997) Britain and the Suppression of Slavery in Ethiopia Slavery and Abolition 18:257-288 doi:10.1080/01440399708575221

Mortimore M, Ariyo J, Bouzou I, Mohammed S, Yamba B (2006) A Dry land Case Study of the Ecosystem Approach - Local Natural Resource Management in the Maradi–Kano Region of Niger-Nigeria. Study Report. World Conservation Union (IUCN), Gland, Switzerland

Okigbo BN (1984) Improved permanent production systems as an alternative to shifting intermittent cultivation FAO Soils Bulletin 53

Pankhurst R (1977) History of the Bareya, Sanqella and Other Ethiopian Slaves From the Borderlands of the Sudan Sudan Notes and Records 58:1-43

Pelican M (2009) Complexities of indigeneity and autochthony: An African example American Ethnologist 36:52-65 doi:10.1111/j.1548-1425.2008.01109.x

Platt SJ, Treloar S, Friend G (2012) Monitoring fire and biodiversity–the fire monitoring program of the Department of Sustainability and Environment Proceedings of the Royal Society of Victoria 124:91-100 doi:10.1071/RS12091

Poppens R, van Dam J, Elbersen H (2013) Bamboo: Analyzing the potential of bamboo feedstock for the biobased economy. NL Agency, Ministry of Economic Affairs, The Netherlands

Prave A, Bates CR, Donaldson CH, Toland H, Condon D, Mark D, Raub TD (2016) Geology and geochronology of the Tana Basin, Ethiopia: LIP volcanism, super eruptions and Eocene–Oligocene environmental change Earth and Planetary Science Letters 443:1-8 doi:10.1016/j.epsl.2016.03.009

Rasmussen PW, Schrank C, Williams MCW (2014) Trends of PCB concentrations in Lake Michigan coho and chinook salmon, 1975–2010 Journal of Great Lakes Research 40:748-754 doi:10.1016/j.jglr.2014.05.011

Ribeiro Filho AA, Adams C, Murrieta RSS (2013) The impacts of shifting cultivation on tropical forest soil: a review Boletim do Museu Paraense Emílio Goeldi Ciências Humanas 8:693-727 doi:10.1590/S1981-81222013000300013

Ruthenberg H (1980) Farming systems in the tropics. Clarendon Press, Oxford

Saugestad S (2001) The inconvenient indigenous: remote area development in Botswana, donor assistance and the first people of the Kalahari. Nordic Africa Institute,

Scaetta H (1935) Geography, Ethiopia's Ally Foreign Affairs 14:62-70 doi:10.2307/20030702

Scott AJ (2012) A world in emergence: Cities and regions in the 21st century. Edward Elgar Publishing, Cheltenham (UK) and Northampton (USA)

Seifu Kebede (2013) Groundwater Occurrence in Regions and Basins. In: Groundwater in Ethiopia. Springer, pp 15-121. doi:: 10.1007/978-3-642-30391-3_2

Seo SN, Mendelsohn R, Dinar A, Hassan R, Kurukulasuriya P (2009) A Ricardian analysis of the distribution of climate change impacts on agriculture across agro-ecological zones in Africa Environmental and Resource Economics 43:313-332 doi:10.1007/s10640-009-9270-z

Sible E, Cooper A, Malki K, Bruder K, Watkins SC, Fofanov Y, Putonti C (2015) Survey of viral populations within Lake Michigan nearshore waters at four Chicago area beaches Data in brief 5:9-12 doi:10.1016/j.dib.2015.08.001

Sileshi Bekele, Teklu Erkossa, Smakhtin V, Fernando A (2009) Improved water and land management in the Ethiopian highlands: Its impact on downstream stakeholders dependent on the Blue Nile. Intermediate Results Dissemination Workshop held at the International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia, 5-6 February 2009. Summary report, abstracts of papers with proceedings on CD-ROM. International Water Management Institute, Colombo, Sri Lanka

Simons GF, Fennig CD (2017) Ethnologue: Languages of the world, 20th edition. SIL international, Dallas (USA). Online version: http://www.ethnologue.com

Sullivan P (2003) Applying the principles of sustainable farming - Fundamentals of sustainable agriculture. Appropriate Technology Transfer for Rural Areas (ATTRA). National Center for Appropriate Technology (NCAT), U.S. Department of Agriculture,

Swedesurvey (2010) Technical Assistance for Responsible Land Administration in Ethiopia, 2010 – 2015. Modality One. Project Document.

Temesgen Gebeyehu (2018) Center–periphery relations, local governance and conflicts in Ethiopia: the experience of Metekel province Social Identities:online early view doi:10.1080/13504630.2017.1310040

Tesfaye Awas, Zemede Asfaw, Nordal I, Sebsebe Demissew (2010) Ethnobotany of Berta and Gumuz people in western Ethiopia Biodiversity 11:45-53 doi:10.1080/14888386.2010.9712663

Thomas DH, Adams WM (1999) Adapting to dams: agrarian change downstream of the Tiga Dam, Northern Nigeria World Development 27:919-935 doi:10.1016/S0305-750X(99)00041-8

Tsegaye Moreda (2015) Listening to their silence? The political reaction of affected communities to large-scale land acquisitions: insights from Ethiopia Journal of Peasant Studies 42:517-539 doi:10.1080/03066150.2014.993621

van Breugel P, Friis I, Sebsebe Demissew, Barnekow Lillesø J-P, Kindt R (2016) Current and future fire regimes and their influence on natural vegetation in Ethiopia Ecosystems 19:369-386 doi:10.1007/s10021-015-9938-x

Veilleux J (2014) Is dam development a mechanism for human security? Scale and perception of the Grand Ethiopian Renaissance Dam on the Blue Nile River in Ethiopia and the Xayaburi Dam on the Mekong River in Laos. Doctoral dissertation. Oregon State University,

WCD (2000) Dams and Development: A New Framework for Decision-making: the Report of the World Commission on Dams. Earthscan, London and Sterling, VA

Westphal E (1975) Agricultural systems in Ethiopia. Centre for Agricultural Publishing and Documentation, Wageningen

Wheeler KG et al. (2016) Cooperative filling approaches for the Grand Ethiopian Renaissance Dam Water International 41:611-634 doi:: 10.1080/02508060.2016.1177698

Wolde-Selassie Abbute (2002) Gumuz and Highland Resettlers: Differing Strategies of Livelihood and Ethnic Relations in Metekel, Northwestern Ethiopia. Transaction Publishers, London

World Bank (2008) Tana & Beles Integrated Water Resources Development: Project Appraisal Document (PAD), Vol.1. Addis Ababa, Ethiopia

Yeshambel Mekuriaw, Mengistu Urge, Getachew Animut (2011) Role of indigenous Bamboo species (Yushania alpina and Oxytenanthera abyssinica) as ruminant feed in northwestern Ethiopia Livestock Research for Rural Development 23:185

Yeshambel Mekuriaw, Mengistu Urge, Getachew Animut (2012) Intake, digestibility, live weight changes and rumen parameters of Washera sheep fed mixtures of lowland bamboo (Oxytenanthera abyssinica) leaves and natural pasture grass hay at different ratios Pakistan Journal of Nutrition 11:322-331 doi:10.3923/pjn.2012.322.331

Yntiso Gebre (2003) Resettlement and the unnoticed losers: Impoverishment disasters among the Gumz in Ethiopia Human organization 62:50-61 doi:10.17730/humo.62.1.4ava5ykea9p0vk10

Zanardi D (2011) The Tana Beles resettlement project in Ethiopia. In: Évora I, Frias S (eds) Seminário sobre Ciências Sociais e Desenvolvimento em África. Centro de Estudos sobre África e do Desenvolvimento, Lisboa, Portugal, pp 79-88

Zeleke Berie (2007) Diversity, Relative Abundance and Biology of Fishes in Beles and Gilgel Beles Rivers, Abay Basin, Ethiopia. MSc thesis, Addis Ababa University.

Figure captions

Fig. 1 Beles basin at the western side of the Ethiopian highlands. G.B. = Gilgel Beles town

Fig. 2 Ethnic groups and languages in Beles basin and surroundings. After Simons and Fennig (2017) and field observations.

Fig. 3 Views of Gumuz homesteads (photos J. Nyssen)

Fig. 4 The DigitalGloble images (left) show the “old” traditional land use with shifting cultivation (typically rendered by plots with different shades of green). The Sentinel 2-derived false colour composites (right; resolution: 10 m x 10 m) show the “new” land use with mainly open fields. Here, dark pink areas display remnants of natural (riverine) vegetation, while bright pink areas show newly converted large-scale agricultural fields (greyish-pink areas have a different soil moisture content). Dark green areas display recently cleared lands. (Sources: DigitalGlobe imagery as displayed in ArcMap 10.4; Sentinel 2 imagery downloaded from https://scihub.copernicus.eu/dhus/#/home; own representation)

Fig. 5 Proposed geographical units of Beles basin as coloured shades on a map of districts and roads. For legend of geographical units A to E, see text