

DOWN 2 EARTH

Drought exposure and vulnerability trends in the Horn of Africa Drylands

Historical analysis of changes in susceptibility and capacity based on socio-economic data, policy observations, and community information on past water security, food security, and livelihoods, for Ethiopia (Oromia), Kenya (Isiolo) and Somalia (Toghdeer)



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1 Introduction

1.1 Context of the report

This report – Down2Earth deliverable 2.2 - comprises **an analysis of historical trends and patterns in socio-economic, demographic, and population data** (led by IVM-VU). The goal of this report is to improve the understanding of historical spatio-temporal expressions of exposure and vulnerability trends across HAD and to add to the existing knowledge of feedbacks among socio-economics, population, land use, and climate. Deliverable 2.1 discusses trends in drought hazard – the third component of risk.

We analysed a diverse set of open-source observed, modelled, and remotely sensed data representing proxies of various socio-economic, demographic, and population conditions. We performed a spatially-explicit time-series analysis and a statistical trend analysis over these datasets to reveal direction and rates of changes, as well as their spatial distribution.

This report provides information that can directly support the integration of the socio-economic dimension into the design and implementation of Down2Earth research and fieldwork, and can support development of new technologies which address societal problems. Moreover, this report emphasizes the importance of incorporation of the gender dimension and ethics in the design of research and innovation in the Down2Earth project.

1.2 Background

Dryland ecosystems and societies in East Africa are at risk due to a combination of unsustainable land use, conflicts, devastating droughts, ongoing climate change, and other issues. Drought-related disasters are very common in the Horn of Africa Drylands (HAD) (Fig.1). One of the worst humanitarian disasters of the world in the past decades was the Ethiopian drought of 1983-85, causing 1 million famine-related deaths¹. The 2010–2011 drought of the Greater Horn of Africa was the worst drought in the region for over 60 years, affecting over 12 million people² and recently, in 2020-2021, the region has suffered from consecutive below-average rainfall seasons again threatening food security³. In Somalia, Ethiopia and Kenya, drought disasters were recorded for respectively 7%, 11% and 20% of the time during the 1961-1991 period. This increased to 19%, 29% and 58%, respectively, in the last thirty years (1991-2021). These disasters affect large parts of society (Fig. 2), with on average 0.5M, 1.5M and 1M people exposed to drought disasters every year, for Somalia, Ethiopia and Kenya respectively.

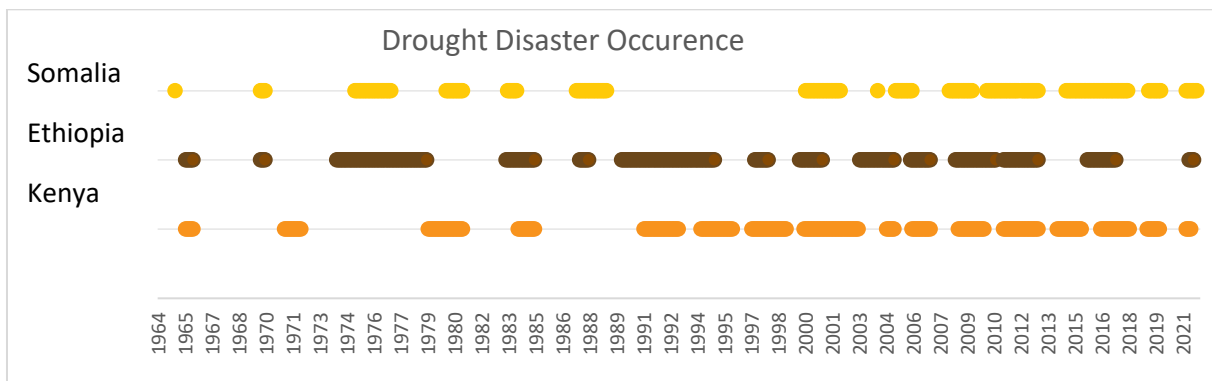


Figure 1: Drought disaster occurrence in Somalia, Ethiopia and Kenya. Data from Em-Dat (2021).

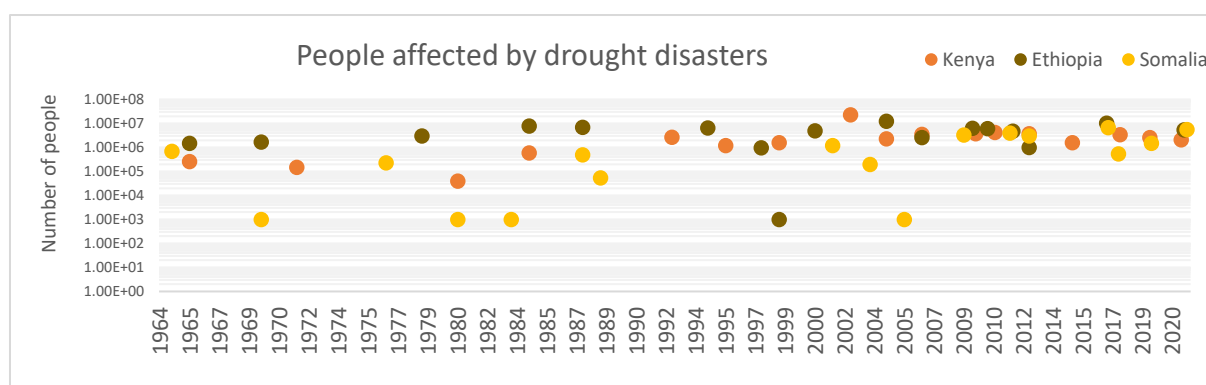


Figure 2: Number of people affected per drought disaster in Somalia, Ethiopia and Kenya. Data from Em-Dat (2021)

Drought disaster risk dynamics and shocks are often driven by underlying socio-economic changes that have been targeted by and/or subjected to highly variable policies or systems of governance. Indeed, drought disaster risk is determined not only by the drought hazard, i.e., the frequency of hydro-meteorological conditions leading to a deficiency in water availability. It is also determined by exposure, i.e. the presence of people, livelihoods, ecosystems, services, infrastructure and resources, by the economic, social, and cultural assets in places that could be adversely affected by drought. Moreover, the vulnerability – i.e. the propensity or predisposition of these exposed components to be adversely affected, their sensitivity or susceptibility to the adverse effects of droughts, and their lack of capacity to cope with and adapt to droughts – is key in the determination of drought disaster risk.

1.3 Objective and method

Diagnosing historical trends in the socio-economic changes that affect drought exposure and vulnerability, and understanding the processes which drive these changes, can provide critical information for improving societal drought adaptation strategies. This requires an assessment of the socio-economic, demographic, policy and population history to understand spatial trends that can affect drought impacts in HAD. To this end, this report presents national trends in indicators that relate to drought vulnerability and exposure, and highlight changes in sensitivity and adaptive capacity of rural communities and developments regarding water management.

Exposure to droughts depends on the type of drought being considered. In total 10 exposure indicators were collected from international databases. They were grouped under population, crop land and livestock exposure. The assessment of drought vulnerability is more complex because it depends on a myriad of drivers⁴. Existing drought vulnerability and risk assessments were used to identify the relevant factors affecting different dimensions of vulnerability to drought impacts including environment, health, society, and economy^{5,6,7,8,9,10,11,12,13,14,15,16}. As there is no consistent method for quantitative assessment of drought vulnerability, one needs to look at proxies incorporating different components that will be affected by drought¹⁷. In total 30 vulnerability indicators are collected from international databases. The evaluated data includes proxies for social sensitivity, economic sensitivity, environmental sensitivity, lack of coping capacity and lack of adaptive capacity¹⁸. Sources for these indicators include the Food and Agriculture Organization of the United Nations (FAO), World Bank, the World Health Organisation (WHO), the United Nations Development Programme (UNDP) and the IGAD Climate Prediction and Applications Centre (ICPAC).

1.4 Study area

This research focusses on multiple case study areas in 3 regions: Oromia (Ethiopia), Isiolo (Kenya) and Togdheer (Somalia) (Fig.3). These arid to semi-arid regions are quite drought-prone and have suffered from several drought disasters in the past (Fig 4-6).

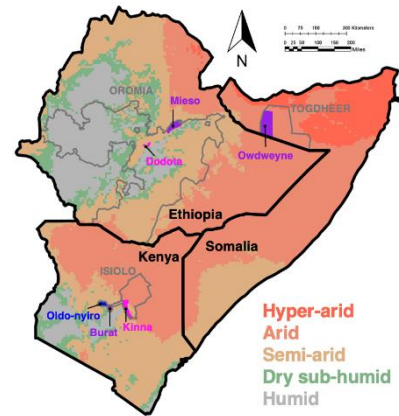


Figure 3: Horn of Africa Drylands study area. Aridity data from Trabucco, Antonio; Zomer, Robert (2019): Global Aridity Index and Potential Evapotranspiration (ET0) Climate Database v2. figshare. Fileset. <https://doi.org/10.6084/m9.figshare.7504448.v3> (edited)

The figures below show time series of the occurrence of drought disasters in these three case studies, according to the EM-DAT database. A drought is classified as a disaster if one of the following conditions is met: 1) Ten (10) or more people reported killed, 2) Hundred (100) or more people reported affected, 3) Declaration of a state of emergency or 4) Call for international assistance.

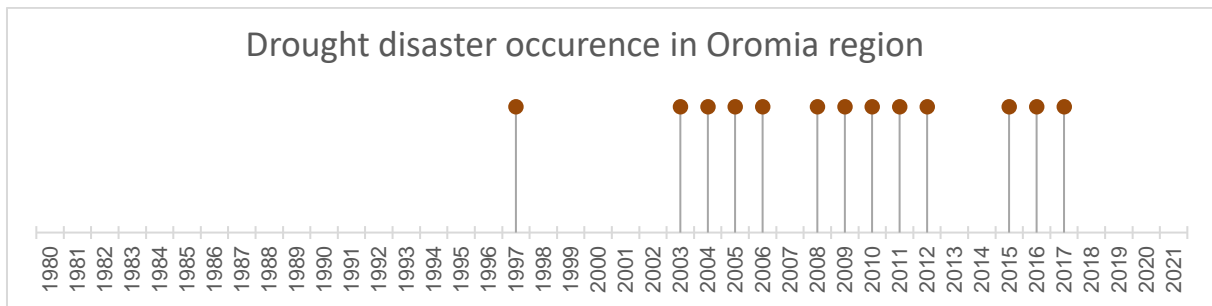


Figure 4: Drought disaster occurrence in Oromia region. Data Em-dat 2021

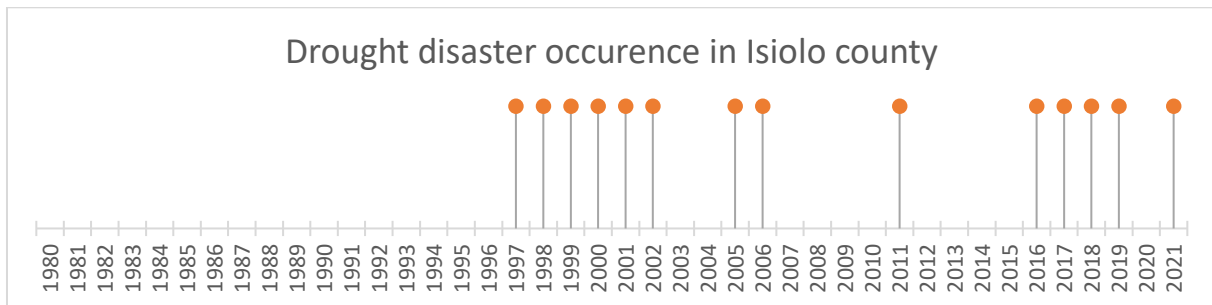


Figure 5: Drought disaster occurrence in Isiolo county. Data Em-dat 2021

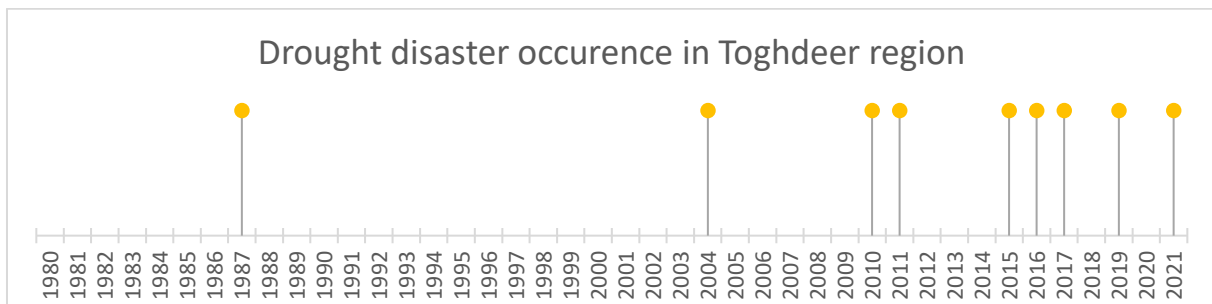


Figure 6: Drought disaster occurrence in Togdheer region. Data Em-dat 2021

2 Observations on exposure in the Horn of Africa Drylands

This section discusses observed national and local trends in demography and land use for Ethiopia, Kenya and Somalia (Table 1). Data on urban and rural population, population growth and migration, livestock, rainfed and irrigated land, protected areas, hydropower installations and water bodies are presented. Besides, local population and livelihood characteristics of 2 woredas (Mieso and Dodota in Oromya, Ethiopia), 3 wards (Oldonyiro, Kinna and Burat in Isiolo county, Kenya) and 1 district (Odweyne in Togdheer region, Somalia) are offered. Together, this will allow to draw conclusions on the changes in exposure in the Horn of Africa.

Table 1 Observations on exposure in Kenya, Ethiopia and Somalia: Data indicators and sources.

	Indicators	Sources
Population	Total population	United Nations Population Division. World Population Prospects, Census reports and other statistical publications from national statistical offices
	Share of rural population	Ibid.
	Population growth	Ibid.
	Migration stock	Ibid.
	Net migration	Ibid.
Livestock	Density	Food and Agriculture Organization
Agriculture	Productive land	Ibid
	Irrigated land	Ibid and Agriculture Organization
Hydropower	Dams	GRandD
River network	Navigation/shipping	Knoema atlas
Exposure in Oromya	Livelihoods	Down2Earth scoping report; DRIER case study
Exposure in Isiolo	Livelihoods	Down2Earth scoping report
Exposure in Togdheer	Livelihoods	Down2Earth scoping report

2.1 National trends in demography and land use

2.1.1 Population

Ethiopia, Kenya and Somalia all saw exponential population growth over the last fifty years (exponential fit of respectively $R^2 = 0.997$, $R^2 = 0.994$, $R^2 = 0.969$). This growth is most pronounced (largest absolute number) in Ethiopia (+91M people) but strongest (largest growth rate) in Kenya (18x the population of 1965) (Fig.7). The share of rural population is high but steadily decreases in the three countries due to ongoing rural-urban migration and natural increase¹⁹.

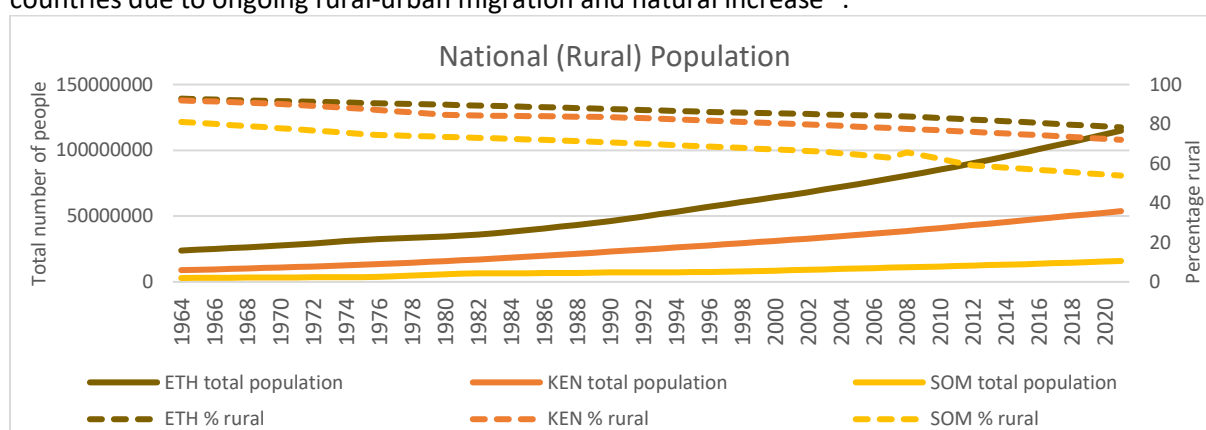


Figure 7: Population dynamics. Left panel: total population (full line) and distribution among urban (striped line) and rural (dotted line) shares in Ethiopia, Kenya and Somalia. 'Urban' and 'rural' are defined by national statistical offices. Population counts all residents regardless of legal status or citizenship in Ethiopia, Kenya and Somalia. Source: (1) United Nations Population Division. World Population Prospects, (2) Census reports and other statistical publications from national statistical offices, (3) United Nations Statistical Division. Population and Vital Statistics Report.

Kenya hosts one of the seven megacities (+10M people) of Africa: Nairobi. Somalia experienced an accelerating growth in urban population. Its young population, combined with an inflow of internal refugees and forced displacement, have resulted in fast growing cities such as Mogadishu, Merka, and Kismayo. Somalia is expected to have a 50/50 distribution among urban and rural population by 2026²⁰, and while cities can be powerful catalysts for economic growth, this rapid and wide urbanisation creates slum expansion and environmental degradation, and is feared to cause further instability in the country²¹.

Somalia also experiences a large interannual variability in growth rate (up to more than 10%). For example, during the late 1970s and early 1980s, war and famine caused numerous large-scale refugee movements in the Horn of Africa²². Many Ethiopians, including people from Eritrea—then part of Ethiopia—sought refuge in Somalia, a dynamic that is visible in Fig.8. Besides, the Ethiopia–Somali border war of 1982-1983 and the United Nations Operations in Somalia during the Somali Civil war in 1991-1995, are characterised by years of low population growth due to high outmigration (Fig.8). Besides conflict, climate-induced disasters (including droughts and floods) can also cause migration fluxes. For example, in Kenya's water scarce arid and semi-arid lands, extreme droughts and related losses of soil fertility lead to internal and international migration²³. Recently, the major drought of 2011 and 2012 in the Horn of Africa – in Somalia contributing to the already food insecure situation due to Al Shabab related terrorism²⁴ – drove large numbers of Somalis and Ethiopians to flee to Kenya in search of assistance and protection²⁵.

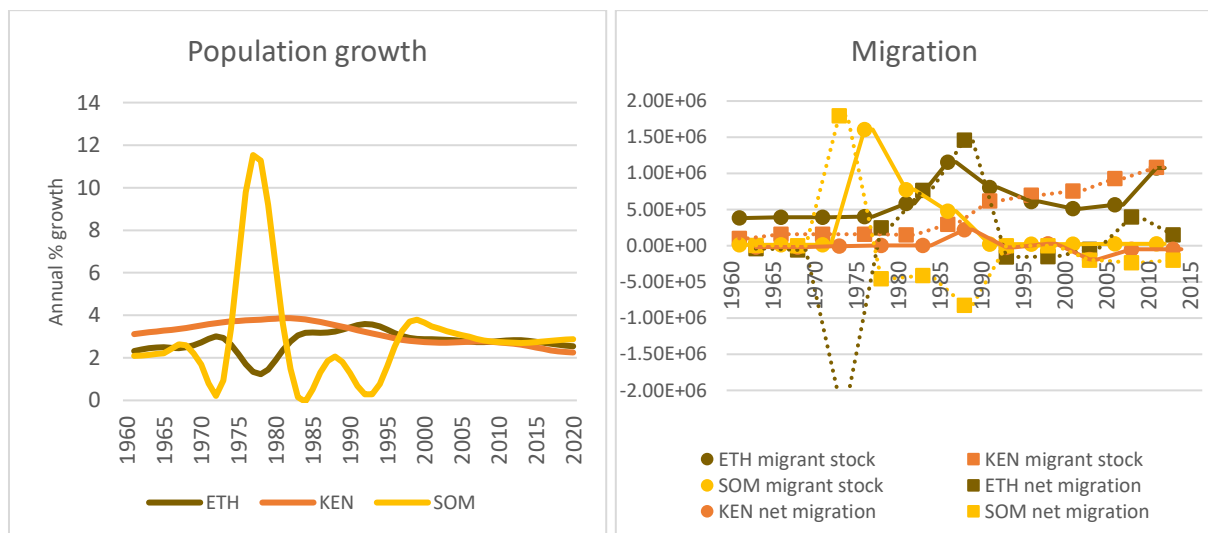


Figure 8: Growth and migration dynamics. Left panel: Annual population growth rate (calculated as the exponential rate of growth of midyear population) expressed as a percentage. Right panel: Net migration and change in migrant stock in Ethiopia, Kenya and Somalia. Net migration is the net total of migrants during the period, that is, the total number of immigrants less the annual number of emigrants, including both citizens and noncitizens. International migrant stockⁱ is the number of people born in a country other than that in which they live. Source: United Nations Population Division, Trends in Total Migrant Stock: 2008 Revision & 2012 Revision, United Nations Population Division. World Population Prospects: 2019 Revision.

ⁱ The estimates are derived by UNPD from the national census data on foreign-born population—people who have residence in one country but were born in another country. A model was used by UNPD to estimate migrants for countries that had no data. Source: United Nations Population Division.

2.1.2 Livestock

Ethiopia has the largest livestock population in Africa (Fig.9), with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens in 2020²⁶. It also has a very high (165% in the last 20 years) growth rate. While growing less fast (60% in the last 20 years), livestock is also very important to the GDP of Kenya: The beef industry is the largest contributor to agricultural GDP, at around 35 percent, while dairy cattle production in Kenya is the second largest contributor to the agricultural GDP²⁷. Somalia has a large population of camels as compared to the other two countries, but no steep upward trends (and even downward a trend at the start of the '90s). There is however little information on national herd distribution and composition²⁸.

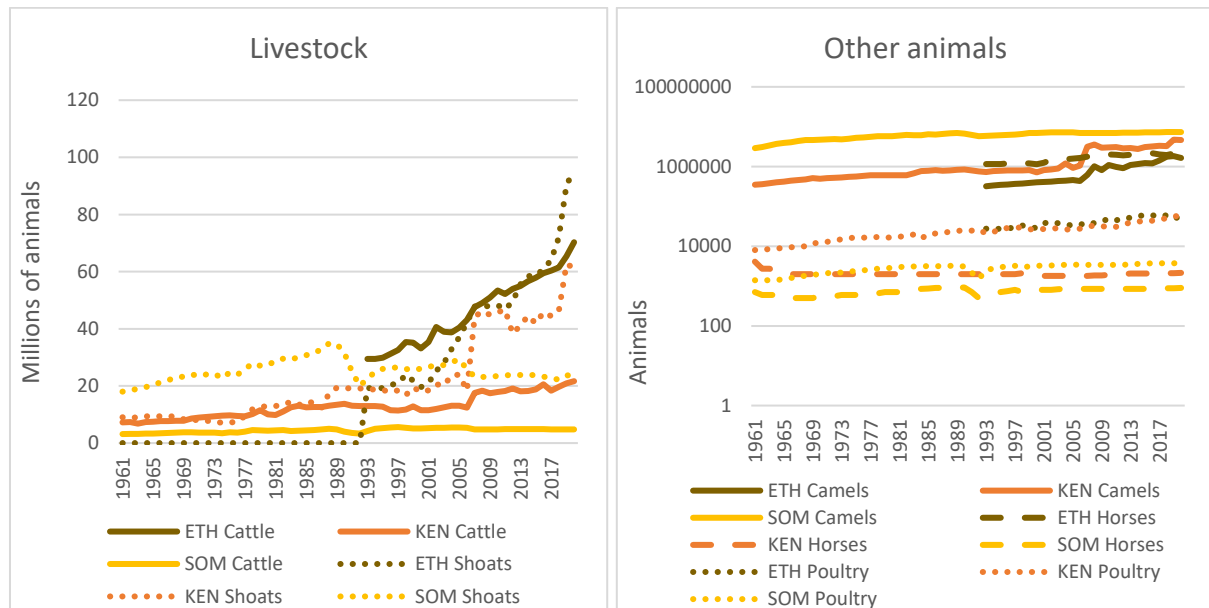


Figure 9: Left panel: Number (million) of cattle, goats and sheep. Right panel: Number of camels, horses and thousand of poultry. Source: FAOstat

2.1.3 Agricultural land and irrigation capacity

Agriculture is one of the sectors facing major impacts from drought. The amount of agricultural land is quite unchanged in Somalia and slightly increases in Kenya due to agricultural expansion in for example the semi-arid lands and along the hillslopes of Mount Kenya and the Taita Hills^{29,30,31} (Fig. 10). In Ethiopia, a decrease in agricultural land can be observed due to the Eritrean independence in 1993. Afterwards, an increase is visible which is instigated by the Agriculture Development Led Industrialization strategy supporting cropland expansion. The greatest growth occurred in the less densely populated lowlands is achieved through deforestation in for example the Gambella region^{32,33} (Fig. 10).

Recent data on the share of irrigated land is scarce. For Kenya, in the first decade of the 21st century only a very low percentage of the agricultural land is irrigated, and no growth is reported (Fig. 5). However, under the Kenya Vision 2030, irrigation expansion and development were put on the agenda³⁴. The National Irrigation Authority estimates the irrigation potential of Kenya at about 1,350,000 acres and, while not portrayed in Fig.10, by 2016 about 500,000 acres were under irrigation³⁵. Besides, Fig.5 shows an exponential increase in irrigation in Ethiopia in the two decades (e.g. the area under irrigation increased more than 50% between 2004 and 2014). The country's policies to prioritize agricultural production and the adoption of new technologies to boost the sector has resulted in large expansions of irrigated area³⁶.

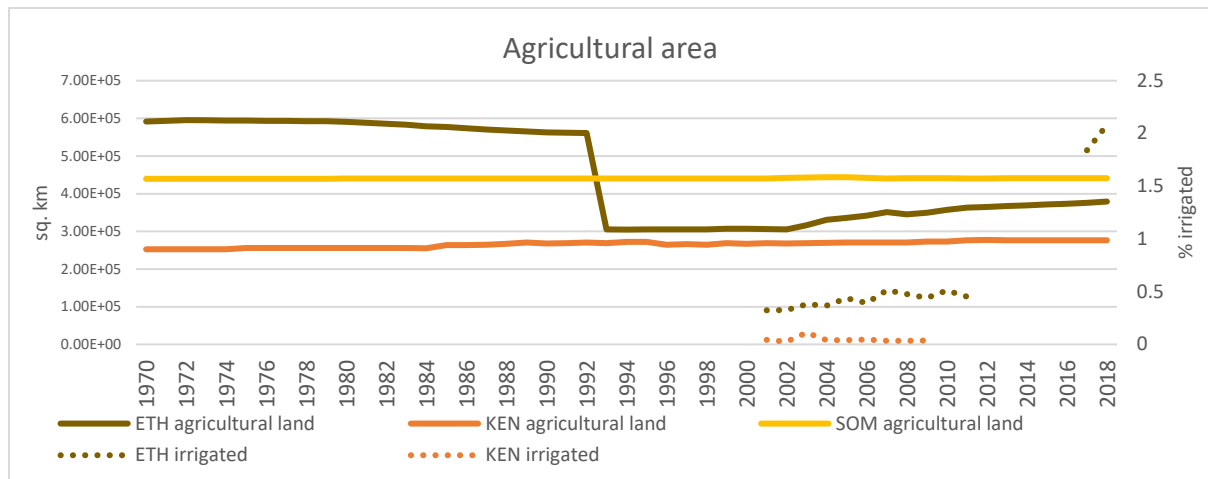


Figure 10: Changes in agricultural land. Left panel: Agricultural land surface and share of irrigated land (dotted line) in Ethiopia, Kenya and Somalia. Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Agricultural irrigated land refers to agricultural areas purposely provided with water, including land irrigated by controlled flooding. Right panel: the amount of arable land (hectare) per person in Ethiopia, Kenya and Somalia. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Source: Food and Agriculture Organization, electronic files and website.

2.1.4 Highly valued and protected nature areas

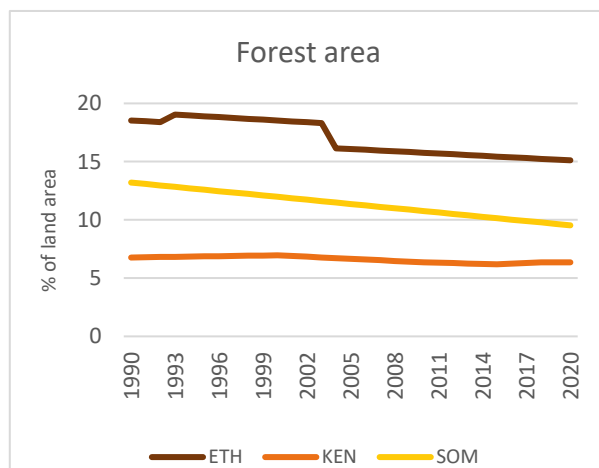


Table 2: Share of (totally or partially) terrestrial protected areas (at least 1,000 hectares, designated by national authorities as scientific reserves with limited public access, national parks, natural monuments, nature reserves or wildlife sanctuaries, protected landscapes, and areas managed mainly for sustainable use. Source: World Database on Protected Areas (WDPA), United Nations Environment World Conservation Monitoring Centre (UNEP-WCMC) in collaboration with governments, non-governmental organizations, academia and industry.

Protected areas (2016)	
Ethiopia	18.47%
Kenya	12.36%
Somalia	0.83%

Figure 11: Share of land covered with forest in Ethiopia, Kenya and Somalia as recorded by FAO and national databases (*this might differ from Deliverable 2.3 which is based on satellite imagery*). Forest area is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens. Source: Food and Agriculture Organization, electronic files and website.

In the HAD, nature conservancies benefit communities with livelihood opportunities, improved governance and enhanced social services – even while natural resource management challenges and human-wildlife conflict exists³⁷. Contrasting with the agricultural expansion, a steady (-0.16% per year) decrease in forest area is observed in Ethiopia, and a slight (-0.12% per year) decrease can be seen in Kenya (Fig.11). In Somalia, a decrease in share of forest area of 12% every year can be estimated from the data presented in Fig.8. From 2001 to 2020, Somalia lost 4.12kha of tree cover³⁸. Deforestation driven by shifting cultivation and charcoal burning causes serious land degradation problems and biodiversity loss³⁹. Ethiopia has a relative high percentage of protected areas compared to the global average, while Kenya scores mediocre in this regard (Table 2). Kenya also saw a dramatic decrease in wildlife due to expanding livestock numbers and decreasing protected area⁴⁰.

2.1.5 Dams, reservoirs presence

Both Ethiopia and Kenya have a significant number of dams (Table 3). They have no reservoirs in the most arid regions of the country, possibly due to the inefficiency of storing surface water in this climate. Ethiopia is also constructing a number of new dams, mainly in the west of the country (Fig.12): 17 dams (mainly on the Omo, Abay, and Akobo rivers) are being constructed or planned. Kenya plans for 6 new dams of which 3 on the Tana river⁴¹. For Somalia, no data was available.

Table 3: Dam constructed for hydropower in Ethiopia (brown) and Kenya (Orange) over time. Source: Grand



Figure 12: Map showing the location of dams and reservoirs in HAD. Blue dots represent dams present in the GRAND database⁴², green dots present dams present in the GOOD2⁴³ database. Orange dots are dams under construction, red dots are planned dams. Source: Global Dam Watch.

Name of dam	Region	Major basin	Date
Gafarsa	Oromiya	Rift Valley	1955
Koka	Oromiya	Rift Valley	1960
Finchaa	Oromiya	Nile Basin	1973
Legadadi (Main)	Oromiya	Rift Valley	1979
Legadadi (Subsidiary)			1979
Angereb			1991
Alwero	Gambela	Nile Basin	1995
Midimar			1996
Dire			1999
Melka Wakena	Oromiya	Shebelli & Juba Basin	
Riuru	Central Province	East Central Coast	1949
Owen Falls		Nile Basin	1954
Sasumua	Central Province	East Central Coast	1956
Kindaruma	Eastern Province	East Central Coast	1968
Kamburu	Eastern Province	East Central Coast	1974
Gitaru	Eastern Province	East Central Coast	1978
Bathi	Central		1980
Masinga	Eastern Province	East Central Coast	1980
Kikoneni	Coast Province	East Central Coast	1981
Mulima	Eastern Province	East Central Coast	1982
Chemeron	Rift Valley Province	Rift Valley	1984
Ellegirini	Rift Valley Province	Nile Basin	1987
Kiambere	Eastern Province	East Central Coast	1987
Manooni	Eastern Province	East Central Coast	1987
Muoni	Rift Valley Province		1987
Moiben	Rift Valley Province		1991
Turkwel	Rift Valley Province		1991
Turkwel	Rift Valley Province	Rift Valley	1991
Thika	Central Province	East Central Coast	1993
Kirindich	Rift Valley Province		2000

2.1.6 River network and navigation

In 2019, inland water for Ethiopia was 768 thousand hectares. Though Ethiopia inland water fluctuated substantially in recent years, it tended to decrease through 2000 - 2019 period ending at 768 thousand hectares in 2019. In the same period, Kenya and Somalia inland water remained stable at around 1,123 and 1,032 thousand hectares respectively (Knoema atlas).

Both Kenya and Ethiopia are part of the Nile Basin, however they are not connected to main, year round navigation routes nor have any major river ports⁴⁴. There are no navigable waterways in Somalia. Gambella (Ethiopia) is connected to Sobat (South Sudan) through a seasonal navigation route on the Baro river. Lake Victoria (with port in Kisumu, Kenya) acts as principal waterway with commercial traffic between Uganda, Tanzania and Kenya.

2.2 Livelihood characteristics in DOWN2EARTH case study regions

2.2.1 Exposure changes in the Drylands

East Africa is characterised by a rapidly growing population – which consists of a rich diversity of ethnic groups, a variety of pastoralists and agro-pastoralists in the semi-arid regions⁴⁵. This demographic growth drives multiple livelihood changes in the ASAL in Eastern Africa. Indeed, changes such as shifting livestock mobility, turning into agro-pastoralism, charcoal production rural-urban migration and villagisation are observed due to increasing market penetration (commercial development) and climate change (environmental shocks). These socio-economic trends – driven by livelihood diversification - cause land degradation (soil salinisation) and landscape changes (vegetation condition) and evidence the exposure dynamics in the HAD⁴⁶.

2.2.2 Population and livelihood zones in Mieso and Dodota woredas in Oromia (Ethiopia)

Mieso and Dodota are located in the Arsi zone (district) in the Oromia region of Ethiopia. According to the Dodota *woreda* (Ethiopian admin level 3) agricultural office in 2021, all livelihoods are based on permanent settlement systems and the total population of the Dodota *woreda* is about 78,925. The current population in the Mieso *woreda* is estimated at about 200,000, mainly in permanent settlement villages but semi-nomadic pastoralism is also present⁴⁷.

The Dodota *woreda* is dominated with mixed crop-livestock production system (Fikre and Demissie, 2012). Both rainfed (8 kebeles) and (recently introduced) irrigated (4 kebeles) agriculture systems are practiced. Rainfed maize forms the major rainfed crop, along with *teff* and wheat. Different types of vegetables (e.g., cabbage, onion, green pepper and tomato) and fruits (e.g., mango, banana, avocado) are cultivated mostly under irrigation. Cattle, goats, sheep and donkeys are the major types of livestock⁴⁷.

Traditionally, the whole Mieso *woreda* was identified as pastoral zone. However, due to a shift in Ethiopian Government policy towards crop production, it is mainly dominated with agro-pastoralists (19 kebeles) and crop producers (5 kebeles) with little pastoralism (7 kebeles) left. The *woreda* is largely rainfed and cultivates sorghum, but maize, sesame, haricot beans and sweet potatoes form other minor crops. Cattle, goats, camels, sheep and donkeys are the type of livestock kept in all livelihood systems⁴⁷.

2.2.3 Population and livelihood zones in Oldonyiro, Kinna and Burat wards in Isiolo (Kenya)

The Oldonyiro, Kinna and Burat *ward* (Kenyan admin level 3) are located in the Isiolo county (district) of Kenya. Based on the 2019 Kenya Population and Housing Census, Isiolo County had a population of 268,002 people, of which 139,510 were male, 128,483 were female, and 9 were intersex⁴⁸. The County had a population density of 11 people per square kilometre, and an average household size of 4.6 people in the same year⁴⁸.

Ol Donyiro and Burat are part of Isiolo Subcounty which has a population of 121,066, while Kinna is located in Garbatulla sub-county which has a population of 99,730 people⁴⁸. Communities in Isiolo county depend on 3 major livelihood activities: livestock keeping, agro-pastoralism and farming. Other prominent economic activities include: small businesses, Village Saving Loans Assemblies/Associations, bee keeping, and charcoal burning and illicit brew (DOWN2EARTH Scoping Study in Isiolo county).

The Oldonyiro *ward* is inhabited by Samburu and Turkana pastoralists who mostly depend on livestock (cows, donkeys, camel, sheep and goats) and livestock products for their livelihood. With increasing climate change impacts, there has been an emergence of small kitchen gardens with vegetables, sorghum, green gram, maize, beans and eggplant as the main crop types. Other livelihood activities

include micro-enterprises, poultry, bee keeping and sand harvesting (DOWN2EARTH Scoping Study in Isiolo county).

Kinna *ward* is inhabited by the Borana community which are predominantly pastoralists and agro-pastoralist engaging in extensive livestock production (sheep, cows, camels, goats, poultry, and donkeys). Historically, the main economic activity in Kinna was semi-nomadic pastoralism, but now more and more crop cultivation (including maize, beans, cowpeas and green grams) with small scale irrigation (tomatoes, watermelon, onions, sugarcane, and pawpaw) takes place around riverine zones (both subsistence and cash crops). Other economic activities include bee keeping and small and medium business enterprises (DOWN2EARTH Scoping Study in Isiolo county).

Burat *ward* is inhabited by different ethnic groups including Somali, Borana, Turkana, Meru and Samburu who mainly engage in smallholder farming and agro-farming practices. Both subsistence and cash crops tomatoes, onions, beans and maize are produced under irrigated conditions. Besides, small herds of cows, camels, goats and donkeys are kept. Its proximity to a major urban area (Isiolo Town) enables small businesses and trading, next to natural-resource based livelihood activities such as sand harvesting and extraction, fuelwood collection and charcoal burning (DOWN2EARTH Scoping Study in Isiolo county).

2.2.4 Population and livelihood zones in Odweyne district, in the Togdheer region (Somalia)

Odweyne district (Somalian admin level 2) is located in the Togdheer region of Somalia. Odweyne is the northeast district of the Togdheer region with an estimated population of 192,000³. It is mostly inhabited by agro-pastoralists, with a few nomadic pastoral villages along the border with Ethiopia. The people in these villages have generally been sedentary for the past 70 years⁴⁹.

Rainfed sorghum, maize, and beans are grown primarily for subsistence, irrigated watermelon, guava, vegetables and sesame are grown as cash crops and camels, sheep and goats are the most common type of livestock in the area. Naturally grown fodder is produced for the dry seasons. Some families manage small businesses in the villages such as teashops, restaurants and small shops selling assorted commodities. Women often sell daily milk at the village centres or the nearest town and young men are involved in cutting trees for charcoal production and firewood⁴⁹.

Somali society has traditionally been nomadic pastoralists, keeping drought resistant livestock species – camels, goats and sheep. However, crop production exists since the 1940s; sesame and watermelon is being cultivated since 15 years ago. Since recently (2018), women cooperatives are trained on kitchen gardening to grow vegetables and fruit trees for business and domestic use⁴⁹.

The irrigation for the vegetables and fruit trees is from shallow wells, plastic-lined pits, underground cisterns (berkads) and an earth dams through locally devised drip irrigation. Besides, Odweyne town and adjacent villages have shallow wells along dry rivers (brackish water) serving nomadic pastoralists from Togdheer and adjacent regions. The ministry and World Vision have commissioned additional drilling projects, although failed to reach water between 450-650m deep. A borehole at Ceel-xume village, the only one in the district, has hard water for human drinking. There are about 1600 berkads, mostly private, of which 64% are functional (2021)⁴⁹.

3 Observations on vulnerability in the Horn of Africa Drylands

This section discusses observed national and local trends (Table 4) in social sensitivity, economic sensitivity, environmental sensitivity, lack of coping capacity and lack of adaptive capacity for Ethiopia, Kenya and Somalia. Data on urban and rural population, population growth and migration, livestock, rainfed and irrigated land, protected areas, hydropower installations and water bodies are presented. Besides, local sensitivity and coping capacity characteristics of 2 woredas (Mieso and Dodota in Oromya, Ethiopia), 3 wards (Oldonyiro, Kinna and Burat in Isiolo county, Kenya) and 1 district (Odweyne in Togdheer region, Somalia) are offered. Together, this allows the possibility to draw conclusions on the changes in vulnerability in the Horn of Africa.

Table 4: Observations on vulnerability in Kenya, Ethiopia and Somalia: Data indicators and sources.

	Indicators	Sources
Social susceptibility	Clean water and sanitation	WHO/UNICEF Joint Programme for Water Supply, Sanitation and Hygiene , Institute for Health Metrics and Evaluation,
	Access to productive land	Food and Agriculture Organization; World Bank and Comtrade database of the United Nations Statistics Division.
	Gender Inequality	ILOSTAT database, Demographic and Health Surveys, CPIA database
	Health, life expectancy	United Nations Population Division, United Nations Statistical Division, World Health Organization, Global Health Observatory UNAIDS, : WHO and UNICEF
	Illiteracy, education	UNESCO Institute for Statistics
	Refugees, conflict, insecurity	The Internal Displacement Monitoring Centre and Uppsala Conflict Data Program and Refugee Data Finder - UN High Commissioner for Refugees, UNHR
	Undernourishment	Food and Agriculture Organization, World Health Organisation
Economic susceptibility	GDP, working population	World Bank national accounts data, ILOSTAT database
	Economic equality	World Bank, Development Research Group
	Market fragility	International Monetary Fund
	Dependency on agriculture	World Bank national accounts data
	Agriculture machinery	FAO
	Hydroelectricity	GRandD and INERA
	Poverty and social security	World Bank, Development Research Group and United Nations Human Settlements Programme, ASPIRE
	Tourism	World Tourism Organization
	Unemployment	ILOSTAT database and United Nations Population Division's World Population Prospects
Environmental susceptibility	Water stress	FAO AQUASTAT
	Fertiliser use	FAO
	Water quality	na
Coping capacity	Access to credit	Global Financial Inclusion Database, World Bank and World Bank, Doing Business project
	Corruption	International Monetary Fund, Financial Access Survey
	Crop varieties	na
	Dam capacity	na
	Government effectiveness	World Bank Group, CPIA database, World Bank, Doing Business project
	Development assistance	International Development Statistics database
	Savings	OECD
Adaptive capacity	Access to electricity and media	IEA Statistics, International Telecommunication Union
	Adaptation plans	Climate analytics
	DRR policies	Climate analytics
	Public participation	Climate analytics
	R&D expenditure	UNESCO Institute for Statistics
Vulnerability in Oromya	Livelihood resilience	D2E scoping report; DRIER case study
Vulnerability in Isiolo	Livelihood resilience	D2E scoping report
Vulnerability in Togdheer	Livelihood resilience	D2E scoping report

3.1 National trends in social susceptibility

3.1.1 Access to clean water & sanitation

A lack of access to clean water and poor sanitation increases vulnerability to drought events. A mortality rate attributed unsafe water sanitation and lack of hygiene is shown in Table 3. In Kenya, unsafe water, sanitation and hygiene (WASH) services elevate the national mortality rate with about 63 persons per 100000 people (Figure 13). Ethiopia and Somalia's mortality rate linked to unsafe water are slightly higher (respectively 73 and 75 persons per 100k people in 2017). For all three countries, and especially Somalia, significant decreases over time can be observed. Other water safety indicators, such as access to sanitation services, basic drinking water services and practicing open defecation, also play a role in determining vulnerability to drought. Increases in access to basic and safely managed WASH (sharp increase in Somalia since 1995; still a low rate of about 5% of the rural population for Ethiopia), and to safe drinking water (higher values but less increase for Kenya) can be observed (Fig.14). Open defecation is decreasing steadily. One can see that in recent years, Ethiopia is catching up with Kenya. Kenya has a higher rate of clean water and sanitation due to its multiple accountability mechanisms and platforms related to creating progress on SDG 6⁵⁰. Somalia shows a steady decline but still has 40% of the rural population practicing it.

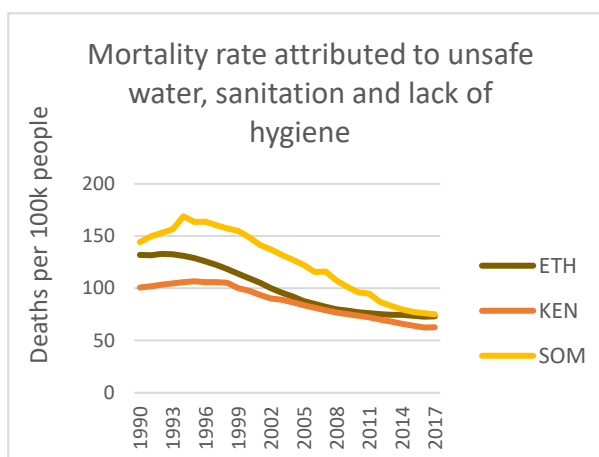


Figure 13: Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene: deaths attributable to unsafe water, sanitation and hygiene focusing on inadequate WASH services. Source: Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2017. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018.

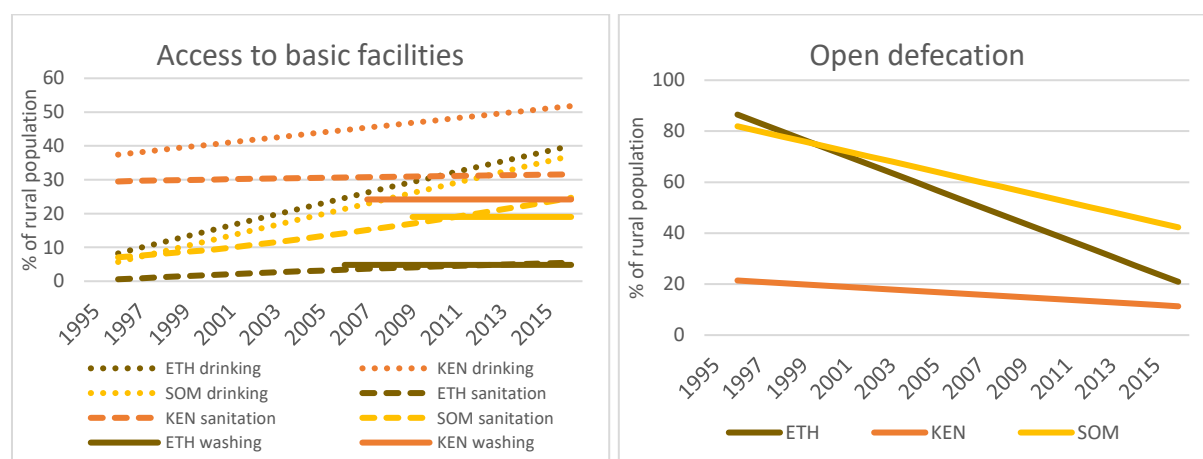


Figure 14: Water safety indicators for the rural population in Ethiopia (brown), Kenya (orange) and Somalia (yellow). Left figure: Dotted line: people with access to at least basic drinking water servicesⁱⁱ. Short-striped line: people with access to at least basic sanitation servicesⁱⁱⁱ. Full line: people with access to at least hand washing facilities. Right figure: Percentage of people practicing open defecation. Source: WHO/UNICEF Joint Programme for Water Supply, Sanitation and Hygiene.

ii Basic drinking water services is defined as drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip. Improved water sources include piped water, boreholes or tubewells, protected dug wells, protected springs, and packaged or delivered water.

iii Basic sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slabs. Safely managed improved sanitation facilities are not shared with other households and where excreta are safely disposed of in situ or transported.

3.1.2 Access to productive land

Food production can be hampered due to droughts causing crop failure and livestock mortality. Stable food availability is crucial for maintaining a food stock that can be used to overcome dry periods. For all three countries, both crop and livestock production has increased since 1960 (Fig.15). Kenya has seen a quite steady upward trend in both crop and livestock production, quintupling its production over the last fifty years⁵¹. Data for Ethiopia starts only in 1992 but the country has seen a particularly sharp increase in crop production since. More variability is visible in the food production in Somalia. Peaks and troughs in crop and livestock productivity match to a large extent, meaning they might be caused by regional events such as droughts (e.g. the dip since 2015 or the one in 1984) and war (e.g. the civil war starting in 1990). This shows that production in Somalia is very vulnerable to all kinds of shocks – particularly conflicts⁵², where famine hits women and children particularly hard⁵³. Continuing soil depletion, land degradation and climate change are expected to reduce agricultural production further^{54,55}.

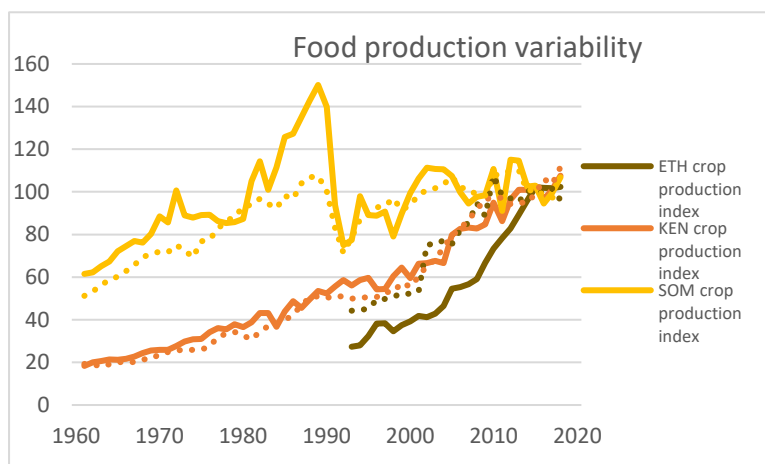


Figure 15: Full line: crop production index for Somalia (yellow), Kenya (orange) and Ethiopia (brown). The index shows agricultural production for each year relative to the base period 2014-2016. It includes all crops except fodder crops. Dotted line: livestock production index for Ethiopia, Kenya and Somalia. The index shows livestock production for each year relative to the base period 2014-2016. It includes meat and milk from all sources, dairy products such as cheese, and eggs, honey, raw silk, wool, and hides and skins. Source: Food and Agriculture Organization

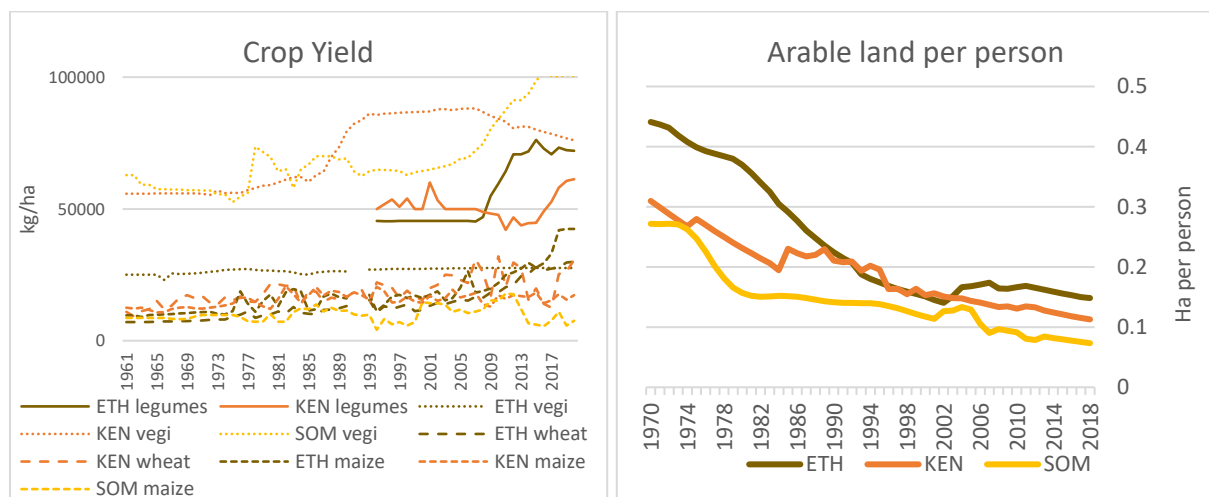


Figure 4: Left panel: Crop yield of the mayor food crops. Right panel: Arable land in hectare per person. Arable land (hectares per person) includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Source: Food and Agriculture Organization.

The production increases are mainly due to increased yield (Fig.16), as the arable land extent does not change significantly in the countries (See section on exposure). Indeed, the amount of arable land per person is decreasing due to the sharp population increases – challenging the production increases with a massively raise in food demand. If there is less arable land per person, more production per hectare is needed to feed all, or more food import is required. Such a reliance on imports can be regarded as vulnerable, given that other countries will prioritise their own food needs whenever production fails. Indeed, due to the sharp population growth, the amount of arable land per person is decreasing strongly, for all three countries (Fig.16). Ethiopia's decline is the largest, reducing by a factor 3 over fifty years. Food imports (Fig.17) in Somalia were high (30% of the merchandise imports) before the 1990s but data afterwards is missing. For Kenya and Ethiopia, this fluctuates around 10% (mostly between 5% and 20% of their merchandise imports).

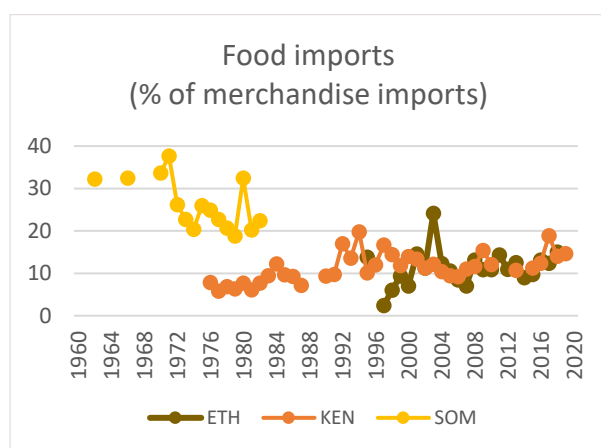


Figure 5: Left panel: food imports. Food comprises food and live animals, beverages and tobacco, animal and vegetable oils and fats and oil seeds, oil nuts, and oil kernels Source: World Bank and Comtrade database of the UN Statistics Division.

3.1.3 Gender inequality^{iv}

In the dryland regions in Kenya, women and woman-headed households (one out of three households in Kenya and one out of four households in Ethiopia) are more vulnerable to climate risks due to gender-bias and unequal opportunities (Fig.18,19)⁵⁶. Indeed clear differences in adaptive responses by gender are found; position of power within society and households push women to survival strategies—often risky ventures - and excessive work burdens; causing challenges to manage both the productive and care work. This differentiate vulnerability requires gender-focused approaches, aware of the often complex local gender roles and relations in existence⁵⁷.

In Kenya and Ethiopia, only 50% of the women are part of the workforce. In both countries, although the total amount of working people has increased (by a significant amount in Ethiopia), the share of women in the workforce has not. In Somalia, no trend is visible either in labour force or in the (very low) share of female participation. The number of seats held by women in national parliaments is increasing but still only one out of five in Kenya and Somalia. Ethiopia performs better with almost 40%, showing the largest increase of the three countries over the last 25 years. The Gender Equality Rating from the CPIA group of the World Bank^v gives moderate equality rating to Kenya and Ethiopia while Somalia receives a lower rating (2/6).

^{iv} Gender equality assesses the extent to which the country has installed institutions and programs to enforce laws and policies that promote equal access for men and women in education, health, the economy, and protection under law. Source: AfDB (2011)

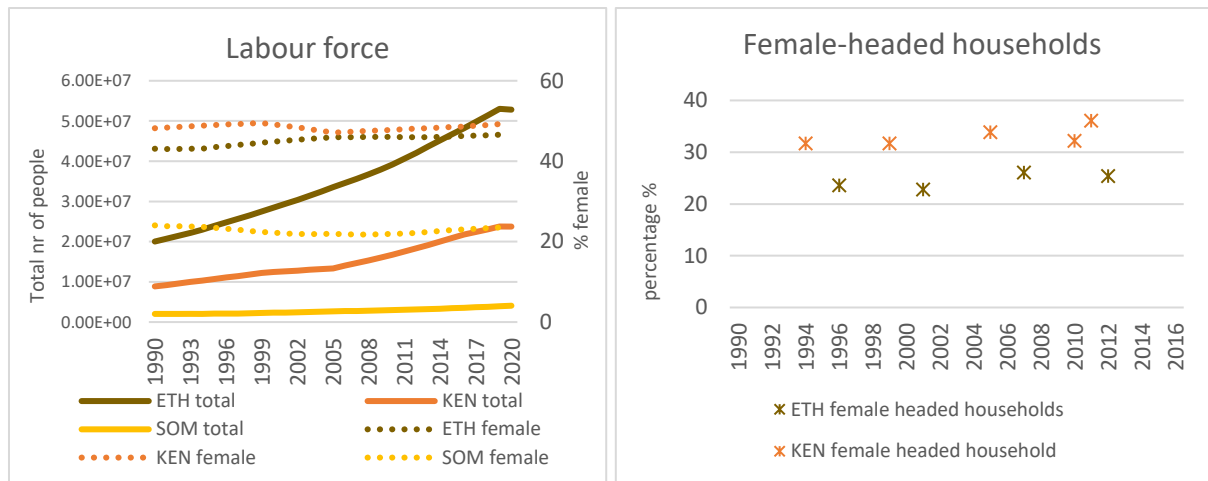


Figure 6: Left panel: Total and Female labour force as a percentage of the total. These graphs show the extent to which people / women are active in the labour force. Labour force comprises people ages 15 and older who supply labour for the production of goods and services during a specified period. Right panel: the percentage of households with a female head. Source: Data from International Labour Organization, ILOSTAT database. Demographic and Health Surveys.

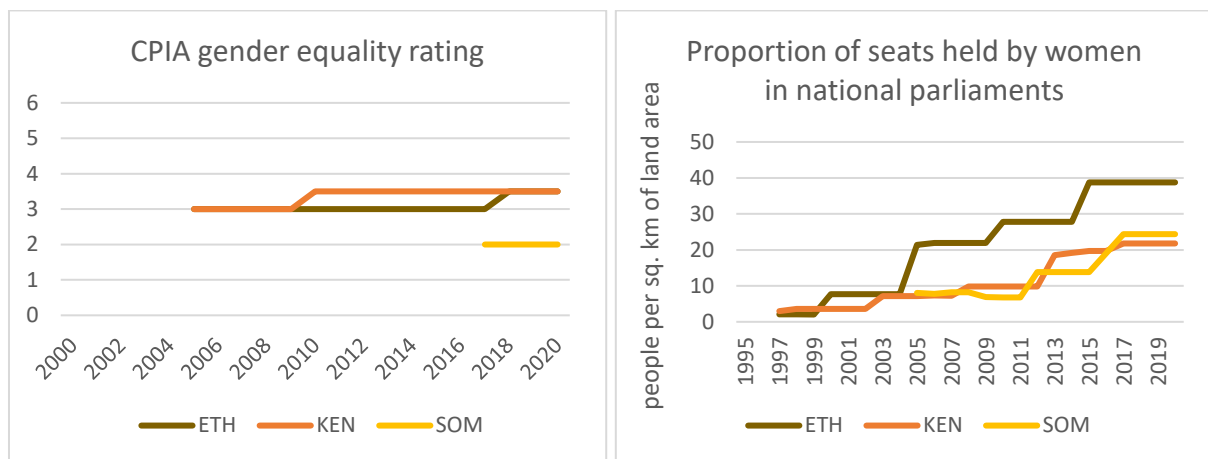


Figure 7: Left panel: Gender equality assesses the extent to which the country has installed institutions and programs to enforce laws and policies that promote equal access for men and women in education, health, the economy, and protection under law. Right panel: the percentage of parliamentary seats in a single or lower chamber held by women. Source: World Bank Group, CPIA database and Inter-Parliamentary Union (IPU)

Table 5: Women participating in the three decisions (own health care, major household purchases, and visiting family) is the percentage of currently married women aged 15-49 who say that they alone or jointly have the final say in (1) own health care, (2) large purchases and (3) visits to family, relatives, and friends. Source: Demographic and Health Surveys

Women participating in the three decisions (% of women age 15-49)						
	2003	2005	2009	2011	2014	2016
Ethiopia		45.4		54.4		70.6
Kenya	25.7		52.3		55.8	

At the household level, inequality among male and female household members exists as well. While a positive trend female participation rate is visible (based on three data points) in Kenya and Ethiopia, only 56% and 71% respectively of the households have women participating in decisions regarding own health care, major household purchases, and visiting family (Table 5). No data was available for Somalia.

3.1.4 Health expenditures, ill-health and Life expectancy

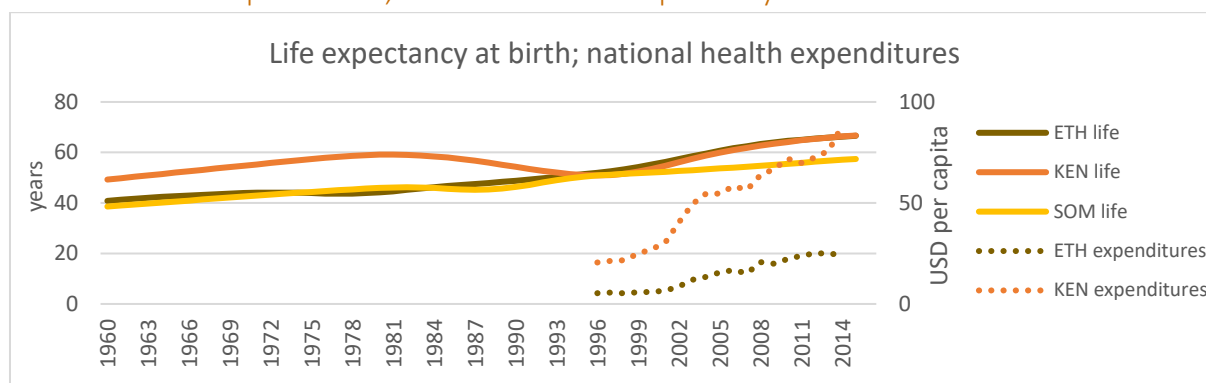


Figure 8: Governmental health expenditure per capita (USD) and Life expectancy at birth. The latter indicates the number of years a new born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Source: World bank, from (1) United Nations Population Division. (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division.

Overall, life expectancy at birth (Fig.20), a proxy for the health situation of a country, has increased over the last 50 years in Kenya, Ethiopia and Somalia. All three countries also experienced a decrease in death by diseases and maternal, prenatal and nutrition conditions (Fig.21). Life expectancy in Ethiopia and Somalia showcases a steady progression, with faster improvements in Ethiopia over the last twenty years. Kenya shows more variability in life expectancy, with a small decline during the 1990's mainly due to HIV/AIDS⁵⁸. The recent exponential increase in Ethiopia may be due to an increased number of nurses and midwives (Fig.21), also showing an increased growth rate in the last twenty years. Kenya has the highest number of medical personnel (both nurses and physicians) and this is reflected in a high – and increasing – national health expenditure (Fig.20). It is striking that while Kenya's health expenditures have been higher than those of Ethiopia, and while it has a higher number of physicians and nurses, the life expectancy in Ethiopia and the share of deaths caused by communicable diseases are equal to those of Kenya.

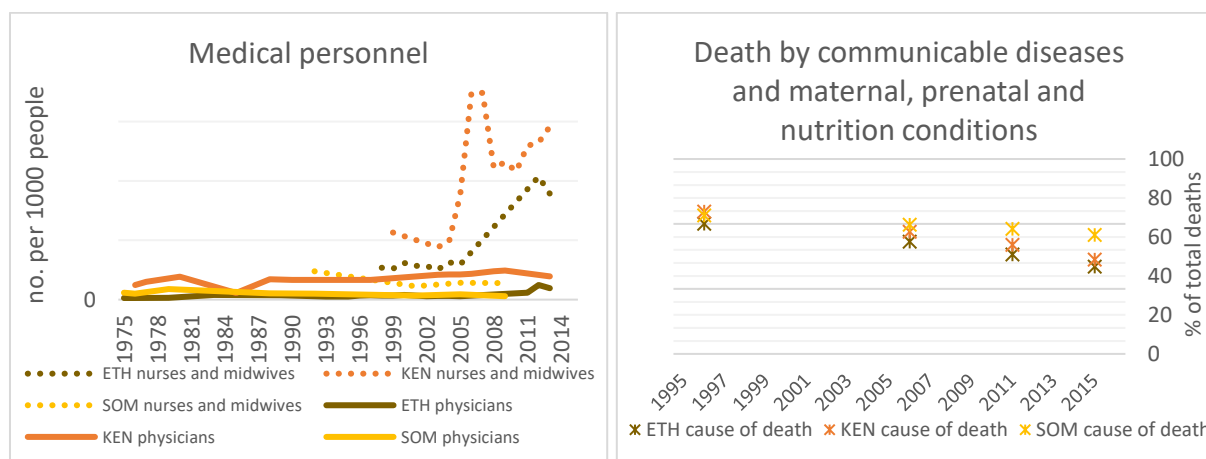


Figure 21: Left panel: Number of nurses and midwives (dotted line), and physicians (line)^{vi}, per thousand people. Right panel: Cause of death^{vii} by communicable diseases and maternal, prenatal and nutrition conditions. Estimates of current health expenditures include healthcare goods and services consumed during each year. Source: World Health Organization's Global Health Workforce Statistics, OECD, supplemented by country data, Global Health Estimates 2020. and World Health Organization Global Health Expenditure database.

vi Nurses and midwives include professionals, auxiliary ones, enrolled nurses, enrolled midwives and other associated personnel. Physicians include generalist and specialist medical practitioners.

vii Cause of death refers to the share of all deaths for all ages by underlying causes. Communicable diseases and maternal, prenatal and nutrition conditions include infectious and parasitic diseases, respiratory infections, and nutritional deficiencies such as underweight and stunting.

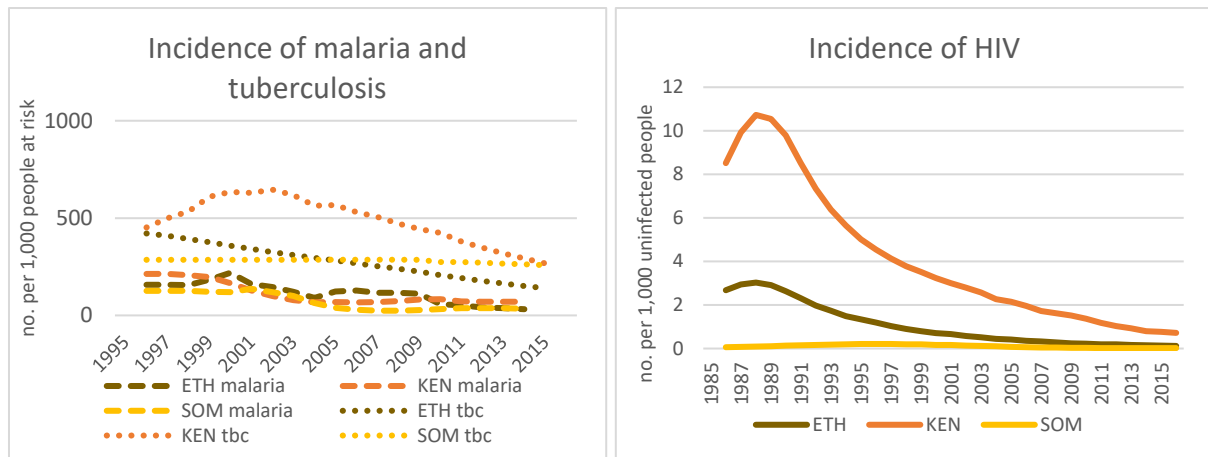


Figure 22: Left panel: The number of new cases of malaria and the estimated number of new and relapse tuberculosis cases. Right panel: Number of new HIV infections among uninfected populations expressed per 1,000 uninfected population. Sources: UNAIDS estimates and World Health Organization, Global Health Observatory Data Repository, Global Tuberculosis Report.

Chronic diseases can increase people's sensitivity to climate risk as they may be more vulnerable to food insecurity and/or have less capacity to cope with the harmful consequences of hazards. Looking into the incidence of malaria, tuberculosis (TBC) and HIV, most have decreased over the last thirty years, in Kenya, Ethiopia and Somalia (Fig.22). Kenya has a particularly high incidence of malaria and HIV⁵⁹ which might explain the high health expenditure costs and its difference with Ethiopia (Fig.20). Better protection and awareness have halved the incidence of malaria in the three countries⁶⁰. Ethiopia and Kenya have also successfully reduced tuberculosis and HIV due to immunization and rapid diagnosis⁶¹ and prevention and control programs⁶². The data on HIV infections in Somalia indicate low rates over the last thirty years, which may be due to insufficient data rather than a representation of reality, but is probably related to the Somali culture and society⁶³.

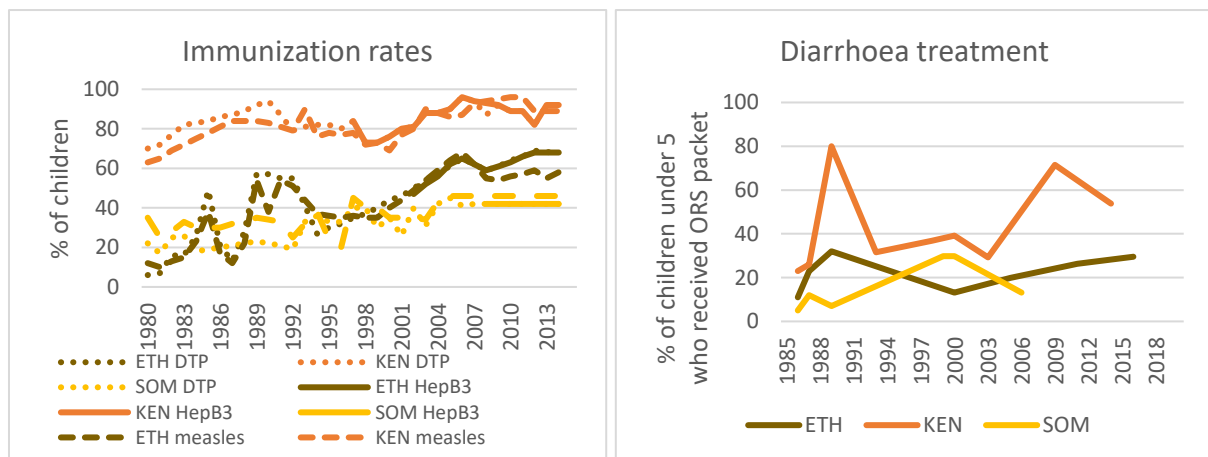
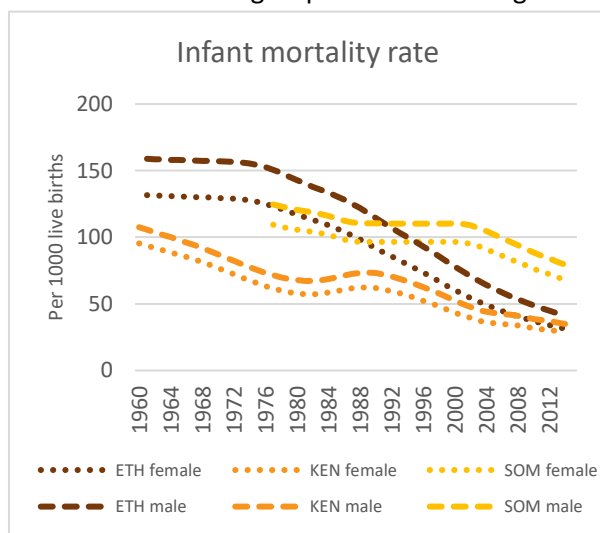


Figure 23: Left panel: Child immunization: Children ages 12-23 months who received 3 doses of diphtheria, pertussis, and tetanus (DPT) vaccinations; children ages 12-23 months who received 3 doses of hepatitis B vaccinations; and children ages 12-23 months who received the measles vaccination. Right panel: Diarrhoea treatment (received ORS packet) Source: WHO and UNICEF, State of the World's Children, Child info, and Demographic and Health Surveys

Likewise, healthy children are less vulnerable to climate risks and food or water insecurity. Immunization rates of diphtheria, pertussis, and tetanus (DTP) and Hepatitis B (HepB3) of young children have increased in Ethiopia, Somalia and Kenya and even reach almost 100% in the latter country, while in Somalia it still covers less than 50% of the 2-year olds (Fig.23). Trends in diarrhoea treatment – in percentage of children who receive oral rehydration therapy (ORS) packets – are less clear, a variability between 30% and 70% is visible for Kenya, while Ethiopia and Somalia vary between 5% and 30%. As diarrhoea can be caused by unsafe washing or drinking water services, this variability may be caused by changes in needs. However, the vast difference between Kenya, which has taken a

comprehensive approach to scale-up ORS production⁶⁴, and the other two countries, shows that the bottleneck is probably in the availability of ORS packages.

Another vulnerable group are children. Significant progress related to health is being made, visible



from the sharply decreasing infant mortality rate (Fig.24). This one has diminished to less than 50 per 1000 live births in Ethiopia and Kenya, while also decreasing the gender gap which was particularly large in Ethiopia before the '80s. Somalia decreased infant mortality to less than 10% at the start of the twenty-first century and shows a sharp decrease since then.

Figure 24: Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year. Source: Estimates developed by the UN Inter-agency Group for Child Mortality Estimation

3.1.5 Illiteracy and education expenditures

Access to education and having an educated population decreases drought vulnerability and increases the coping capacity of communities. Poor educational attainment results in low literacy rates in the Horn of Africa⁶⁵. Ethiopia has increased governmental expenditure on education in the last forty years (from 2% to over 5% of GDP) and this has resulted in augmented literacy rates (18% and 36% in 1990 to 44% and 59% in 2013 for women and men respectively) (Fig.25). While the difference between male and female literacy remains significant, recent slight improvements in this regard are visible too (in 1990, the male literacy rate was 50% higher than the female literacy rate, this is reduced to 25% in 2016). In Kenya, education expenditures vary between 5 and 7% of GDP, this is higher than in Ethiopia and results in a higher literacy rate (between 66% and 87%) (Fig.25). However, no clear trend can be observed over time. While high, there is also a significant gap among male and female literacy (respectively 85% and 78% in 2014). For Somalia there is no data on education expenditure and literacy rates.

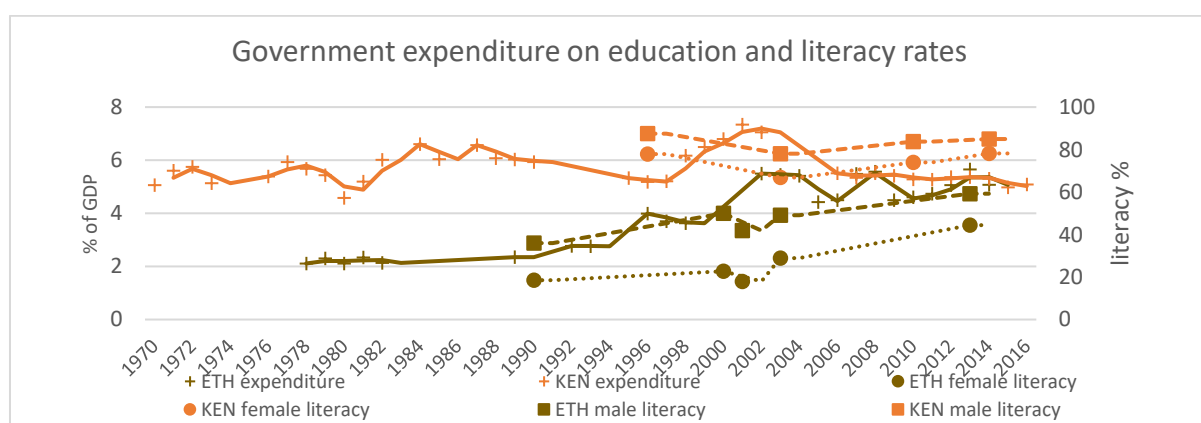


Figure 9: Government expenditures on education (full line) and literacy rates for female (dotted line) and male (striped line) population in Ethiopia and Kenya. General government expenditure on education (current, capital, and transfers) is expressed as a percentage of GDP. It includes expenditure funded by transfers from international sources to government. Adult literacy rate is the percentage of people ages 15 and above who can both read and write with understanding a short simple statement about their everyday life. Source: UNESCO Institute for Statistics. Data as of September 2021.

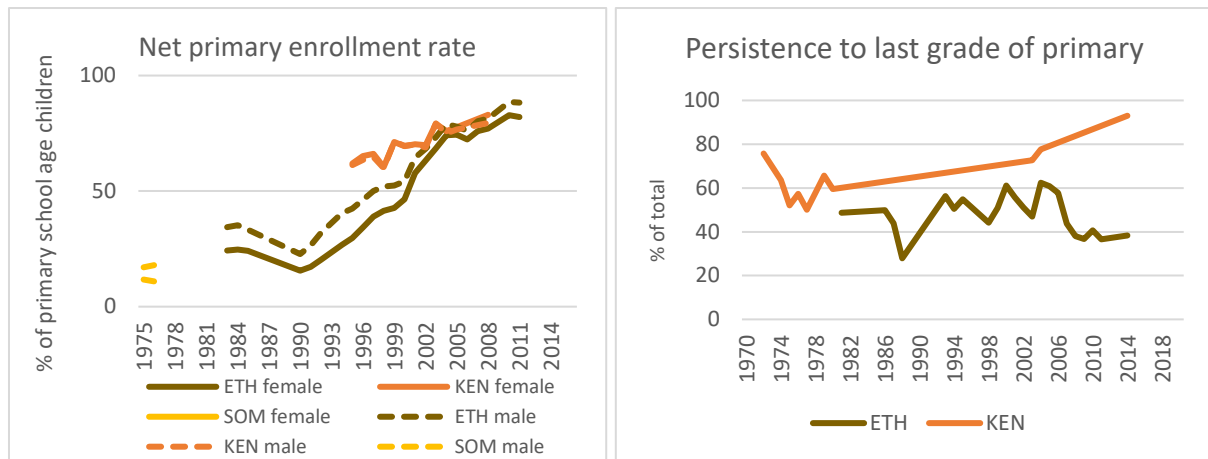


Figure 10: Primary education. Left panel: Primary enrolment rates per gender in Ethiopia, Kenya and Somalia. Adjusted net enrolment is the number of pupils of the school-age group for primary education, enrolled either in primary or secondary education. Right panel: Percent of the students attending school to the last grade of primary school. Persistence to last grade of primary is the percentage of children enrolled in the first grade of primary school who eventually reach the last grade of primary education. The estimate is based on the reconstructed cohort method. Source: UNESCO Institute for Statistics.

Looking into the primary enrolment rates and persistence to the last grade of primary (Fig.26) can serve as another proxy for education (prospects). The former has increased in both Kenya and Ethiopia, while Ethiopia also presents a decreasing gender gap and catches up with the initially higher rates in Kenya. Persistence, however, is quite low and variable (around 50%) in this country and does not show an increasing trend. In Kenya, an elevation of persistence rates is visible and would soon reach towards 100% if the trend continues.

While education reduces drought vulnerability, drought itself also has a wide-ranging impact on children's education. It can contribute to children being taken out of school⁶⁶. Droughts can force families into poverty, after which children – often girls – drop out of school to be involved in fetching water or finding pasture, and other negative coping strategies involving child labour⁶⁷. At the same time young boys in pastoralist communities may be forced out of school as they move around with livestock in search of water and pasture. Besides, drought events can lead to longer-than-average distances to water sources or to grazing land, and push towards coping strategies, leading to migration or creating extra labour; this causes school dropouts among children (especially girls)⁶⁸. Scientists⁶⁹ found that the proximity to water sources and water price have an effect on the pupil's participation in education. Indeed, low school enrolment, low class attendance, involvement in class activities and low retention of pupils in school are recurring problems in child education among dryland households⁷⁰.

3.1.6 Refugee population, Conflict and insecurity

Droughts can lead to temporary or permanent displacement. At the same time, displaced people are often more vulnerable to droughts. While there is some interannual variability, slightly upward trends since 2008 in internally displaced people due to disasters can be observed in the three countries (Fig.27). The amount of people displaced due to conflict and violence has slightly decreased in the last ten years in Kenya, but not in Somalia and Ethiopia. Looking into refugee population, a decreasing trend can be observed in Somalia (which has a peak during the Ogaden war when many Ethiopians fled to neighbouring countries⁷¹). Recently, an opposite flow is present: Somalis flee to Ethiopia to escape famine and violence⁷². In 2011, the HAD experienced prolonged drought leading to an influx of refugees into Kenya mostly from Somalia⁷³. The Kenya government estimates there to have been up to 2,000 weekly arrivals of refugees impacted by drought at the height of the famine.

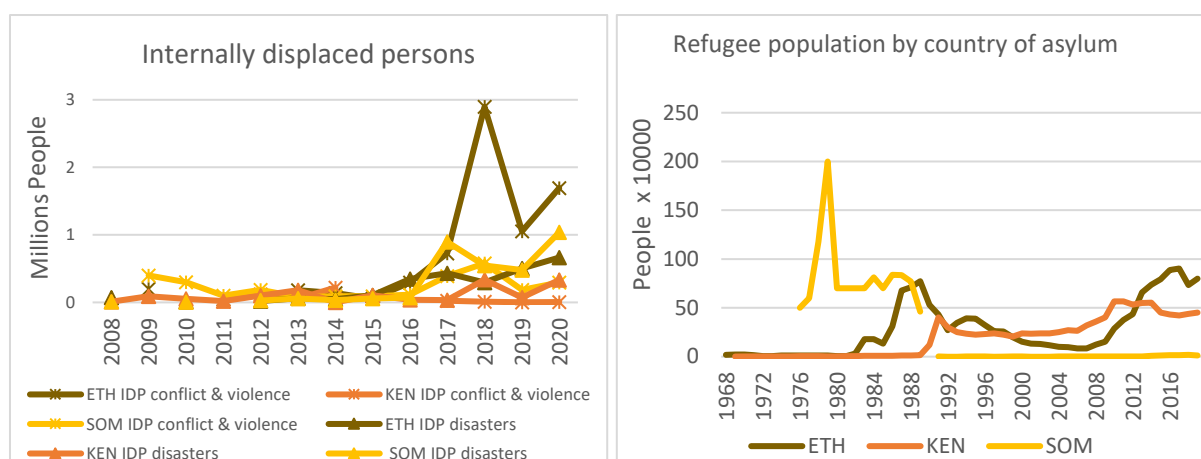


Figure 11: Left panel: Internally displaced people^{viii} due to disasters, conflict and violence. Right panel: refugee population by country of asylum. Refugees are people who are recognized as refugees under the 1951 Convention. Country of asylum is the country where an asylum claim was filed and granted. Source: The Internal Displacement Monitoring Centre and Uppsala Conflict Data Program and Refugee Data Finder - UN High Commissioner for Refugees

In battle-related deaths (Fig.28), spikes can be seen in Somalia and Ethiopia in '84-'86 and in Ethiopia in '95-'96. Recently, Kenya experienced battle related deaths for around 50-100 people per year while for Somalia this is 1500-2500. The effect of the Ethiopia-Tigray war that started in 2020 is not yet visible in these graphs, but IOM estimates 2.1 internally displaced people by mid-2021⁷⁴ and 3240 well-documented casualties (actual amount probably higher)⁷⁵.

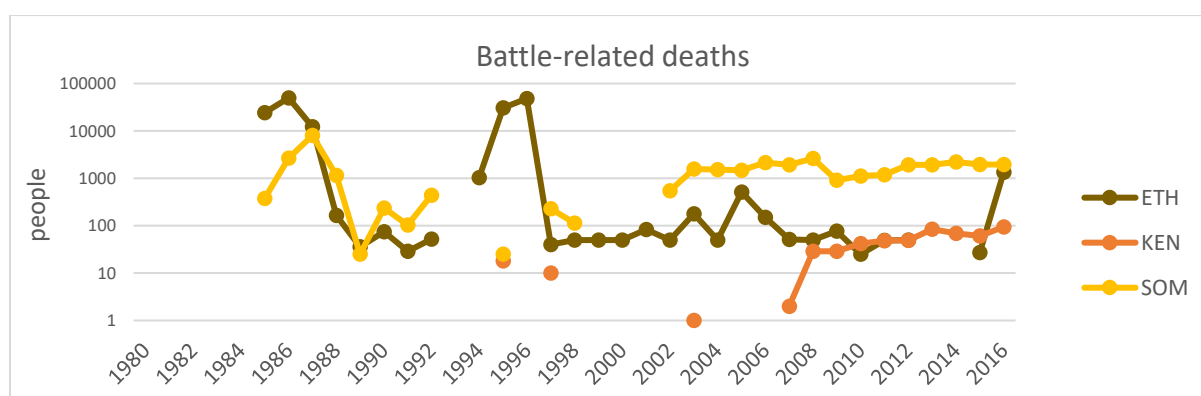


Figure 12: Battle-related deaths; --military as well as civilian-- deaths in battle-related conflicts between warring parties in the conflict dyad. Source: My world in Data. World Bank.

3.1.7 Undernourishment

Child malnutrition can be caused by socio-economic conditions or by shocks such as drought causing fodder and staple shortages⁷⁶. Children without steady access to food might be even more vulnerable to diseases when a drought hits. While the number of children being underweight or stunting has steadily decreased in Ethiopia and Kenya, Somalia saw a spike in 2002 (Fig.29). The prevalence of wasting does not show such a clear trend and lies around 5%, 10% and 15% for Kenya, Ethiopia and Somalia respectively. In addition, the share of undernourished people decreased in the last 20 years in Kenya and Ethiopia, the latter showing the strongest decrease (from almost 50% to 15% of the population). The number of people in moderate or severe food insecurity seem to have increased in

^{viii} Internally displaced persons are defined according to the 1998 Guiding Principles (<http://www.internal-displacement.org/publications/1998/ocha-guiding-principles-on-internal-displacement>) as people or groups of people who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of armed conflict, or to avoid the effects of armed conflict, situations of generalized violence, violations of human rights, or natural or human-made disasters and who have not crossed an international border.

Kenya since 2010. Somalia does not show a decrease in undernourishment since 1995, and displays a peak between 2004 and 2009 due to droughts and conflict⁷⁷. Somalia also has the highest number of people in moderate (79%) and severe (43%) food insecurity.

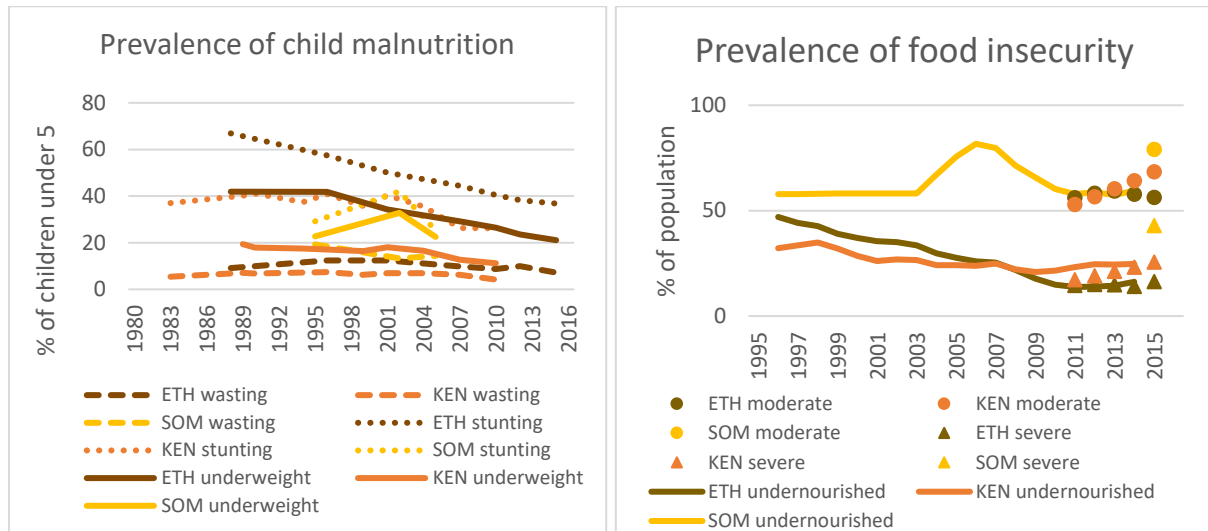


Figure 13 Prevalence of (severe) wasting (weight for height); stunting (height for age), and underweight (weight for age) of children under 5 years old^{ix}. Right panel: The percentage of people in the population who live in households classified as food insecure ^x or undernourished. Source: Food and Agriculture Organization of the United Nations (FAO) and World Health Organisation.

ix (Severe) wasting happens when children's weight for height is more than two (three) standard deviations below the median for the international reference population. Stunting happens when children's height for age is more than two standard deviations below the median for the international reference population. Underweight happens when children's weight for age is more than two standard deviations below the median for the international reference population.

x A household is classified as moderately or severely food insecure when at least one adult in the household has reported to have been exposed to low quality diets and might have been forced to also reduce the quantity of food they would normally eat because of a lack of money or other resources. A household is classified as severely food insecure when at least one adult in the household has reported to have been forced to reduce the quantity of the food, to have skipped meals, having gone hungry, or having to go for a whole day without eating because of a lack of money or other resources. People are classified as undernourished if their habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and health.

3.2 National trends in economic susceptibility

3.2.1 GDP & age-dependency ratio

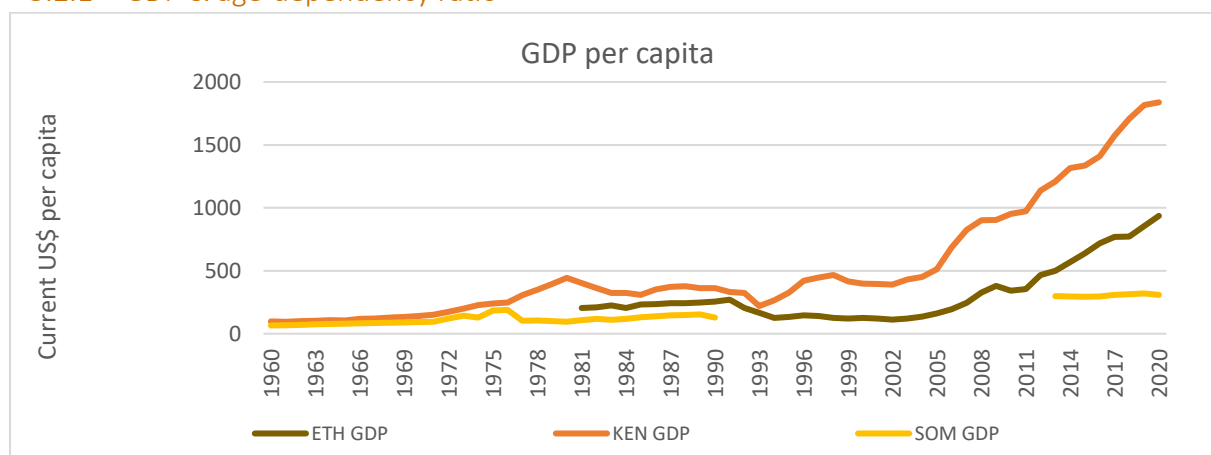


Figure 14: Gross Domestic Product (GDP) per capita for Ethiopia, Kenya and Somalia. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Source: World Bank national accounts data

Looking at the national scale, economic development is clearly visible for Kenya and Ethiopia (Fig.30), which both display an increase in GDP growth since the start of the 21st century. Kenya tripled its GDP per capita in the last twenty years and has a value double that of Ethiopia. Ethiopia had a low GDP per capita in the 1990's but quadrupled since. Somalia has a lot of missing data, but the latest numbers do not show a trend in GDP per capita. Countries with a high GDP per capita may be more resilient to shocks because they can better prevent, mitigate and prepare for droughts and enable faster recovery from the residual risk. However, disasters such as droughts can reduce GDP growth as well^{78;79;80;81}.

The ratio of dependents to the working-age population is about 100% in the three countries (Fig.31)—this is high compared to the international average of 55% in 2018 (data World Bank). A higher ratio indicates more financial stress on working people, possible political instability and an elevated investment risk factor⁸². However, Kenya has seen an increasing share of working-age population since the 1990s and Ethiopia followed this trend after 2000, indicating a reduced burden for the working-age population. The high age dependency ratio of Somalia can be linked to its peculiar demography with high fertility rate and many young children⁸³.

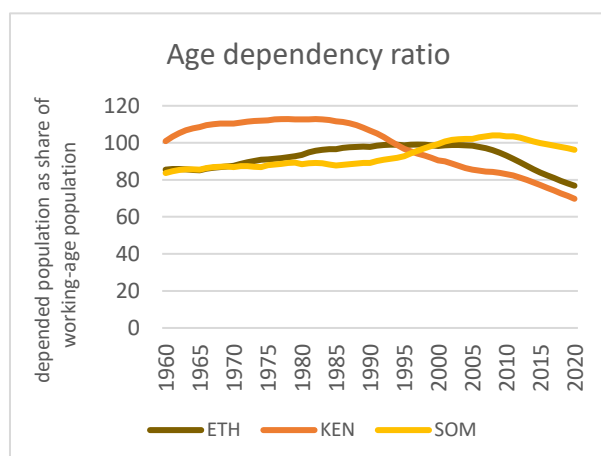


Figure 31: Age dependency ratio is the ratio of dependents--people younger than 15 or older than 64--to the working-age population--those ages 15-64. Data are shown as the proportion of dependents per 100 working-age population. Source: ILOSTAT database

3.2.2 GINI index and HDI

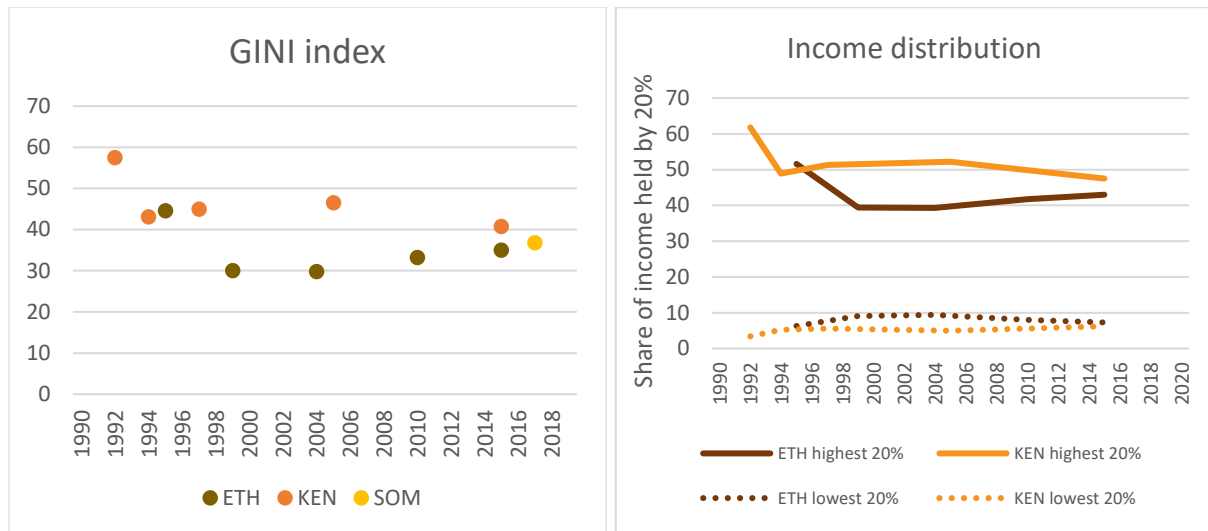
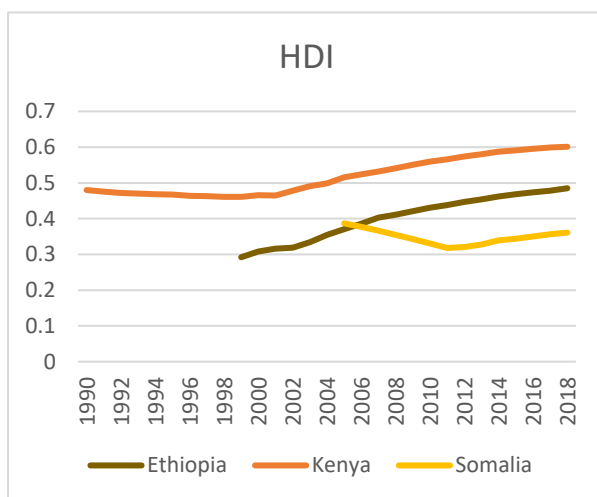


Figure 32: GINI index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution^{xi}. Right panel: Percentage share of income, the share that accrues to subgroups of population indicated by quintiles. Source: World Bank, Development Research Group

Looking into within-country economic inequality – part of a vicious cycle increasing a country's vulnerability⁸⁴, we see that the Gini Index¹² of the three countries is around 35-40 - which is low compared to a global average estimated on 0.61-0.68⁸⁵ (Fig.32). Kenya and Ethiopia had a higher Gini index in the 1990s so an increase in social equality was achieved – but the change has been variable over time. This is a result of the changing income distribution, which more clearly shows the development over time: before 2000, the two countries saw a sharp decrease in the share of income held by the richest 20%, but this has stagnated since. The share held by the lowest 20% has increased marginally.



While Somalia has seen a reduction in Human Development Index (HDI) (Fig. 33) due to the ongoing war, Ethiopia and Kenya have seen increases from 2000 onwards – with Kenya scoring consequently higher than Ethiopia.

Figure 33: Human development Index (HDI), an average of the values of three dimensions: education, health and standard of living which are measured with the following indicators: 'Mean years of schooling of adults aged 25+' and 'Expected years of schooling of children aged 6'; 'Life expectancy at birth' and 'Gross National Income per capita (PPP, 2011 US\$)'. Source: <https://www.nature.com/articles/sdata201938>

^{xi} A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line.

3.2.3 Market fragility

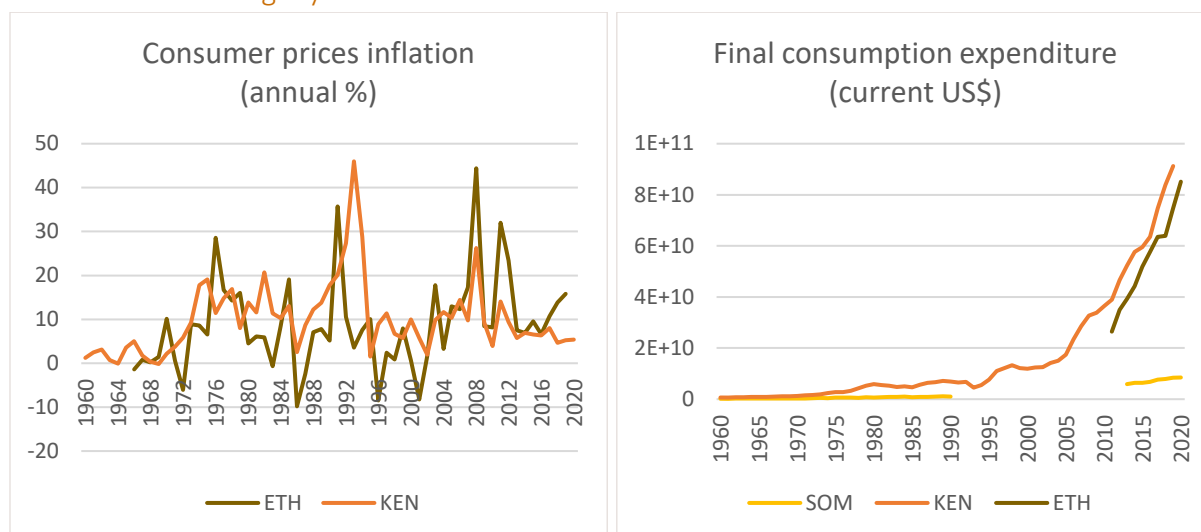


Figure 34: Left panel: Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals. Right panel: Final consumption expenditure (formerly total consumption), the sum of household final consumption expenditure (private consumption) and general government final consumption expenditure (general government consumption). Source: International Monetary Fund, International Financial Statistics and data files and World Bank national accounts data

Purchasing power and consumption expenditures indicate how economically strong households are, which directly reflects on their coping capacity under drought risk. With high inflation, markets that could allow households to mitigate or recover from droughts, will be less affordable. While no trend is clear, the inflation on the consumer price index for Kenya and Ethiopia has consistently been higher than 0; especially in Kenya (Fig.34). While both countries show drops in 1985-6 and 2001-2, they show inflation peaks in 1990-2, 2007 and 2011-2. Kenya's highest ever inflation rate of 46% was recorded in 1993 just after the 1992 General Election⁸⁶; while Ethiopia sees inflation caused by excess money supply and/or increased food demand; or in the case of 2007 a conflict-induced reduction in cereal production⁸⁷.

3.2.4 Agricultural GDP and Dependency on agriculture

Agriculture is a sector which is vulnerable to droughts. When a large share of GDP or of the national employment is dependent on agricultural production, the country can be considered vulnerable to drought shocks. The value added by agriculture in the three countries is quite high (Fig.35), with Kenya and Ethiopia around 35% of their GDP in 2020. A decreasing trend is visible in Ethiopia, while numbers in Kenya are also variable but does not display a clear trend.

In addition, employment in agriculture is quite high (around 75% in Somalia and Ethiopia and 55% in Kenya), meaning that the livelihood of a large share of the population is vulnerable to drought-induced production losses. Kenya shows an increasing trend over time, while Somalia and Ethiopia exhibit a slightly decreasing trend. Kenya also has a gender gap (a larger share of females are employed in agriculture, forestry, and fishing – probably caused by rural-urban migration of men searching for other livelihood opportunities). Remarkably, Ethiopia has a lower share of female employment in agriculture while the two other countries experience the opposite – this might be because of the unpaid status of such work (causing it to be excluded from census).

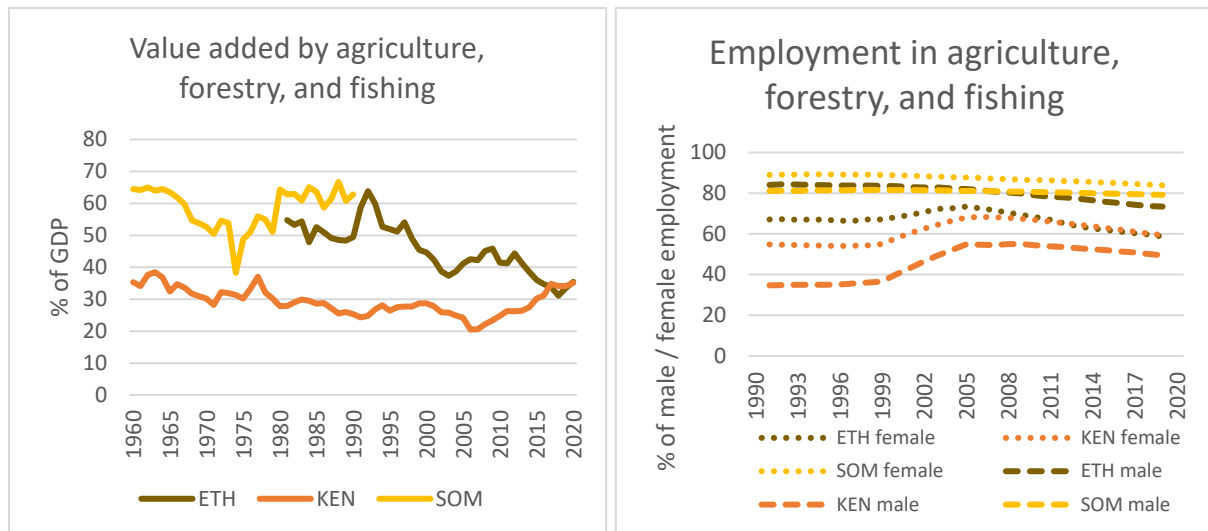


Figure 35: Left panel: Value added by agriculture (cultivation of crops and livestock production), forestry, and fishing (includes hunting); the net output of a sector after adding up all outputs and subtracting intermediate inputs, as percentage of the GDP. Right panel: Employment in agriculture, forestry and fishing. Employment is defined as persons of working age who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not at work due to temporary absence from a job, or to working-time arrangement Source: World Bank national accounts data.

3.2.5 Agricultural machinery

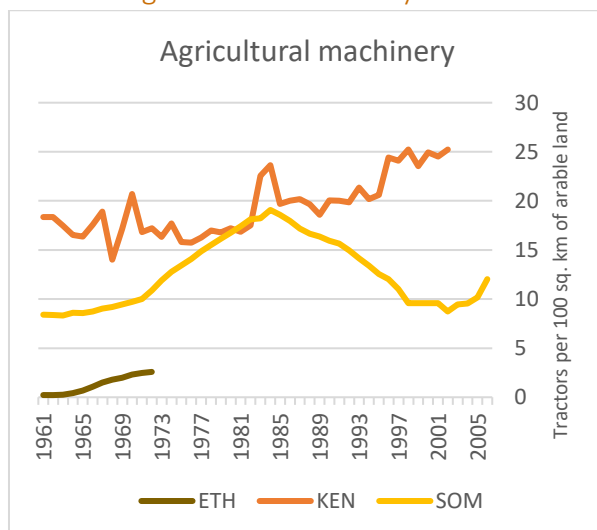


Figure 15: Left panel: Amount of agricultural machines per 100km² of arable land. Agricultural machinery refers to the number of wheel and crawler tractors (excluding garden tractors) in use in agriculture at the end of the calendar year. Source: FAO

Agricultural technologies and agronomic developments can increase and stabilise crop yields, reducing the vulnerability of production and thus of farmers to drought. The number of tractors have increased in Kenya (Fig.36). While some variability over time is visible, the country had around 25 tractors per 100km² of arable land in the early 2000's. The decline in tractors per 100 sq. km of arable land in Somalia from approximately 1985 to 1997 as seen in Figure 29 may be attributed to the Somali Civil War and its associated instability and socio-political and economic challenges such as increased fuel prices and reduced (international) market access⁸⁸. The civil war led to both a decline in total land under cultivation, as well as large-scale looting and loss of agricultural machinery⁸⁹. The stagnation and eventual increase in agricultural machinery from around 1997 onwards may be a consequence of military clashes beginning to decline relative to prior years around 1995.

3.2.6 Hydroelectricity

The evolution of hydropower production in Ethiopia (Fig.37) shows an increased use of this renewable source. While droughts can limit the generation of this type of energy (which would be visible through fluctuations in the production numbers), the building of new dams, reservoirs and hydropower installations is larger. Kenya's installed capacity stands at 7185 MW⁹⁰, and with the implementation of the Grand Ethiopian Renaissance Dam, 5.25GW capacity will be added⁹¹. The countries' hydropower potential is the 2nd highest in Africa. In Kenya, where more than 39% of the electricity comes from hydropower, more fluctuations are present while no strong increasing trend is visible⁹². Kenya's installed capacity stands at 837 MW⁹³. No data is found for Somalia.

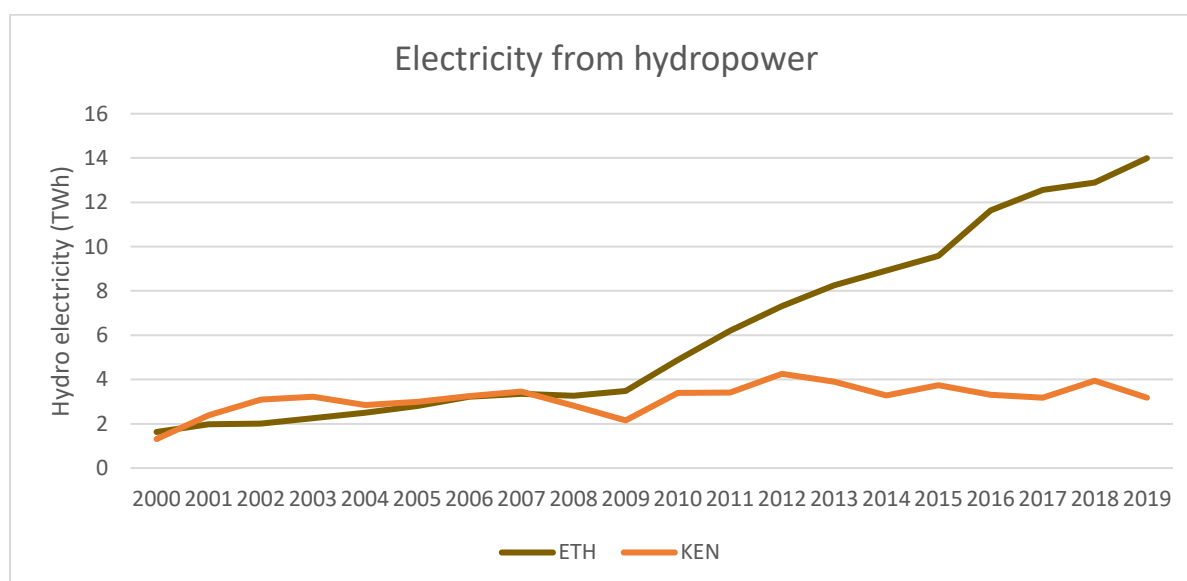


Figure 16: Hydroelectricity. Annual hydropower generation is measured in terawatt-hours (TWh). Source: BP Statistical Review of World Energy & EmberLink ^{xii}

3.2.7 Poverty and social security

Poverty is strongly correlated with capacity to cope with disasters ⁹⁴. Highest poverty rates are found in Somalia, while Ethiopia has seen a decrease in extreme poverty (<\$1.9); from 70% to 30% of the population during the 1991–2012 period (Fig.38). Kenya shows more variability, fluctuating around 40%; an increase in extreme poverty is for example visible in 2000 due to a teetering economy⁹⁵. The peak in extreme poverty around the year 2000 coincides with the approximate period that KANU, the ruling national party since the independence of Kenya in 1963, was ousted in democratic elections. The coalition that followed instituted several economic and socio-political reforms. Slums often lack access to safely managed WASH services and drinking water, increasing the vulnerability to droughts for the poor people living there⁹⁶. Additionally, Ethiopia sees a decrease in vulnerability, reducing its share of urban population living in slums from almost 100% in 1985 to less than 64% in 2015 (Fig.38). In Kenya, the share of urban population living in slums is lower overall and recently also reduced to around 46%. Somalia did not report significant change in slums in the past 15 years and showcases a high rate of 72% of the urban population living in slums – this high number is caused by the country's continuous civil war⁹⁷.

^{xii}

<https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html>
<https://ember-climate.org/data/>

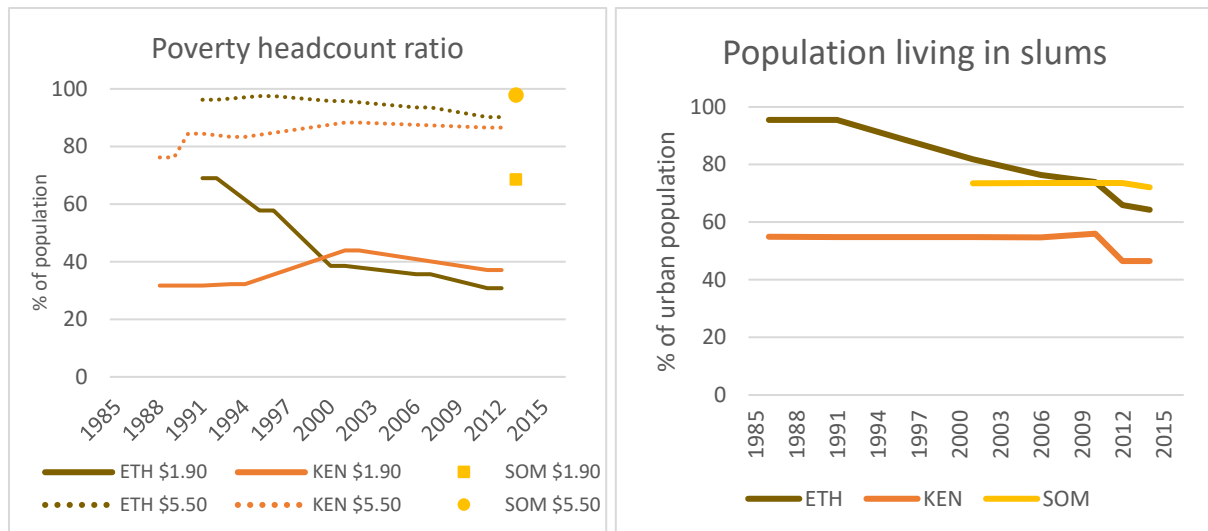


Figure 17: Left panel: Poverty headcount ratio is the percentage of the population living on less than \$1.90/ \$5.50 a day at 2011 international prices. Right panel: Population living in slums is the proportion of the urban population living in slum households. A slum household is defined as a group of individuals living under the same roof lacking one or more of the following conditions: access to improved water, access to improved sanitation, sufficient living area, housing durability, and security of tenure. Source: World Bank, Development Research Group and United Nations Human Settlements Programme

Social security, the presence of safety nets (Table 6) and public work programs such as cash-for-work and food-for-work significantly reduce social sensitivity to drought impacts, as it can avoid indirect impacts of livelihood loss such as raised poverty levels. The main social safety net programmes in the semi-arid areas in Kenya and Ethiopia are the Kenyan Hunger Safety Net Programme and the Ethiopian Productive Safety Net Programme. These particularly target food insecure populations in dryland regions, aiming at reducing poverty through regular cash transfers and related mechanisms. The Ethiopian Productive Safety Net Programme aims to serve a dual function in that public works are implemented in drought-affected rural areas through food-for-work and cash-for-work schemes⁹⁸.

Social safety nets in Ethiopia and Kenya cover about one fifth of the population (Table 6). While Ethiopia has seen a decrease in coverage during the first decade of the twenty-first century, Kenya saw a significant increase⁹⁹. For example, over 240,000 households in 23 ASAL counties received emergency cash transfer from government once the drought disaster alert was issued in 2021¹⁰⁰. There are no data points for Somalia so no clear conclusion on a trend can be drawn.

The adequacy of social programs (Table 7) measures the total amount received by beneficiaries of these programs, as a share of their total welfare. Both Ethiopia and Kenya saw a decrease in this share for social insurance, social protection and social safety net programs. This decrease can be due to a reduced pay-out amount to the beneficiaries, or an overall progress in welfare. Data for Kenya is from 12015, after which they have put large efforts on increasing the adequacy¹⁰¹

Table 6: Coverage of social safety net programs shows the percentage of population participating in cash transfers and last resort programs, non-contributory social pensions, other cash transfers programs, conditional cash transfers, in-kind food transfers, school feeding, other social assistance programs and public works programs. Source: ASPIRE: The Atlas of Social Protection - Indicators of Resilience and Equity, The World Bank. Data are based on national representative household surveys.

Coverage of social safety net programs (% of population)					
	2004	2005	2010	2015	2018
Ethiopia	51%		13%	21%	21%
Kenya		20%		26%	

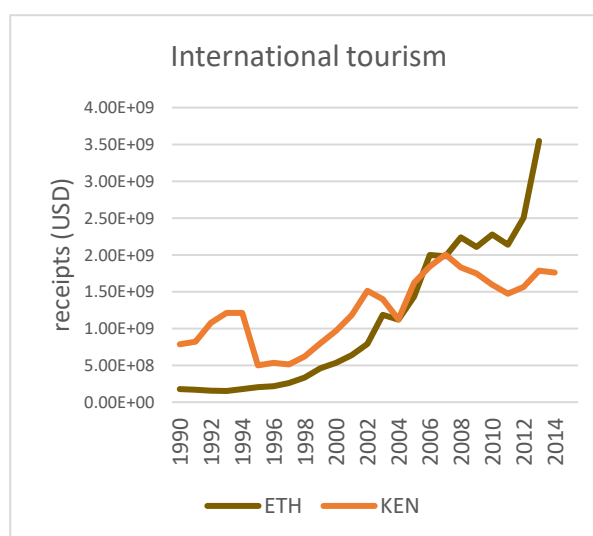
Table 7: Adequacy of social insurance programs ^{xiii}, Adequacy of social safety net programs ^{xiv}, and Adequacy of social safety net programs ^{xv}. Source: ASPIRE: The Atlas of Social Protection - Indicators of Resilience and Equity, The World Bank. Data are based on national representative household surveys.

Share of total welfare of the transfer amount received by social programs			
	2005	2015	2018
Adequacy of social insurance programs			
Ethiopia		21.0%	12.7%
Kenya	45.5%	5.6%	
Adequacy of social protection and labour programs			
Ethiopia		11.6%	8.3%
Kenya	18.9%	5.9%	
Adequacy of social safety net programs			
Ethiopia		9.5%	7.4%
Kenya	8.0%	6.0%	

3.2.8 Tourism

International tourists they bring economic growth to regions, they make use of the natural resources and can contribute to or be affected by water and food shortages¹⁰² – as such they affect both exposure and vulnerability to droughts. Kenya has seen a variable increase in tourism over the last three decades (Fig. 39). A general growth is hampered by the post-election violence in 2008 and the threat of terrorism in the country mostly from Al Shabaab militants in Somalia¹⁰³. Recently, Ethiopia has seen a massive growth in tourism: the sector grew by 48.6% in 2018 – the largest of any country in the world¹⁰⁴ – but saw a sharp decrease since 2020¹⁰⁵ due to national conflicts and COVID-19.

Figure 18: Right: International tourism receipts in USD for Ethiopia and Kenya. International tourism receipts are expenditures by international inbound visitors, including payments to national carriers for international transport. These receipts include any other prepayment made for goods or services received in the destination country. Source: World Tourism Organization, Yearbook of Tourism Statistics, Compendium of Tourism Statistics and data files, and IMF and World Bank exports estimates.



^{xiii} Social insurance programs include old age contributory pensions (including survivors and disability) and social security and health insurance benefits (including occupational injury benefits, paid sick leave, maternity and other social insurance).

^{xiv} Social safety net programs include cash transfers and last resort programs, non-contributory social pensions, other cash transfers programs (child, family and orphan allowances, birth and death grants, disability benefits, and other allowances), conditional cash transfers, in-kind food transfers (food stamps and vouchers, food rations, supplementary feeding, and emergency food distribution), school feeding, other social assistance programs (housing allowances, scholarships, fee waivers, health subsidies, and other social assistance) and public works programs (cash for work and food for work).

^{xv} Social safety net programs include cash transfers and last resort programs, non-contributory social pensions, other cash transfers programs (child, family and orphan allowances, birth and death grants, disability benefits, and other allowances), conditional cash transfers, in-kind food transfers (food stamps and vouchers, food rations, supplementary feeding, and emergency food distribution), school feeding, other social assistance programs (housing allowances, scholarships, fee waivers, health subsidies, and other social assistance) and public works programs (cash for work and food for work).

3.2.9 Unemployment

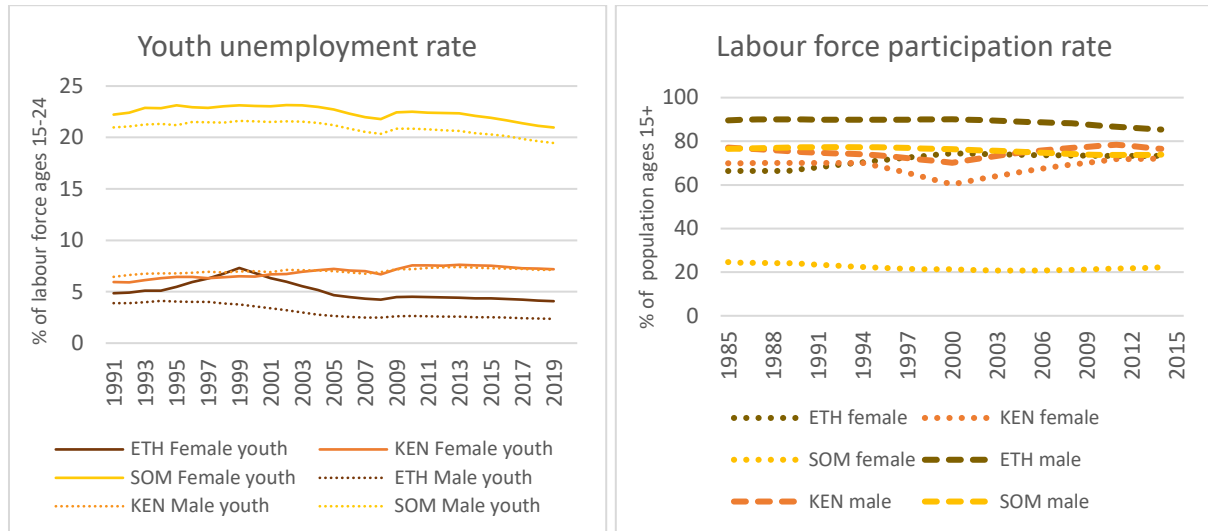
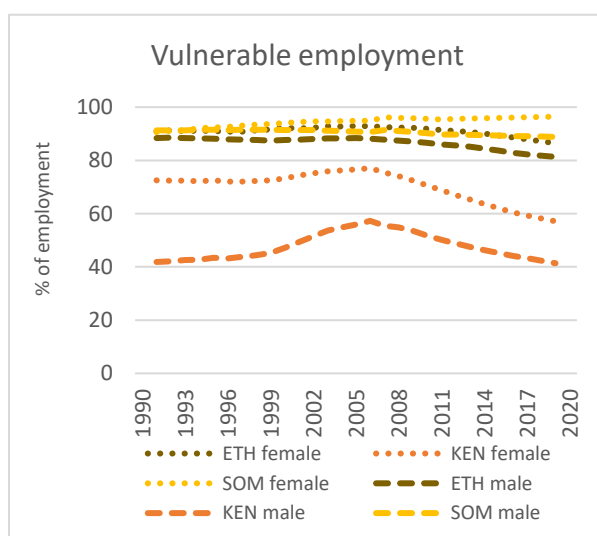


Figure 40: Left panel: Youth unemployment refers to the share of the labour force ages 15-24 without work but available for and seeking employment. Right panel: Labour force participation rate, the proportion of the population ages 15 and older that is economically active: all people who supply labour for the production of goods and services during a specified period. Source: ILOSTAT database and United Nations Population Division's World Population Prospects

A healthy economy and stable job market reduces vulnerability (in particular economic sensitivity) to droughts. Somalia has high shares of youth unemployment (over 20%) (Fig.40), which can be a driver for migration to the larger cities or abroad. Kenya displays a slight increase in youth unemployment over time, increasing economic vulnerability; while Ethiopia displays the lowest rate and a decreasing trend, with only 4% of the female and 2.5% of the male youth facing unemployment in 2019. Besides, the proportion of working-age (male) population that is economically active is quite high in Ethiopia (85%) as compared to the other two countries; there is however a clear gender gap. In this respect, Somalia has the highest gender gap, with only 20% of the females and almost 75% of the male population at working-age being economically active. Kenya's labour force participation rate is around 80% and this country shows the smallest gender gap. The (gender gap in) rates of unemployment and labour participation – in combination with traditional household task distributions - increases the vulnerability of women to the effect of drought disasters¹⁰⁶.



The share of vulnerable employment – contributing family workers and own-account workers – is high in Somalia and Ethiopia (a small decreasing trend is visible for the latter) (Fig.41). While both are about 80%, Kenya has only about 50% of the people in vulnerable employment. However, Kenya has a large gender gap of almost 10% here. People employed as family workers or own-account workers can be seen more vulnerable to shocks as they have no external income to cope with them.

Figure 41: Left panel: Vulnerable employment ; contributing family workers and own-account workers as a percentage of total employment. Source: ILOSTAT database

3.3 National trends in environmental susceptibility

3.3.1 Baseline water stress

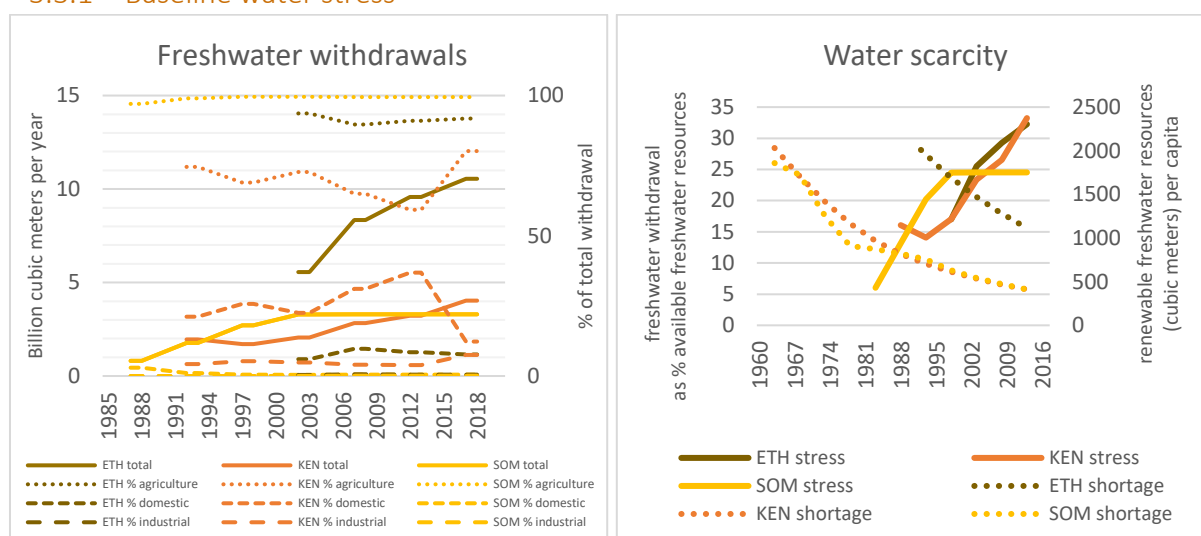
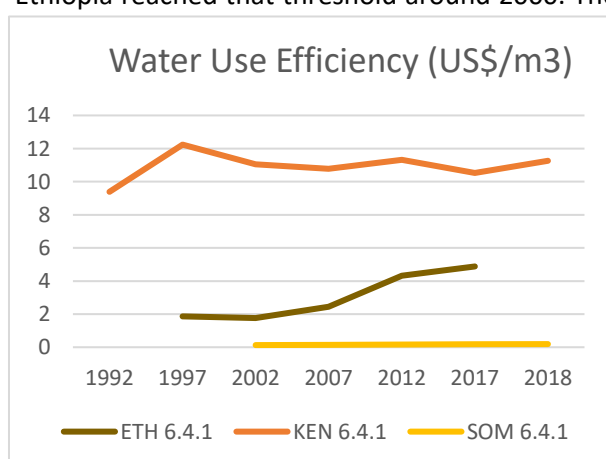


Figure 42: Left panel: Annual freshwater withdrawals, total and share used for agriculture. Withdrawals for agriculture are total withdrawals for irrigation and livestock production. Right panel: water stress index (freshwater withdrawals as share of renewable water^{xvi}) and water shortage index (renewable water availability per person)^{xvii}. Source: Food and Agriculture Organization, AQUASTAT data, and World Bank and OECD GDP estimates..

The total freshwater withdrawals are an indicator for the water demand of a country; which is strongly linked to drought vulnerability. A clear upward trend in water withdrawals is visible for Ethiopia (Fig.42), of which almost 90% is allocated to agriculture. Somalia displays a steady amount of water withdrawals since 2000, almost all of which is used for agriculture. In Kenya, freshwater withdrawal is used for both domestic water demand and agricultural water demand and their shares vary over time (+60% for agriculture, 30% for domestic use). Looking into the water stress and water shortage of the country, we see sharp increases in the percentage of available freshwater resources withdrawn and sharp decreases in the amount of renewable freshwater resources per capita. Given that 1700 cubic meters per capita is seen as the threshold for water shortage¹⁰⁷, Kenya and Somalia reached this threshold already around 1970 (Somalia reaches 500 by today, indicating extreme shortage), while Ethiopia reached that threshold around 2000. The water stress for Somalia is around 25%, for Kenya and Ethiopia 33% (in 2015); all of which are still quite low compared to global averages. Kenya has the highest water use efficiency, that of Ethiopia is rising (Fig.43).



The water stress for Somalia is around 25%, for Kenya and Ethiopia 33% (in 2015); all of which are still quite low compared to global averages. Kenya has the highest water use efficiency, that of Ethiopia is rising (Fig.43).

Figure 43: Water Use Efficiency, calculated as GDP in constant prices divided by annual total water withdrawals - SDG6 part 4.1. Source: Aquastat.

^{xvi} The level of water stress: freshwater withdrawal as a proportion of available freshwater resources is the ratio between total freshwater withdrawn by all major sectors and total renewable freshwater resources, after taking into account environmental water requirements. Main sectors, as defined by ISIC standards, include agriculture; forestry and fishing; manufacturing; electricity industry; and services).

^{xvii} The level of water scarcity: Renewable internal freshwater resources flows (internal renewable resources (internal river flows and groundwater from rainfall) in the country) per capita.

3.3.2 Fertilizer use

Pre 2010, fertilizer consumption has fluctuated and increased from 13kg per hectare arable land in 1971 to 44kg/ha in 2011 (Fig.44). Afterwards, this number dropped significantly, possibly due to environmental concerns. Ethiopia saw a variable but sharp increase in fertilizer use going from 0.6kg per hectare arable land in 1969 to 36kg / ha in 2018 (16% annual growth rate). Both still show low values compared to a world average of 200kg/ga in 2018¹⁰⁸.

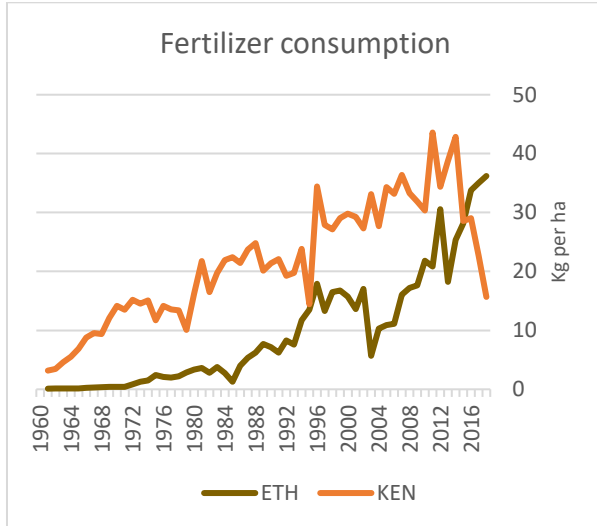


Figure 4420: Fertilizer consumption; the quantity of plant nutrients used per unit of arable land. Fertilizer products cover nitrogenous, potash, and phosphate fertilizers (including ground rock phosphate). Traditional nutrients--animal and plant manures--are not included. Source: Food and Agriculture Organization.

3.3.3 Water quality

No uniform indicator showing data for trend analysis is found. Some scattered studies on quality changes (such as KITHIIA (2007) An assessment of water quality changes within the Athi and Nairobi river basins during the last decade. IAHS Publ. 314) exist and point to increasing trends in water quality degradation due to changes in land-use systems. Industrial, population (rural–urban migration) growth and agricultural activities can contribute significant amounts of water pollutants – but there is not enough data to conclude on national trends.

3.4 Lack of coping capacity

3.4.1 Access to credit

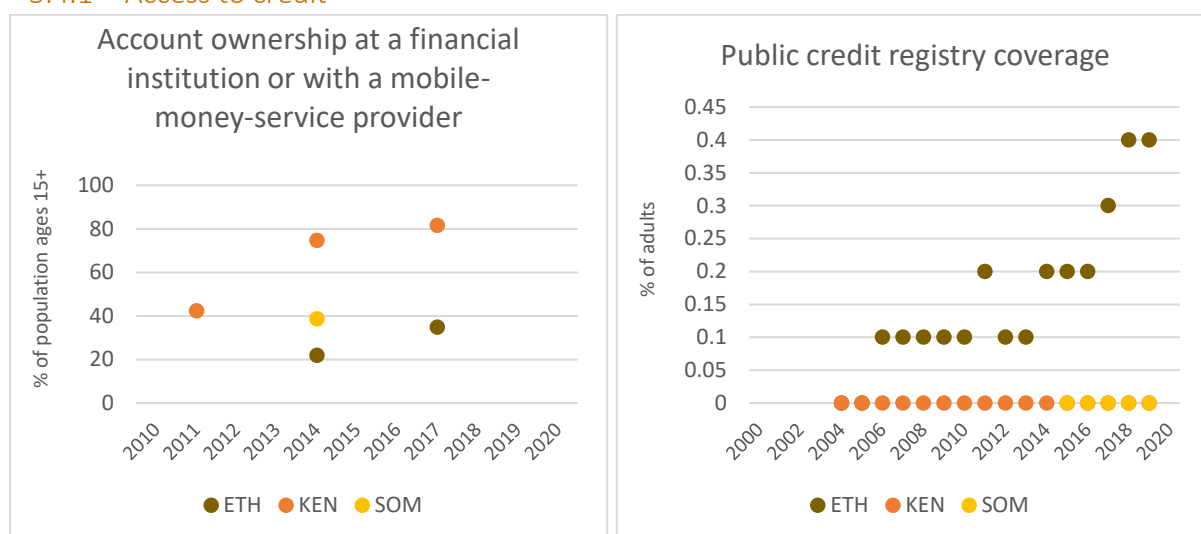


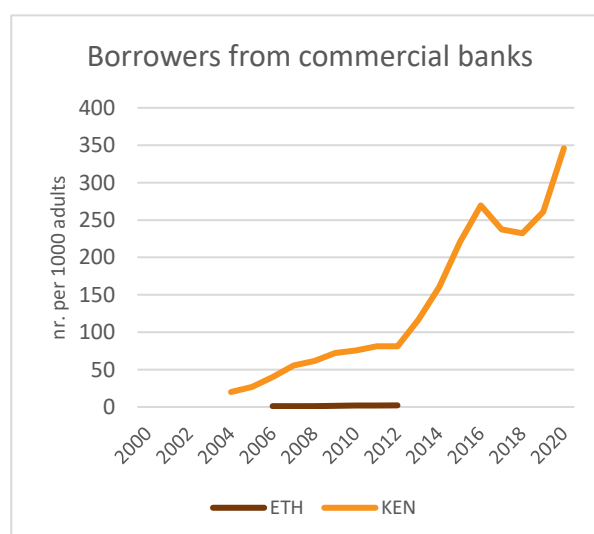
Figure 45: Left panel: Account ownership, the percentage of respondents who report having an account at a bank or another type of financial institution or report personally using a mobile money service in the past 12 months (% age 15+). Right panel: Public credit registry coverage, the number of individuals and firms listed in a public credit registry with current information on repayment history, unpaid debts, or credit outstanding. Source: Demirguc-Kunt et al., 2018, Global Financial Inclusion Database, World Bank and World Bank, Doing Business project.

Within Kenya, local savings and credit associations also act a form of informal insurance, as do Iddir (traditional burial societies in Ethiopia) whom some have proposed can play a greater role in risk sharing. An inherent danger remains if the poorest and most vulnerable are not enabled to access services such as micro-insurance schemes as this results in further cementing existing exclusion⁵⁷.

Not having access to credits is often cited as a barrier for adaptation¹⁰⁹. While only few data points are available, both Kenya and Ethiopia showed an increase in access to financial institutions through mobile-money-service providers, reaching respectively 80% and 35% in 2017 (Fig.45). Somalia reached almost 40% in 2014, but no more recent data is available. It also has a relatively sophisticated money transfer system through the Hawala system that has worked for decades since the onset of war and collapse of the banking system. Most recently formal money transfer operators have also taken root in Somalia.

At the same time, Kenya has seen an enormous increase in the number of borrowers from commercial banks, reaching 34.5% of the adults by 2020 which is 4.5 times higher than ten years prior. Ethiopia has a relatively lesser number of borrowers registered, and only a small increase is visible until 2012 (Fig.46). No data for Somalia was available.

Figure 21: Borrowers from commercial banks, the reported number of resident customers that are nonfinancial corporations (public and private) and households who obtained loans from commercial banks and other banks functioning as commercial banks. Source: International Monetary Fund, Financial Access Survey



3.4.2 Corruption

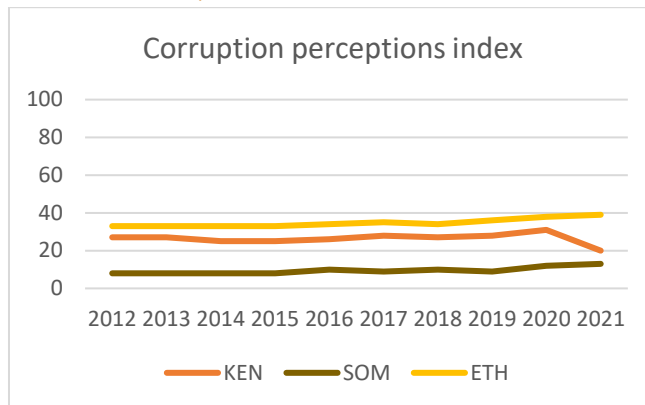


Figure 22: Corruption perception index^{xviii}. Source: Transparency.org

In terms of corruption (Fig.47), Somalia scores very low, ranking as one but last among the 180 countries analysed. However, even Somalia sees an increase (so a reduction in corruption perception) over time. Kenya shows the most variable index, with a decrease in 2014, 2018 and 2021 compared to the preceding years.

3.4.3 Crop varieties

Dryland farmers have long used crop diversification and informal systems of seed collection, saving and exchange to ensure food security in drought prone region⁵⁷. Agricultural drought risk management in the HAD (for Kenya specified in documents such as, the Climate Smart Agriculture in Kenya policy brief 2020; Kenya Climate Smart Agriculture Strategy 2017-2026; Kenya Climate Smart Agriculture Implementation Framework 2018-2027 (KCSAIF) and Agricultural Sector Growth and Transformation Strategy (ASTGS)) hinges on the use of drought resistant seed varieties and agroforestry but such practices are often not widely adopted (Okumu 2020¹¹⁰). No data on trend in changing varieties could be found.

3.4.4 Dam capacity

The total dam capacity for Kenya and Ethiopia was respectively 24.79 km³ and 31.48 km³ in 2008. Both countries saw an increase. Kenya shows a slow growth rate of 1.2% per year since 1972, while Ethiopia shows a sharp increase with an average annual growth rate of 29.3% since 1997¹¹¹. No data on dam capacity in Somalia is available.

On a smaller scale, much effort with respect to micro-scale water harvesting and storage (sand dams, farm ponds, contour bunds) is being done but no large-scale data is available.

^{xviii} The Corruption Perceptions Index (CPI) is the most widely-used global corruption ranking in the world. It measures how corrupt each country's public sector is perceived to be, according to experts and businesspeople. A country's score is the perceived level of public sector corruption on a scale of 0-100, where 0 means highly corrupt and 100 means very clean.

3.4.5 Government effectiveness

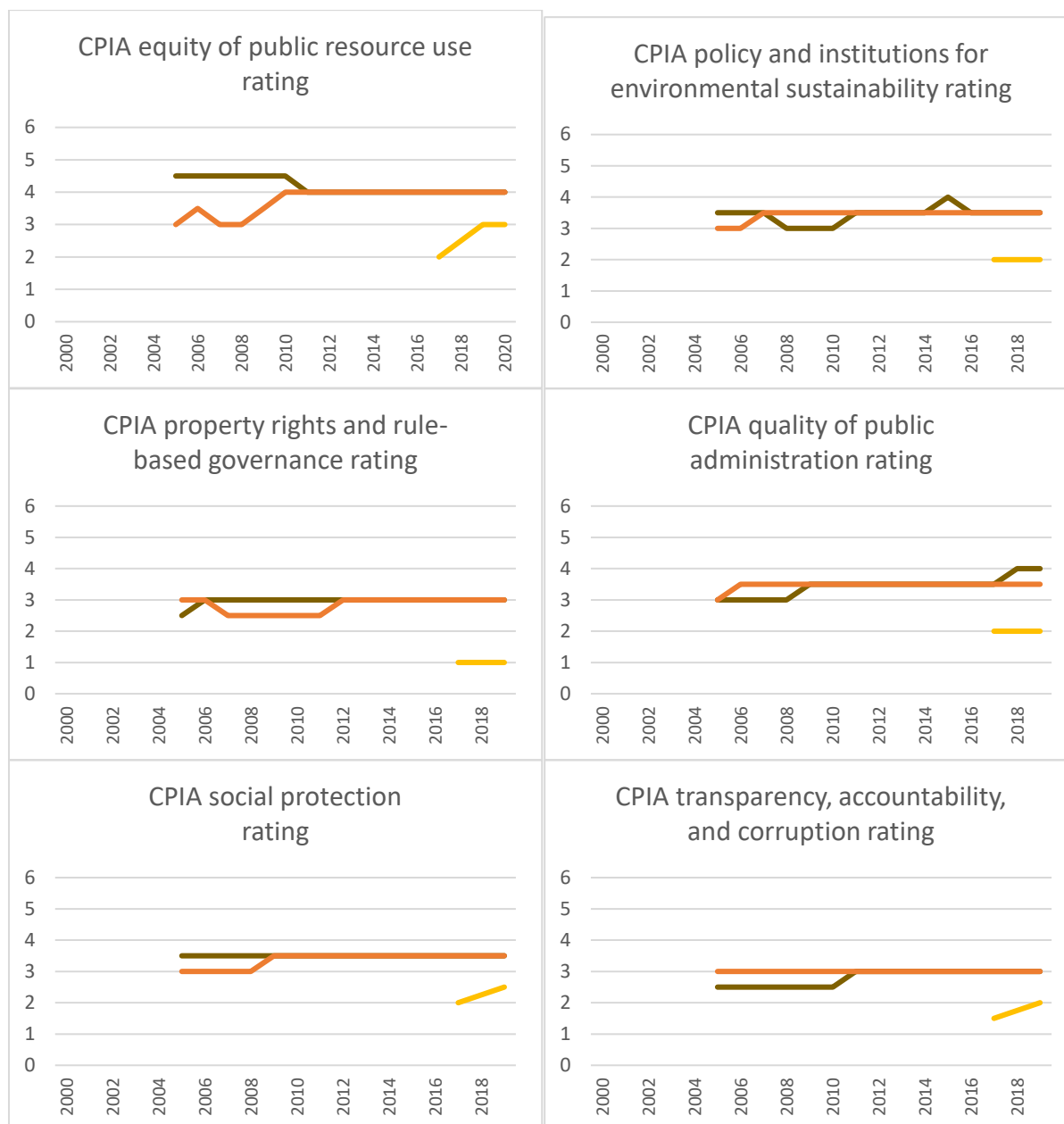


Figure 23: Indicators from the Country Policy and Institutional Assessment (CPIA) assessment of the World Bank. Top left: Equity of public resource use assesses the extent to which the pattern of public expenditures and revenue collection affects the poor and is consistent with national poverty reduction priorities. Top right: Policy and institutions for environmental sustainability assess the extent to which environmental policies foster the protection and sustainable use of natural resources and the management of pollution. Middle left: Property rights and rule-based governance assess the extent to which private economic activity is facilitated by an effective legal system and rule-based governance structure in which property and contract rights are reliably respected and enforced. Middle right: Quality of public administration assesses the extent to which civilian central government staff is structured to design and implement government policy and deliver services effectively. Bottom left: Social protection and labour assess government policies in social protection and labour market regulations that reduce the risk of becoming poor, assist those who are poor to better manage further risks, and ensure a minimal level of welfare to all people. Bottom right: Transparency, accountability, and corruption in the public sector assess the extent to which the executive can be held accountable for its use of funds and for the results of its actions by the electorate and by the legislature and judiciary, and the extent to which public employees within the executive are required to account for administrative decisions, use of resources, and results obtained. Source: World Bank Group, CPIA database

Looking into multiple Country Policy and Institutional Assessment indicators (Fig.48), it is remarkable that Kenya and Ethiopia perform quite similarly, with scores of around 3 out of 6 (in some cases, Kenya catches up on Ethiopia around 2010, in other cases the opposite is true). Somalia usually performs worse, with an average of 2 out of 6. Scores on equity of public resource use rating are higher (4 out of 6) but here Ethiopia saw a decreasing rate (coming from 4.5 before 2010). Regarding quality of public administration rating, Ethiopia made recent improvements, scoring 4 out of 6 since 2018. Policy and governance environment are often considered one of the major drought vulnerability indicators, as they can be a proxy for national-level adaptation and preparedness. In addition, legal rights concerning loans can be considered in this category (Table 8). Here, Kenya outperforms Ethiopia with 11/12 over 3/12 in the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending.

Table 8: Strength of legal rights index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. The index ranges from 0 to 12, with higher scores indicating that these laws are better designed to expand access to credit. Source: World Bank, Doing Business project

Strength of legal rights index (0=weak to 12=strong) (2019)	
Ethiopia	3
Kenya	11
Somalia	0

3.4.6 Reliance on development assistance

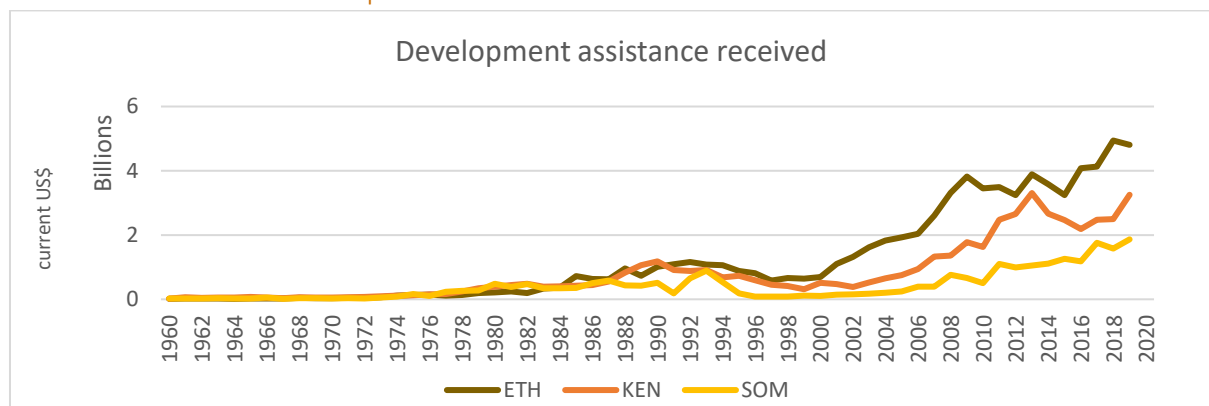


Figure 24: Net official development assistance (ODA) received. ODA consists of disbursements of loans made on concessional terms and grants by official agencies of the members of the Development Assistance Committee, by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients. It includes loans with a grant element of at least 25 percent. Source: Development Assistance Committee of the Organisation for Economic Co-operation and Development, Geographical Distribution of Financial Flows to Developing Countries, Development Co-operation Report, and International Development Statistics database

Increases in official development assistance are visible for all three countries (Fig.39) – which can assist them coping with drought disasters. The sharpest increase is visible in Ethiopia, while Somalia receives less than half of the 5M received by Ethiopia. From 2002 to 2019, all funders worldwide committed \$2.29 billion \$663 million and \$111 million in development finance to respectively Kenya, Ethiopia and Somalia for Climate Adaptation¹¹².

3.4.7 Savings

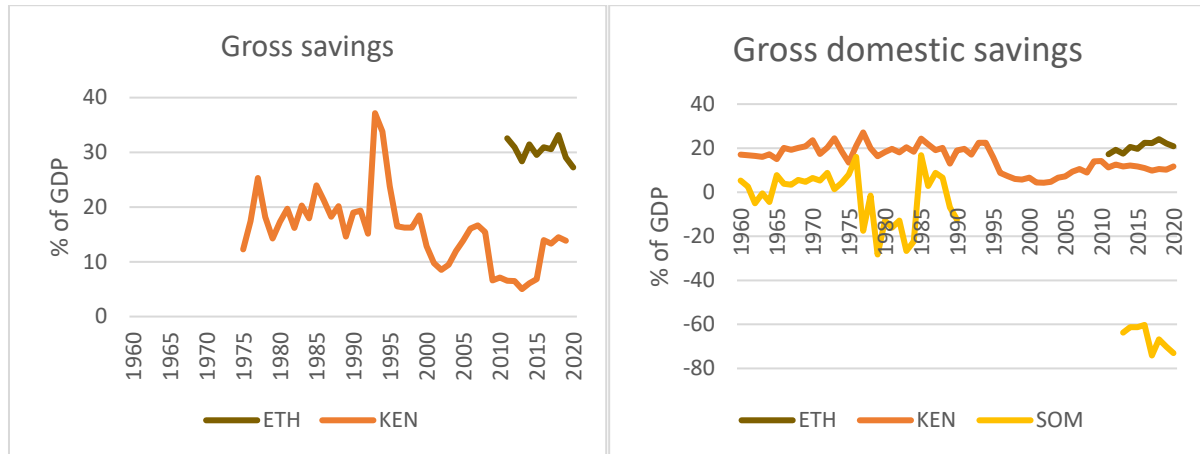


Figure 250: Left Panel: Gross national savings calculated as gross national income less total consumption, plus net transfers. Right panel: Gross domestic savings calculated as GDP less final consumption expenditure (total consumption). Source: World Bank national accounts data, and OECD National Accounts data files.

Another key facet of risk management is the spreading of risk through a variety of means. Next to insurance, savings can be used to overcome shocks. National savings (Fig.50) allow countries to establish emergency funds and use money for disaster risk reduction and building back better after a disaster hit. Kenya has a low amount of savings as share of its GDP, and sees a decrease in the last 20 years. Ethiopia (only a few years of data) has a higher share of savings.

3.5 Lack of adaptive capacity

3.5.1 Access to electricity and media

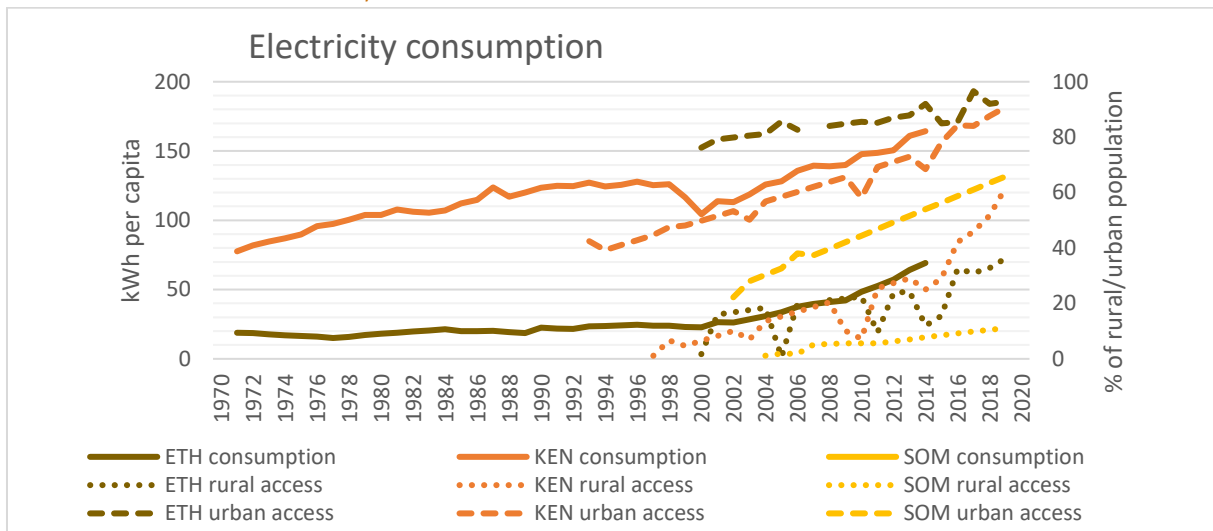


Figure 51: Access and consumption of electricity (Note: no data for absolute consumption values were available for Somalia). Electric power consumption measures the production of power plants and combined heat and power plants less transmission, distribution, and transformation losses and own use by heat and power plants. Access to electricity is the percentage of population with access to electricity. Electrification data are collected from industry, national surveys and international sources. Source: IEA Statistics © OECD/IEA

Access to electricity is crucial for receiving early warning signals and sharing adaptation knowledge (through radio, tv). Increasing trends in energy consumptions are visible in all three countries, with also the rural access to energy increasing. In 2020, 11% of the rural population in Somalia had access to electricity; this was 36% and 63% in respectively Ethiopia and Kenya (Fig.51). These numbers are still quite low compared to other countries¹¹³.

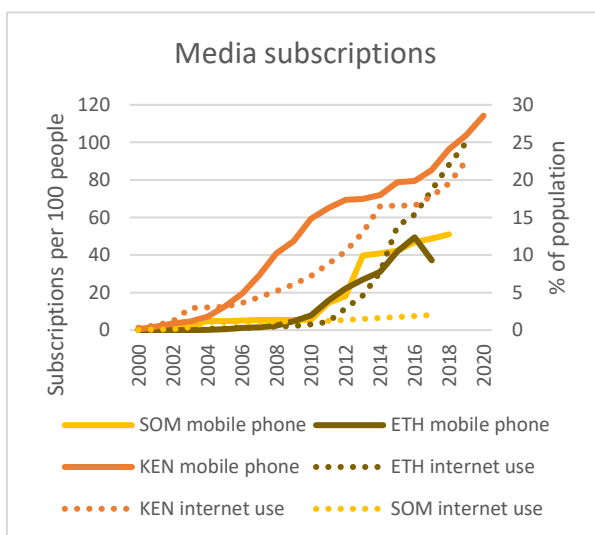


Figure 52: Mobile phone and Internet users. Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc. Source: International Telecommunication Union (ITU) World Telecommunication/ICT Indicators Database.

Access to information through national media allows people to prepare for upcoming disasters or to disseminate knowledge regarding adaptation measures. The recent emergence of mobile phones and internet has allowed for more connectedness and information exchange. Kenya has seen a rise in subscriptions to mobile phones since 2005, reaching now more than 100 subscriptions per 100 people (Fig.52). Ethiopia and Somalia has seen increases in mobile phone subscriptions since 2010 but reach about 50 subscriptions per 100 people in 2018 – more access to mobile networks can be achieved here. Considering the emergence of internet use, access stays limited in Somalia. Kenya has experienced a linear increase in access to internet since 2000 while Ethiopia has seen an exponential increase since 2010, both reaching about 25% of the population.

3.5.2 Adaptation policies/plans

Countries in the region have made significant progress in setting in place climate policies including ratification of the Paris Agreement and the submission of updated NDCs¹¹⁴ which contain targets to reduce their greenhouse gas emissions as well as their plans and targets on adaptation. The recent NDC synthesis report noted the fact that adaptation plan had by and large been quantified and costed in the updated NDCs which is the case for Ethiopia and Kenya¹¹⁴.

An initial analysis conducted under this project (Table 7, Fig.53) indicates that enforcement of the NDCs and other climate adaptation policies remains a challenge. Accessibility is also a challenge with little information on how vulnerable populations can access means for adaptation. This will need to be addressed to ensure implementation of the set policies and their targets¹¹⁵.

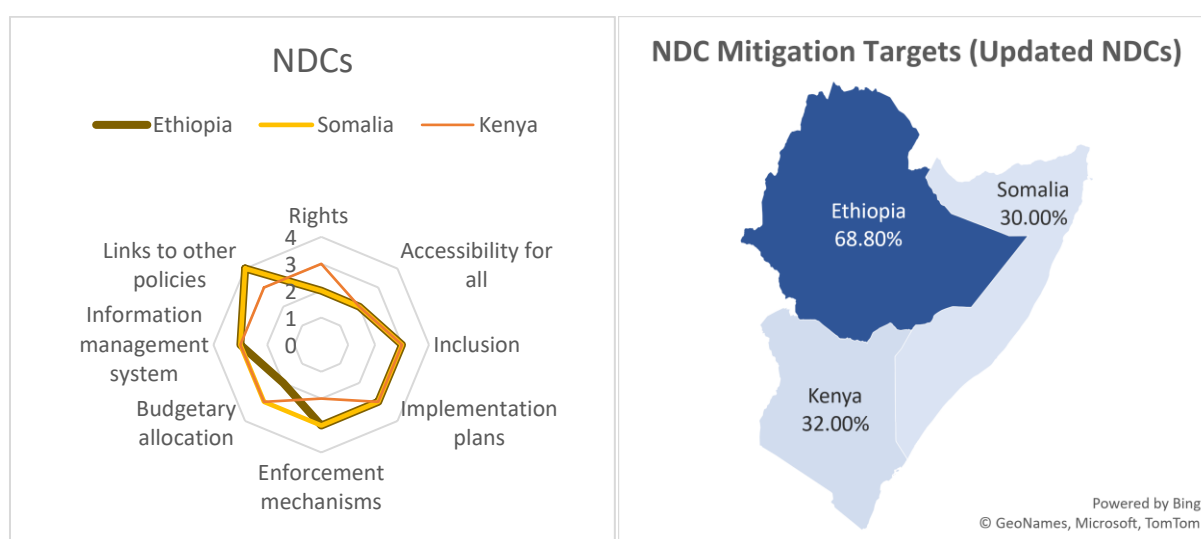


Figure 53: NDC Analysis for Ethiopia, Kenya and Somalia (Climate Analytics, 2021)

An analysis of the regional policies related to climate change adaptation including those relevant to Isiolo, Mieso and Odweyne (Table 9) reveals that local level adaptation policies are largely in place but these are often limited by lack of clear enforcement mechanism and a weak monitoring and evaluation framework. This is however countered by robust implementation plans, access and inclusion frameworks as is the case of Isiolo for instance with their climate change fund act that provides for local level ward planning committees that come up with projects that should be funded from 2% of annual county budget and other sources of climate finance¹¹⁶.

Table 9: list of the policies identified for analysis.

Kenya	Somalia	Ethiopia
NDC	NDC	NDC
National Adaptation Plan (2015-2030)	National Adaptation Program of Action (NAPA)	CRGE-NAP
National Climate Change Policy/Action Plan	Somaliland Climate Change Policy (draft)	Ethiopian Programme of Adaptation to Climate Change
Agricultural Sector Development Strategy (now outdated)	National environmental action plan and strategy to combat desertification	Climate Resilient Green Economy Strategy
Food and Nutrition Security Policy	Somaliland Food and Water Security Strategy 2030	Food Security Strategy
Water Act/National Irrigation Policy National Water Harvesting and Storage Regulations	National Water Strategy	
Isiolo Climate Change Fund Act and Policy		

A number of adaptation initiatives have been undertaken in Ethiopia, Kenya and Somalia to address climate change especially the adverse impacts (table 7). Most of these are outlined in the NDCs as well

as in the national adaptation plans. Ethiopia, Kenya and Somalia have all set out areas of strategic focus on adaptation to climate change that are outlined by sector. This are mostly around, water and food security, agriculture, health among other sectors, In the countries updated NDCs they have set out targets for adaptation with the intent of having adaptation as a priority (Ethiopia NDC, 2021; Kenya NDC, 2021; Somalia NDC, 2022).

3.5.3 Disaster prevention and preparedness / Disaster risk policies

Countries in the region have come up with a number of policies to address disasters (Table 10). Ethiopia's policies on disaster emphasize the need for early action and preparedness in the face of anticipated disasters. The countries are also aligned with the Sendai framework on disaster risk reduction and have made efforts to align their respective policies to this.

In 2017, at the Africa-Arab Platform for Disaster Risk Reduction in Tunisia, Somalia noted that implementation of its national DRM strategy¹¹⁷ had contributed to 'strengthening disaster risk governance to manage disaster risk'. It also committed to aligning its policies to the Sendai framework as well as reporting on progress in meeting the global goals regularly. In the same year, the EAC committed to implementing its 2016 EAC Disaster Risk Reduction and Management Act and for reporting on the Sendai targets by its member states to ensure effective DRR management on the EAC countries¹¹⁸.

CARIAA found that, in Kenya, the National Drought Management Authority's (NDMA) use of Ward and County Adaptation Planning Committees and a County Steering Group has resulted in better coordination of actions. Devolution has been accompanied by increased resources and there has been some improvement in access to services and information. However, a shortfall exists in coordination and integration between different sectors and levels of government and with activities of other non-state actors in Kenya. There is also incoherence between planning and development cycles. Devolution has seen a substantial transfer of power and authority to county and local levels. However, different institutions and actors appear to have overlapping and competing relationships due to the incomplete nature of devolution (CARIAA ASSAR work in Kenya).

CARIAA found that, in Ethiopia, there is insufficient 'nestedness' in policies, practices, and decision making across different levels and sectors of governance in Ethiopia. Despite the fragmented transfer of authority and power among various line agencies in Ethiopia, devolved power and authority has enabled woreda- and kebele-level officials to respond to local needs more effectively. The greater freedom afforded by decentralisation means that there is greater flexibility to select and manage responses and infrastructures as required at a local level. However, a majority of actors and institutions at the woreda and kebele levels have problems of resource constraints. Allied to the lack of resources are capacity deficits that often mean external assistance is valuable and necessary for interventions (CARIAA ASSAR work in Ethiopia).

Table 10: DRR policies

	Policies
Ethiopia	National Policy on Disaster Prevention and Management Ethiopia Disaster Risk Management Policy
Kenya	National Policy for Disaster Management
Somalia	National Environment Research and Disaster- preparedness (NERAD) Agency Somaliland National Disaster Risk Management Policy

3.5.4 Public participation in local policy

Public participation in policy has evolved over the years in the three countries. Kenya's laws and policies are largely participatory as anchored in its 2010 constitution. As a result, an analysis of the NDCs indicated the participation of various stakeholders among them communities, academia and research, private sector and civil society¹¹⁹.

Somalia has similarly incorporated public participation in policy making. Its first NDC as well as the updated document noted that community elders, the regions of Somaliland and Puntland among others had been involved in its development¹²⁰. Ethiopia also reported that there had been a wide range of stakeholder consultations to develop the updated NDC. Infact the assessment reflects this, showing that inclusion is a major element of the NDCs ranking at 3 in Figure 48 above.

3.5.5 Research and development expenditure

Governmental expenditure on research and development (Table 11) has shown quite a variability for both Kenya and Ethiopia. The AU set out to have countries commit 1% of GDP to R&D¹²¹ – which is not yet reached by most countries. Based on the data of 2007 and 2010, expenditure doubled in Kenya, reaching 0.79% of the GDP in 2010. In Ethiopia, R&D expenditure is measured more frequently and excluding an outlier of 0.60% in 2013, the country is characterized by a linearly increasing trend reaching 0.27% in 2017. Recent numbers (2022) show 0.6% and 0.8% for Ethiopia and Kenya. Augmenting national coping capacity, such expenditures can – depending on how they are spent - improve resilience towards climate change and droughts, as for example agricultural or WASH R&D or R&D related to basin management can significantly alter communities vulnerability to droughts.

Table 4: Gross domestic expenditures on research and development (R&D), expressed as a percent of GDP. They include both capital and current expenditures in the four main sectors: Business enterprise, Government, Higher education and Private non-profit. R&D covers basic research, applied research, and experimental development. Source: UNESCO Institute for Statistics.

Research and development expenditure (% of GDP)						
	2005	2007	2010	2013	2017	2022
Ethiopia	0.17917	0.17089	0.24137	0.60474	0.27437	0.6
Kenya		0.35521	0.78577			0.8

3.6 Livelihood resilience of in DOWN2EARTH case study regions

3.6.1 Vulnerability changes in the Drylands

East Africa has a largely agrarian political economy, with high dependence of the local communities on crop production and pastoralism for their livelihood and employment – which makes them vulnerable to drought shock⁴⁵. Livelihood and land use changes driven by climate change, political marginalisation, land distribution challenges and socio-economic development induce a shift in vulnerability in the Horn of Africa Drylands. These changes can benefit some but constraint access to natural resources (e.g., pasture, dry season water sources)⁴⁶. For the latter, this causes ill-fitted livelihood systems causing underdevelopment, poverty, and maladaptive policies (CARIAA ASSAR report Ethiopia). While efforts to provide information through extension services, mobile phones and broadcast media aim to prepare people better for droughts (forecasting, early warning and advice), this goes hand in hand with reduced indigenous skills in interpreting signs of weather change hampering adaptation interventions. It changes how people understand their environment and their (perceived) agency to manage risks⁴⁶. While decentralisation allows local officials to respond to local needs, more effort is needed in this regard to reduce vulnerability to drought through action on water governance and disaster risk management (CARIAA ASSAR report Kenya).

3.6.2 Vulnerability to droughts in Mieso and Dodota Woredas in Oromia (Ethiopia)

Below (Table 12) the specific sensitivity and coping capacity factors of the dryland woredas Mieso and Dodota in Ethiopia are summarized.

Table 52: Vulnerability factors in Bural, Kinna and Oldinyiro. Source: Department of Geography and Environmental Studies, Addis Ababa University, Ethiopia (2021) Drought Resilience in East African Region (DRIER): Ethiopian Case Study

Vulnerability	Details
Agricultural sensitivity	Dodota + Mieso: Land scarcity is caused by population growth and government land investment
	Mieso+Dodota: there is a presence of invasive weeds such as <i>Nech Lebash</i> (local Amharic name) and <i>Kartile</i> which did not die even when pesticides were applied
	About 80 to 90% of the people started to use modern agricultural technologies. Through the help and advice of extension workers, they started to apply fertilizers and row plantation methods. As a result, crop productivity has increased from 10-12 quintals per hectare to 38-40 quintals per hectare
	Model farmers are organized into associations, received loan from banks/ credit service institutes and bought tractors. The use of tractors is largely reducing the prevalence of weeds.
	Emergence of use of herbicides (e.g. 24D for weed leaf), different types of pesticide for <i>wag</i> (fungus) and <i>Topik</i> which destroys grass from farmland
Social sensitivity	Mieso: pressures on social services by displaced people, Food security
	Dodota+Mieso: presence of safety net: large numbers of people are supported by PSNP
	Health problems and diseases due to malnutrition and lack of sanitation water (e.g. causing cholera)
	When in drought, women and children often have to take care of milking cows and other ruminants, which makes them to be exposed to intense heat and get physically weak
	Gender equality: women commonly give priority to men and children e.g. food offering, hence they are always affected a lot whenever there are scarcities of food
	When water fetching distance is larger, children could not get their breakfast at the right time and there is not be water to keep their sanitation.
Safety	During droughts, some children have quit from schools and even more would quit as they would not have anything to feed themselves. In contrast, it is also possible that children who were previously looking after cattle, are getting back to school when most of the livestock are lost due to drought
	Mieso: The traditional livestock rearing system is challenged by frequent conflict with the neighbouring Somali people (common practice to drive/loot camels and other livestock from each other) result: internal displacement (searching for safer homes → increased land pressure)
	Dodota: crop damage by wild animals
Economic sensitivity	Women are robbed by men when they came back home from market after selling their collected firewood and other items
	Dodota: Absence of job opportunities for youths /Mieso: outside of livestock rearing. Many jobless educated youths present (no way of establishing own businesses or firms -> braindrain, exodus)
	Dodota+Mieso: Absence of market and/ or price fluctuations for agricultural products

	Dodota+Mieso: Increased price for agricultural inputs and other basic food (Grain prices keep increasing while production due to climate and degradation keeps decreasing: pressure on livelihoods)
	Mieso: absence of electric power supply and frequent electricity power interruption
	Imbalance of prices of items sold and bought such as high and increasing price for agricultural inputs, low price for agricultural products and broker intervention
Water security	Water table mainly for underground water holes has lowered due to excessive exploitation of available surface and underground water resources.
	People are forced to travel long distances and spend much time (5-8 hours) to fetch water for domestic uses (Donkeys needed)
	People work on watershed management and development activities through community participation and individually: farmers created holes and accumulated water by diverting rainwater from roads, upland valleys to irrigated farm land to enhance crop and forage production
	Rainwater harvesting was widely practiced in both <i>woreda</i> by constructing community and private ponds near to their village to overcome water shortage
	<i>Ella</i> (water dug out from the sand on river beds) is the main source of water during dry season in the rural areas of Mieso <i>woreda</i> . Ponds also provide water for few months (2-3 months) after the <i>kiremt</i> rain
Coping capacity	In (agro)pastoral areas): practicing seasonal migration to cope the seasonal shortage of pasture and water
	Agro-pastoralists started to make livestock or poultry trade (buying young animals, intensively feeding them during the rainy season, selling them) to prepare for droughts (i.e. practice animal fattening).
	Some people started to use (wheat) irrigation farming as adaptation strategy. Besides, those who live near Awash River and other water sources, pump water to be used for some cash crops production such as <i>chat</i> .
	Some people started to grow short season crop varieties (e.g. sorghum)
	Some drought resistant breed of milk cows are herded which have better milk production were brought from Borena (southern Ethiopia) and distributed to farmers. Improved goat and chicken varieties were also distributed to farmers
Government	Mieso: Attempts had been made to implement watershed development projects by practicing forestry/ re-forestry and other soil and water conservation (SWC) activities such as pond construction, check dams, area closure, farm terraces, soil and stone bund (every year all members of local communities participated for 30 to 40 days)
	Government strengthens the existing irrigation scheme by supporting farmers by distributing water pump motors in order to produce new crop varieties which have high market demand/ value (e.g. wheat, vegetables, fruits)
	Mieso: The government provided support and distributed water pump engines to the community
	Agro-pastoralists planted tree seedlings provided by the government (the green legacy project of the government of Ethiopia)
	government established FTC (Farmers' Training Centre) is poorly furnished but offers training to farmers e.g. use and application of agricultural technologies
	A market place for livestock was also set up by concerned office in collaboration with PCDP (Pastoral Community Development Project)
	Dodota: government works on income diversification and job creation opportunities for youths such as poultry farming projects

3.6.3 Vulnerability to droughts in Odweyne District in the Toghddeer region (Somalia)

Below (Table 13) the specific sensitivity and coping capacity factors of the dryland district Odweyne in Somalia are summarized.

Table 63: Vulnerability factors in Bural, Kinna and Oldinyiro. Source: Ahmed Aden (2021) DOWN2EARTH Scoping Study in Odweyne District, Somaliland..

Vulnerability	Details
Agricultural sensitivity	Land tenure (illegal land grabbing, expanding private grazing enclosures) is a major cause of clan and family conflicts in both rural and urban areas. (land policy 2017)
	Land degradation: declining land productivity, loss of indigenous plant species and advancing gullies in the farms and potential grazing areas
social sensitivity	Gender equality: women tend not to access weather information directly – from any source, traditional or external

economic sensitivity	There is an absence of an affordable electricity system: Part of the problem for use of external meteorological sources certainly seems to be fundamentally about access to electricity (no access to national radio or TV)
	Relatively cheaper mobile networks are widely accessible in Somalia. Over 90% of the adult population in the rural villages use simple mobile phones for sending and receiving calls, messages and e-cash
Governance	village committees and clan elders adjudicate land dispute
	During 2017 drought, aid agencies have imported fodder blocks
	Conditional and unconditional cash transfers are considered effective for helping rural households slowly rebuild their livestock herds
	The National Disaster Preparedness and Food Reserve Authority (NADFOR) has responsibility for accessing and communicating weather-related information and especially early warning information, disseminated via national radio and television channels
Coping capacity	Herders diversify livestock species by keeping small herds of camels, goats and sheep
	Individual or extended households have constructed the berkads during the 1980s. However, reduced economic capacity of the owners hampers repair
	Great reliance on aid agencies for financial and technical assistance to maintain water harvesting structures
	When the fodder is exhausted and animals cannot find enough from daily grazing, sorghum, maize and other cereals are cooked for both human and livestock. Animals are given morning and evening meals
	Many people are adopting crop production as alternative livelihood source.

3.6.4 Vulnerability to droughts in Burat, Kinna, en Oldonyiro wards in Isiolo (Kenya)

In 2013, 94% of Isiolo County inhabitants in male-headed households relied on firewood or charcoal for cooking fuel. 59% of residents utilized improved water sources, while 41% relied on unimproved sources¹²². The latter includes water from sources such as ponds, dams, streams, rivers, unprotected springs and wells, jabia, water vendors, and others. In terms of human development indicators, Isiolo County has a Gender Inequality Index score of 0.45, which is well-below the national score of 0.555. The County also has a relatively lower life expectancy at birth of 57.6 years compared to the national average of 64.3 years. 49% of Isiolo County inhabitants are literate, compared to an 85.9% literacy rate nationwide. Lastly, Isiolo County has a school enrolment rate of 49%, which is significantly lower than the national enrolment rate of 74.8%¹²³. Below (Table 14) the specific sensitivity and coping capacity factors of the dryland district Isiolo in Kenya are summarized.

Table 7: Vulnerability factors in Bural, Kinna and Oldinyiro. Source: DOWN2EARTH Scoping Study in Isiolo county

Vulnerability	Details
Agricultural / land use sensitivity	Injudicious use of grazing and water resources e.g. influx of camels from rich/wealthy people who graze in areas designated for dry seasons leaving the locals with no place to graze their livestock during drought
Social sensitivity	High illiteracy levels
	Cultural practices such as early and forced marriages prevent girls from obtaining an education
	The poverty level is 71%.
	Women and children are the major collectors of the water for household needs, farming and livestock support
	During periods of drought children tend to stop schooling and help the parents in the search of food and feeding livestock
	Isiolo has a largely patriarchal society, in which decision-making authority is generally seen to be vested in men rather than women, at both community-wide and household levels
Economic sensitivity	There is a poor infrastructure; high costs of transportation due to poor road network.
	The completion of tarmacked road from Isiolo town to Kinna is likely to spur development activities and provision of essential services and amenities in the area
	90% of the population relies on wood and charcoal for fuel
	There is a lack of market for both crops and livestock → the community has been over-reliant on the neighbouring communities such as Meru and Isiolo to sell their produce
	There is a low capacity of the local community to diversify their livelihoods: Most of the residents are stuck to keeping livestock, while a few are gradually incorporating crop farming or small business ventures
	Mobile networks are available, providing services that are affordable and reliable
Safety	Frequent conflict between famers and pastoralist, where pastoralist invaded into farmers' lands
	Frequent conflict between wild animals (such as elephants) and humans over resources

	Continuous land conflicts since 1995
Governance	Organized group elders plan and manage the range land and resolve conflict emerging from resource based conflict
Coping capacity	The main livestock cattle breeds are Zebu and Boran which are drought and disease resistant and are bred mainly for beef production
	A few farmers also keep dairy breeds like the Toggenburg and the Swiss Alpine and many crosses of local and exotic breeds
	Charcoal burning is an income generating activity during shock
	There is access to emergency support through government, NGOs and organized group leaders
	During drought: water tracking, disease surveillance and livestock restocking, and cash transfer are supported by both government and NGOs
	There is an increased urbanization and changes in cultural beliefs: the women in the Community have started undertaking casual work like washing of clothes.
Water safety	There is variable access to both traditional and modern sources of climatic information and prediction
	In many cases the provision of reliable information does not match people's hopes
	<ul style="list-style-type: none"> • Three rock catchments- Mokori, Lenguruma and Kawalash • 1 water pipeline from Ewaso- Nyiro to Oldonyiro. • 30 sand dams • 3 boreholes; 2 shallow wells with hand pumps but these are not functioning. • 14 water pans

The figures below (Fig.54) show the frequency of occurrence of several harmful impacts of droughts in Isiolo county. The county has an average walking distance to water sources of 3.5, but this elevates to 5km in 40% of the time. 18% of the children below 5 have a Mid-Upper Arm Circumference (MUAC) lower than 135 – they are classified as wasting. This share elevates to 28% in 10% of the time – when extreme drought events or droughts compounded with other stabilities lead to severe production losses. On average 63k people require food assistance in the country. This might elevate to 95k in 10% of the time – again linked to food production reductions.

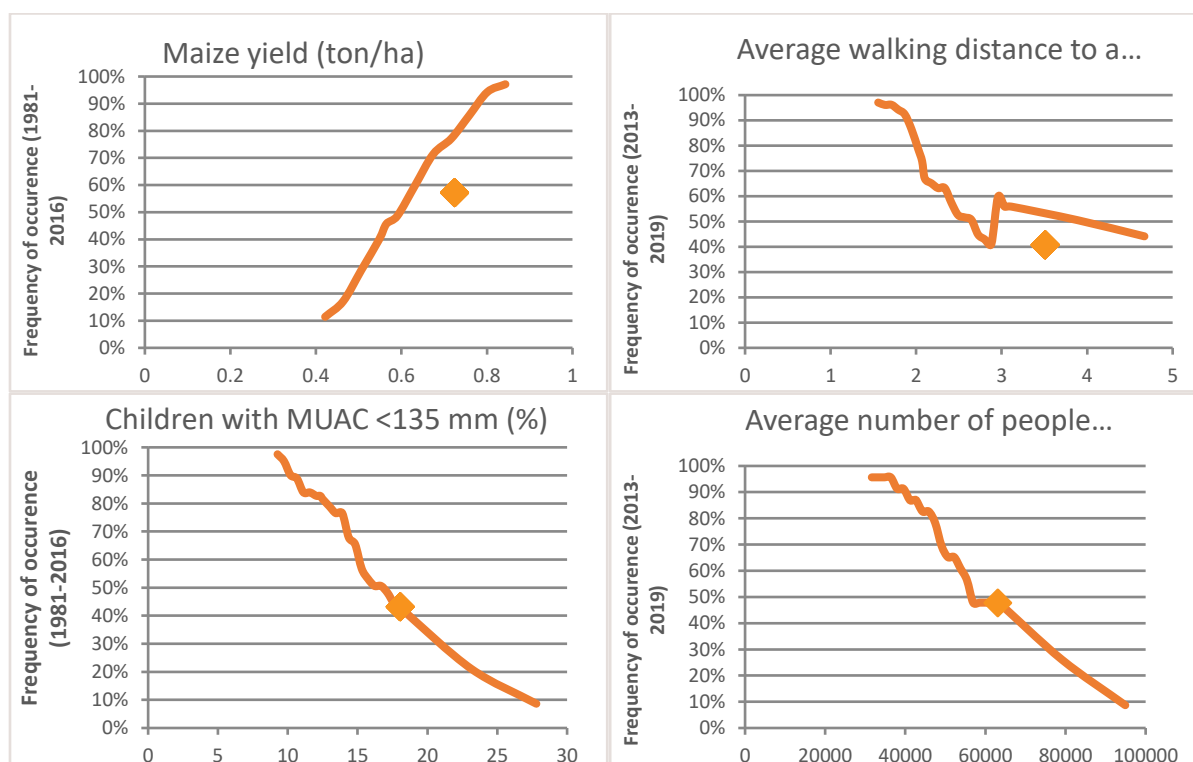


Figure 26: Frequency of drought-related impacts. Source: NDMA reports. Mean value indicated by the orange diamond

4 Conclusion on drought risk trends in the Horn of Africa Drylands

4.1 National drought risk trends experienced in Somalia, Kenya and Ethiopia

4.1.1 Changes in vulnerability and exposure to droughts in Somalia

While population is still increasing at a high rate, the population in rural drylands is not increasing as fast, due strong urban-rural migration. There is a decreasing amount of protected area and no change in the agricultural area (no data on irrigated land) (Table 15). We can therefore conclude that there is no clear trend in exposure over time in the rural drylands. Climate change will probably drive more people out of the rural regions, while technological development in the future will hopefully increase the presence of irrigated agricultural land.

Table 15: Summary of historic trends observed in the analysed data, for Somalia. Levels are relative for the HAD. Hazard-related drought risk factors should be found in Deliverable2.1

Risk factor (Contribution to risk)	Historic change	Current level	Observed trend
Exposure	No clear trend	Intermediate	High urbanisation rates, but still large number of dryland population. Decreasing protected area.
Social vulnerability (-)	Slightly decreasing	High	Sharp increase in access to clean water and sanitation and slowly increasing life expectancy BUT high level of gender inequality, low immunization rates; unsafe and unstable security situation, high levels of food insecurity
Economic vulnerability (-)	barely decreasing	Very high	Increasing age dependency ratio; low GDP growth and consumption expenditures, variable amount of agricultural machinery, high levels of poverty and unemployment, high level of vulnerable employment BUT decreasing dependency on in agriculture
Environmental vulnerability (-)	Increasing	Very high	High water withdrawal, increasing water shortage
Coping capacity (+)	Slightly increasing	Very low	Low and not increasing access to credit, low number of dams and no data on planned dams, low number of government effectiveness, increasing but not high number of development assistance
Adaptive capacity (+)	Increasing	low	Increasing access to electricity (not a lot of data!)

Much data related to vulnerability is missing for Somalia (e.g. on schooling, literacy, child wellbeing, economic equality, poverty data, adaptive capacity). It is therefore hard to evaluate trends in vulnerability. However, vulnerability to droughts is very high and not really decreasing. Somalia faces increasing water insecurity, insufficient healthcare, high levels of gender inequality, high unemployment rates, and low GDP growth. What is more, the peculiar demography of Somalia¹²⁴, with many young people without much possibilities, creates an instable situation and is a breeding ground for violence – which will further increase vulnerability to droughts. The few proxies for coping and adaptive capacity analysed, show a slightly increasing trend due to the increasing development assistance, and access to electricity.

4.1.2 Changes in vulnerability and exposure to droughts in Ethiopia

Ethiopia has a large population that keeps growing. While the rate of increase is less than that of other HAD countries, the absolute number of people potentially exposed is increasing a lot. There was a sharp decrease in agricultural land due to the split with Eritrea, and there is a decreasing forest area (Table 16). We can therefore conclude that there is an increasing population exposure but decreasing livelihood exposure over time.

Table 16: Summary of historic trends observed in the analysed data, for Ethiopia. Levels are relative for the HAD. Hazard-related drought risk factors should be found in Deliverable2.1

Risk factor	Historic change	Current level	Observed trend
Exposure	Mostly strongly increasing	high	Large population growth, in-migration (but outmigration during current war); less agricultural land due to split with Eritrea, increasing irrigation, decreasing forest area
Social vulnerability	Strongly decreasing	high	Strong decrease in open defecation and mortality due to unsafe water, strong increase in access to safe drinking water but still bad WASH facilities, strong increase in food production and crop yields, strong decrease in arable land per person, mediate labour participation rate for women, good representation in parliament, low health expenditures, sharp decreasing infant mortality, increasing education expenditures, increasing primary enrolment; increasing number of refugees and IDP; recent increase in battle-related deaths; high but decreasing malnutrition
Economic vulnerability	decreasing	Medium	Growing GDP, decreasing age dependency, varying GINI (increasing in last years), decreasing value added by agriculture, high employment in agriculture, decreasing poverty rate and people in slums, decreasing coverage of safety nets, sharply increasing tourism, high vulnerable employment
Environmental vulnerability	strongly Increasing	high	Increasing, large amount of freshwater withdrawal, increasing water shortage, water stress, low water use efficiency, increasing fertiliser use
Coping capacity	increasing	Medium	Increasing number of dams, increasing public credit registry, low legal right strength, high access to development assistance
Adaptive capacity	increasing	low	Low but increasing access to electricity, sharp increase in internet use, low, unstable R&D budget

In Ethiopia, vulnerability to droughts is high. It is decreasing on some fronts but not in others. Improvements are made with respect to gender equality, health, education, poverty and labour participation. However, the agricultural dependency is still high (but there is an increasing coverage of irrigated agriculture), food security remains an issue (while yields increase, the arable land per person decreases a lot), and the access to basic WASH still low. Also, there is a high level of water withdrawal (and low water productivity) and more dams are planned to be constructed. An increasing use of fertiliser and increasing water shortage and stress show vulnerabilities with respect to water security. Besides, safety became a major concern due to the increased number of refugees and the current war – which also created a famine (Nyssen 2021¹²⁵). The latter will have a large influence on many of the vulnerability indicators of the last two years (but they were usually not in the datasets). With respect to coping and adaptive capacity, we see existing weaknesses (legal strength, access to electricity) barely improved, but there is an increasing public credit registry and internet use visible – which can alleviate financial and knowledge barriers to adaptation.

4.1.3 Changes in vulnerability and exposure to droughts in Kenya

Kenya has experienced a fast population growth and also an increase exposed nature parks and hydropower facilities (Table 17). In terms of vulnerability, Kenya has improved its health and WASH facilities, however still faces high levels of gender inequality and no substantial improvements on food security or poverty are made, there is a low adequacy of the existing social programs. Besides, there is an increasing agricultural dependency – a sector vulnerable to droughts – but the increase in agricultural machinery might reduce the sectors vulnerability. The country has a high water use efficiency (as compared to the other HAD countries) and many plans for new dams, which is needed given the increasing water shortage. Lastly, Kenya has an increasing coping and adaptive capacity, mainly due to increased access to credit, electricity, and media

Table 17: Summary of historic trends observed in the analysed data, for Kenya. Levels are relative for the HAD. Hazard-related drought risk factors should be found in Deliverable2.1

Risk factor	Historic change	Current level	Observed trend
Exposure	Increasing	medium	Fast population growth, in-migration, many (hydropower) dams
Social vulnerability	decreasing	medium	Decreasing mortality due to unsafe WASH, high access to basic facilities, steady increase in food production, mediate decrease in land per person, mediate labour participation rate for women, bad representation in parliament and not so much decision power for woman Increasing life expectancy, high health expenditures and higher amount of physicians, high but decreasing incidence of TBC and HIV, high immunization rates, increasing persistence to last grade of primary, no clear decrease in prevalence of food insecurity
Economic vulnerability	Variable	high	Sharp growing GDP, decreasing age dependency, variable GINI coefficient (no decrease), increasing employment in agriculture, increase in agricultural machinery, no sharp decrease in poverty, low adequacy of social programs,
Environmental vulnerability	Increasing	medium	Slightly increasing freshwater withdrawal, high level (and increasing) water shortage, water stress, high water use efficiency.
Coping capacity	Increasing strongly	medium	Increasing access to credit, number of borrowers
Adaptive capacity	increasing	medium	Good and increasing access to electricity, increasing internet and mobile phone use, low R&D budget

4.1.4 Regional differences in (trends of) vulnerability and exposure to droughts

Multiple trends were observed in the data presented above. A short summary is presented in figure 55. There is a clear increase in environmental vulnerability to droughts in all three countries; more water shortage, water stress, and high or elevating levels of water withdrawal will make all three countries more vulnerable to hydrological droughts. Kenya and Somalia have only low decreases in economic vulnerability (but the absolute level of Somalia is much lower than that of Kenya) while Ethiopia sees sharp decreases in poverty and elevating tourism. Kenya and Ethiopia experienced sharp decreases in social vulnerability, while Somalia does not see improvements in immunization rate, education, or food security. Talking about changes in coping and adaptive capacity, Kenya has already a large number of dams but Ethiopia plans on building a lot in the near future. Both have an increasing public credit and electricity, but this increase is higher in Kenya.

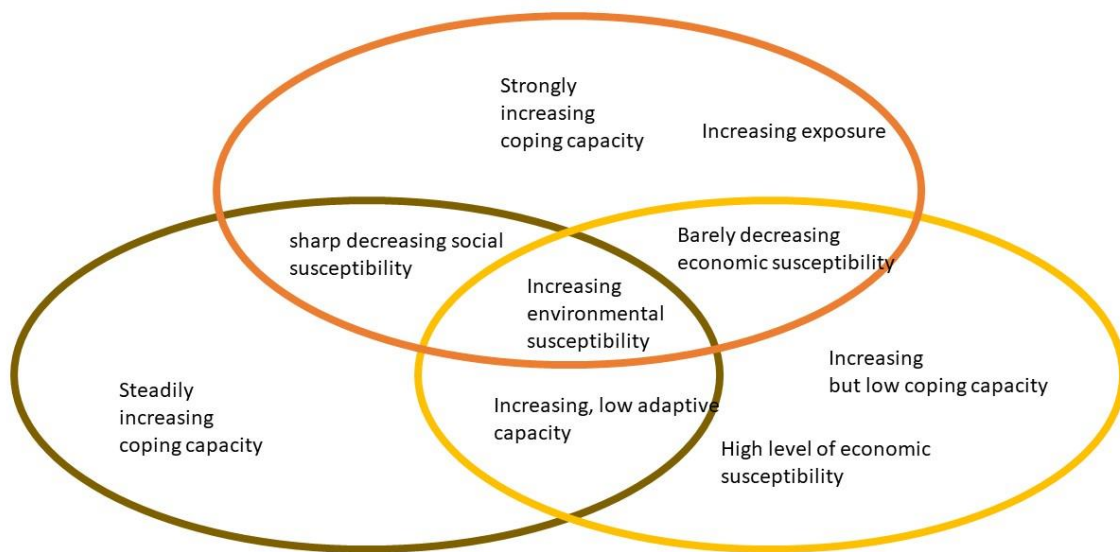


Figure 27: Trends in exposure and vulnerability for Kenya (orange), Ethiopia (brown) and Somalia (yellow). Hazard-related drought risk factors should be found in Deliverable2.1

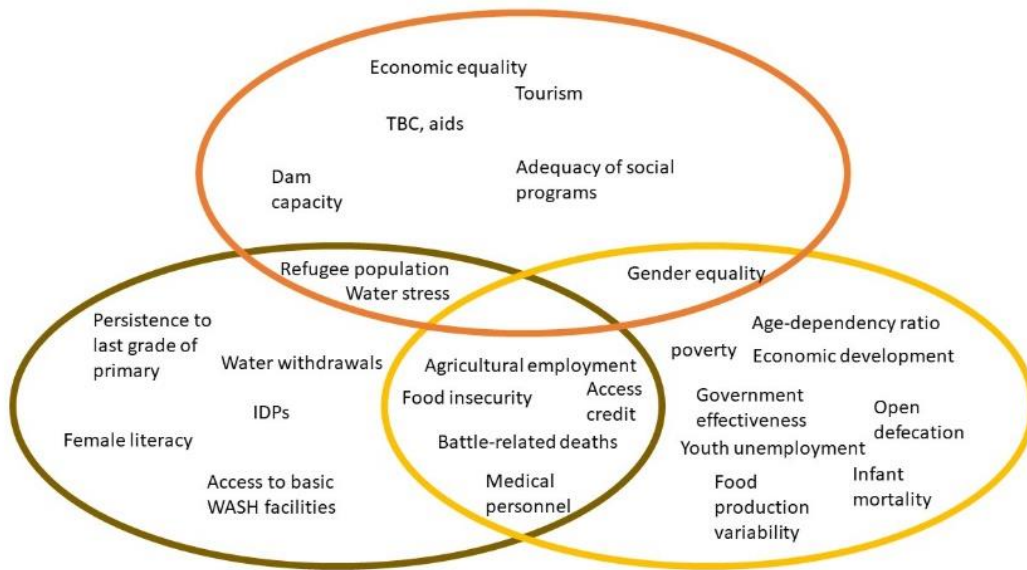


Figure 56: Remaining vulnerabilities for Kenya (orange), Ethiopia (brown) and Somalia (yellow). Hazard-related drought risk factors should be found in Deliverable2.1

While in general, vulnerability has decreased over time, some key sensitivities and gaps in coping or adaptive capacity remain in each of the countries (Fig.56_ – they will have to improve on these aspects if they want to achieve the Sustainable Development Goals (SDGs) and prevent new and reduce existing disaster risks (Sendai Goals). Somalia can be characterised as most vulnerable of the three, a logic consequence of the countries' instability. Low government effectivity results in low economic development (SDG8), poverty (SDG1), and its demographic structure results in a high age-dependency ratio and high rates of youth unemployment. Both Somalia and Ethiopia have experienced and are still experiencing war conditions (SDG16) – making them highly susceptible to other shocks. It also results in a high number of battle-related deaths and internally displaced people – the latter reported results in high pressure on the social services in Oromia. The two countries have high rates of agricultural employment – if not supported by irrigation and agricultural technologies, this makes the employment vulnerable to droughts and this relates closely to high rates of food insecurity (SDG2). Moreover, both have a low rural access to electricity (SDG7); in the Odweyne district in Somalia there is even and absence of affordable electricity reported.

Ethiopia is further characterised by low water efficiency and low access to basic drinking water and sanitation (SDG6). This results in health problems and diseases; and to large waking distances to fetch water, as is visible in the case study areas in Oromia. It also suffers from a high water stress – which it has in common with Kenya. Moreover, in Ethiopia education stays behind (SDG4), showing through a low female literacy and low persistence to last primary grade. While knowledge is known to reduce vulnerability and elevate capacity to adapt, the water and food scarce situation results in school dropouts, particularly reported in Oromia. The country also has – similarly to Kenya – a large refugee population, a group known to be vulnerable due to their social and economic disadvantageous situation. Kenya has the highest development status but still shows some vulnerabilities with respect to health (SDG3) and economic equality (SDG10) – this results in high poverty levels in rural regions such as 71% in Isiolo and reliance on sub-optimal income sources such as charcoal burning. Besides, its tourism incomes are very variable and there is only a slow increase in dam capacity. Lastly, together with Somalia, it does not perform well with respect to gender equality (SDG5). This can for example result in differentiated access to weather information, as is reported in the Toghdeer region in Somalia, or in decision-making vested in men, as reported in Isiolo in Kenya.

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