

NATURAL RESOURCES AND ECONOMIC GROWTH IN EAST AFRICA

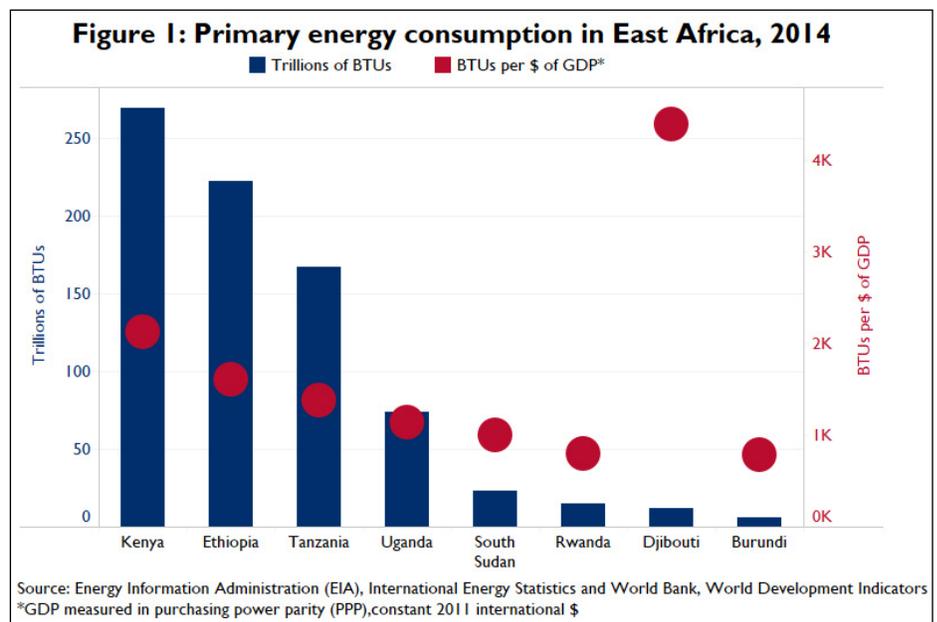
East Africa offers unique opportunities and challenges for the management of natural resources in sub-Saharan Africa. Although energy production and trade have lagged behind the rest of sub-Saharan Africa, East African countries hold considerable oil reserves and great potential for renewable energy including geothermal, hydro, solar, and wind. Many East Africans—particularly those residing in rural areas—lack access to electricity, but strengthened regulatory frameworks and the potential for increased intra-regional energy trade hold promise for expanded access in the future. In addition to energy, East Africa's abundant biodiversity contributes to the economy through fisheries in the region's lakes and coastal waters and through wildlife tourism. However, East Africa's natural resources face particular vulnerabilities with the threat of climate change, given the region's high population growth, reliance on rain-fed agriculture, and recent history of extreme weather events.

This paper will examine the current state of natural resources in East Africa—with an analysis of energy, water, biodiversity, and climate change—and investments that U.S. foreign assistance has made in these areas. For the purposes of this analysis, East Africa includes Burundi, Djibouti, Kenya, Ethiopia, Rwanda, South Sudan, Tanzania, and Uganda.

ENERGY

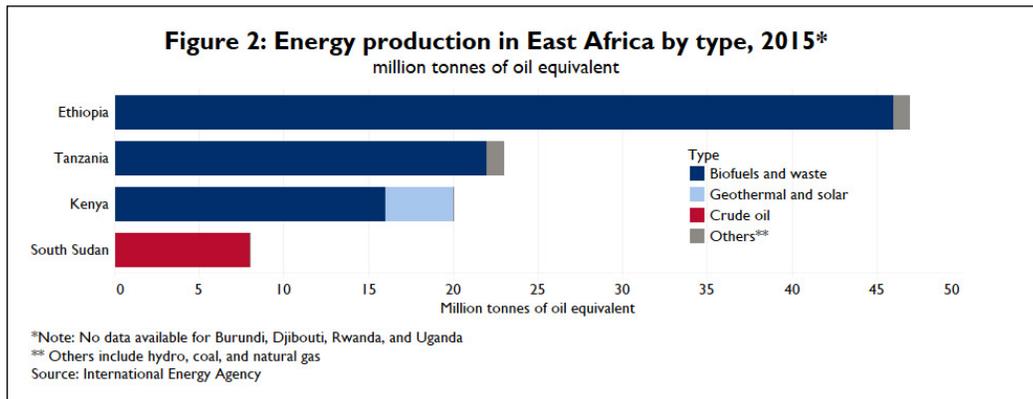
Energy Consumption and Production

Figure 1 shows primary energy consumption in East Africa by country, both in trillions of British thermal units (BTUs) and contextualized in terms of gross domestic product (GDP). Kenya is the largest consumer of primary energy in absolute terms, at 270 billion BTUs in 2014, followed closely by Ethiopia (Energy Information Administration [EIA], 2017). Djibouti's high consumption in GDP terms is likely due in part to its highly urbanized population—77.4 percent in 2016 compared with the East African average of 29.2 percent—and relatively low reliance on agriculture—agriculture value added accounted for only 3.9 percent of Djibouti's economy in 2007, the latest year with data available (World Bank, 2017).



Energy consumption in East Africa has risen more than 150 percent from 1990, from 0.27 BTUs in 1990 to 0.69 BTUs in 2014.¹ This rise in energy consumption has coincided with a relatively diminished role of agriculture in the region's economies: in 1990, agriculture value added composed an average of 40.5 percent of the GDP of East African countries, but by 2014 that number fell to 33.3 percent (World Bank, 2017). Although agriculture still makes

up a much larger share of East African economies than the global average of 12.1 percent, East African countries are likely consuming more energy as their generally more energy-intensive industrial and services sectors grow. For example, the EIA estimates that the industrial sector consumes about 54 percent of the world's delivered energy and industry value added has increased from an average of 16.4 percent of East African economies' GDP in 1990 to nearly 20 percent in 2014 (EIA, 2016; p. 1). This growth is particularly pronounced in some of the larger East African economies: industry value added comprised about 17.7 percent of Tanzania's economy in 1990, compared to 25 percent in 2014 (World Bank, 2017).



Although data on energy production is relatively scarce, the International Energy Agency has some data on production by energy type for four East African countries: Kenya, Tanzania, Ethiopia, and South Sudan. Eighty-six percent of the energy produced by the four countries in 2015 was in the form of biofuels and waste,² which comprised the majori-

ty of each country's production, with the exception of South Sudan (International Energy Agency [IEA], 2017). South Sudan was the only country to produce crude oil, which accounted for 97.4 percent of the country's energy output and 7.7 percent of the four countries' total energy production in 2015. In the four countries, geothermal and solar production, despite recent discoveries of resources in the region, accounted for only 4 percent of the total production. Coal and natural gas in Tanzania and hydro power in Ethiopia, Kenya, and Tanzania accounted for less than 2 percent of total energy production in the four countries (IEA, 2017).

There are indications that recent discoveries of energy reserves will likely result in significantly increased production in East Africa in the future. The IEA, in its Africa Energy Outlook 2014 special report, noted that East Africa³ holds about 18 billion barrels of oil resources—primarily in South Sudan and Uganda—about 9 percent of the total remaining recoverable oil resources in sub-Saharan Africa (IEA, 2014; p. 49). The East African Rift Basin holds great potential for oil production, particularly in Uganda and Kenya, but also in several neighboring countries (IEA, 2014; p. 50). The 2007 Kingfisher discovery in Uganda accounts for approximately 1.7 billion barrels of recoverable oil, and smaller, though still significant, reserves have been discovered in the Lokichar basin in Kenya and Ogaden Basin in Ethiopia (IEA, 2014; p. 50). Although Tanzania is excluded from the Africa Energy Outlook's analysis of East Africa, the report notes that major natural gas resources have been discovered off the shore of southern Tanzania. Much of the gas is expected to be produced for export given the country's relatively low gas consumption (IEA, 2014; p. 154).

Renewable Energy

In terms of non-oil and gas energy production, the East African Rift Valley is viewed by many as "one of the most exciting prospects in the world for geothermal development," with potential estimated between 10 and 15 gigawatts, much of which is concentrated in Ethiopia and Kenya (IEA, 2014; p. 59). The potential accounts for more than the region's current power generation. Kenya has installed 250 megawatts (MW) of geothermal capacity as of 2014, and is on track to develop more than 5,000 MW by 2030, about 50 percent of the country's estimated potential. Ethiopia recently launched the Corbetti Power Project, which aims to add one gigawatts of capacity over the next decade, and several others have started exploration on their geothermal potential (IEA, 2014; p. 59).

Other areas of promise for renewable sources include solar across all African countries and hydroelectric power in many countries (IEA, 2014; p. 19). In Ethiopia, for example, construction of the Grand Ethiopian Renaissance Dam (GERD), which will be Africa's largest hydroelectric dam and is expected to provide for all of Ethiopia's domestic energy needs, is more than half complete (Vall, 2017). Although surplus generation from the GERD project is likely to help neighboring countries meet their energy needs, the project is causing geopolitical conflict with Egypt given that the dam is likely to reduce downstream water supply from the Nile River, which Egypt relies on for the majority of its water needs (Vall, 2017). Wind capacity is also being harnessed in countries like Kenya, which plans to add over 400 megawatts of wind capacity by 2020 (IEA, 2014; p. 59). In its East Africa Regional Development Cooperation Strategy (RDCCS) 2016-2021, USAID aims to increase renewable energy generation and investment in East Africa, but notes that donor and private sector engagement is essential for renewable energy to fill the energy deficit in the region (U.S. Agency for International Development, Kenya and East Africa [USAID/KEA], 2016; p. 25).

Energy Trade

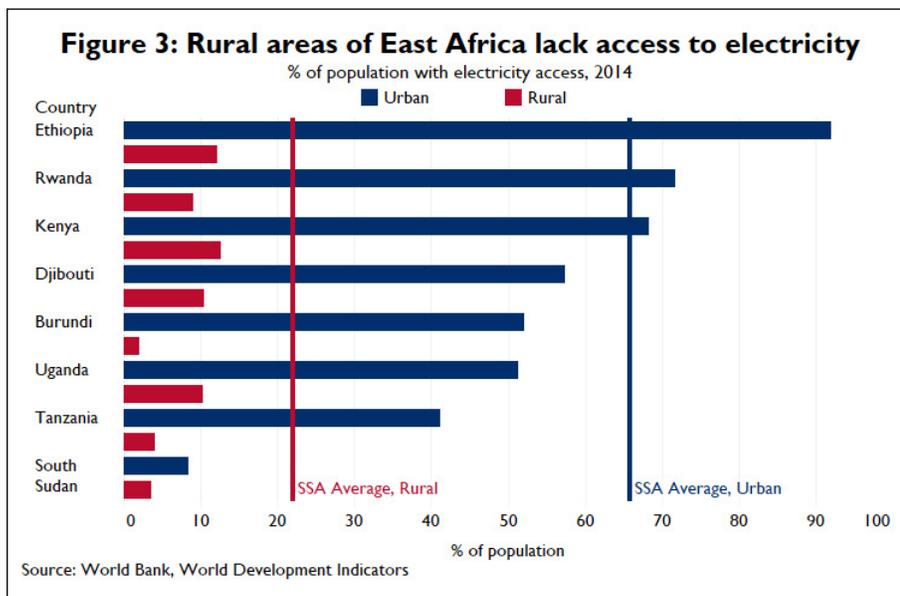
Data on energy trade in East Africa is sparse, but, like energy production data, the IEA has some data available on trade by energy type for four East African countries: Kenya, Tanzania, Ethiopia, and South Sudan. South Sudan was the only significant energy exporter of the four countries in 2015, exporting almost all (99.7 percent) of its crude oil production, at nearly 7,500 thousand tonnes of oil equivalent (ktoe) (IEA, 2017). Kenya and Ethiopia each recorded less than 15 ktoe in exports, made up of electricity and oil products. Tanzania recorded no energy exports in 2015. 90.2 percent of energy imports to the four East African countries were oil products, with Kenya importing 4,385 ktoe and Ethiopia and Tanzania importing slightly less at 3,472 and 3,309 ktoe respectively. Coal and crude oil made up almost all of the remaining imports, and electricity imports to Kenya and Tanzania comprised less than 0.1 percent of total energy imports to the four countries in 2015 (IEA, 2017).

Reflective of the IEA data in 2015, the World Energy Outlook special report on Africa mentions that while sub-Saharan Africa in general is a significant exporter of crude oil, behind only the Middle East and Russia in global exporters, exports from East Africa have been minimal, due in large part to political uncertainty in South Sudan prohibiting additional exports (IEA, 2014; p. 61). In terms of renewable energy, Ethiopia plans to expand intra-regional East African electricity exports with increased hydropower generation, and construction has begun to enhance interconnections with Kenya. Furthermore, the Manantali dam in Mali and Ruzizi dam on the border of Rwanda and the Democratic Republic of the Congo hold hope for improved hydropower sharing between East and Central African neighbors (IEA, 2014; p. 64).

Access to Electricity

Access to electricity is a major component of the energy sector, and an area of concern for many East African countries. Lack of access to electricity has adverse economic impacts: one study found that electricity outages in sub-Saharan Africa costs the region 2.1 percent of its GDP (World Economic Forum [WEF], 2012; p. 31). The 2016 World Bank Regulatory Indicators for Sustainable Energy (RISE) report—which scores countries on their regulatory frameworks and policy environment towards the energy sector in various countries—notes that, while Kenya, Uganda, and Tanzania are all leaders in creating an enabling environment for energy access in sub-Saharan Africa, they also appear in the top ten countries with highest electricity deficit, along with Ethiopia, meaning a large number of their population lacks access to electricity (Banerjee, Moreno, Sinton, Primiani, and Seong, 2017; p. XVII).

This access gap is particularly pronounced when disaggregating the data by rural and urban populations. While urban populations in all East African countries have greater access to electricity than rural populations, the distance from East African countries to the SSA average illustrates the wide gap in access. The urban populations of three East African countries have electricity access above the urban sub-Saharan Africa regional average of 66 percent: Kenya, Ethiopia, and Rwanda (World Bank, 2017). However, all East African countries perform far lower than the sub-Saharan African average in terms of rural access to electricity: in Kenya, the East African country with the highest share of ru-



ral access, only 12.6 percent of the rural population has electricity access, nearly half the sub-Saharan Africa regional average of 21.9 percent (World Bank, 2017). These numbers, coupled with the relatively large proportion of East African populations residing in rural areas, highlight the need to expand electricity access, particularly to rural populations.

The IEA, in its Africa Energy Outlook special report, projects growth in energy access to 2040 based on a probable path for energy markets given continuation of existing policies and implementation of commitments and plans that had been announced as of mid-2014. Based

on these estimates, East Africa achieves the most rapid pace of growth in access to electricity amongst all sub-Saharan African sub-regions, with particularly strong expansion of electricity access in Ethiopia, Kenya, and Rwanda (IEA, 2014; p. 124). However, the report projects that by 2040, one third of sub-Saharan Africa's population without electricity will be rural East African, highlighting the continued need to develop solutions for these populations (IEA, 2014; p. 124).

In recent years, several East African countries have established programs to help expand electricity access to greater shares of their population. For example, Kenya Power provides loan programs to support the payment of connection fees for low-income customers in addition to a subsidy—through an agreement with the World Bank—to residents in informal settlements and low-income areas to connect to prepaid meters at a lower rate (Banerjee et al., 2017; p. 77). Similarly, Rwanda has rapidly electrified in recent years due in part to its Electricity Access Rollout Programme, which offers switchboards at affordable payment installments for low-income households to connect to grid electricity without fully wiring their homes (IEA, 2014; p. 32).

Regulatory and Business Environment

In addition to energy access, the RISE report takes into account energy efficiency and renewable energy when scoring countries on their regulatory environment and policy support to the energy sector. The three pillars are aggregated to form a composite indicator that allows for benchmarking of energy sector policies and regulatory frameworks in each country against their regional and global competitors. The pillar scores allow policymakers to identify their country's relative strengths and weaknesses, aiming to develop policies and regulations in each country that will attract investment in the sustainable energy sector. Kenya performs the best of all East African countries on the overall composite indicator, receiving a score of 64.33 out of a possible 100 points (Banerjee et al., 2017). This indicates that Kenya has in place a relatively strong set of policies and regulations that will enable the country to boost investment in the sustainable energy sector and achieve its energy goals. No other East African country performed better than the global average of 55.56, but all countries except South Sudan performed higher than the sub-Saharan African average of 32.7 (Banerjee et al., 2017). As already noted, South Sudan's score was driven in part by its poor performance on energy access, but it received its lowest score on the renewable energy pillar, 10.29, landing in the bottom five countries covered in that pillar (Banerjee et al., 2017; p. 135). Of particular note, South Sudan is one of only eight countries covered in the RISE report that do not allow for private ownership of renewable energy generation (Banerjee et al., 2017; p. 138).

The RISE report includes an analysis of how 55 countries with energy access deficiencies—defined as countries where greater than 90 percent or one million people are without electricity access—perform on the energy access pillar. The report takes into account a country's electrification plan, frameworks for various grid systems, consumer affordability, and utility transparency and creditworthiness when

evaluating energy access (Banerjee et al., 2017; p. 12). Three East African countries—Kenya, Uganda, and Tanzania—all fall within the top five energy deficient scorers on the distribution of energy access. The report notes that the three countries are “bright spots...leading the efforts to create an attractive enabling environment” in frameworks for grid electrification, mini-grids, and stand-alone systems (Banerjee et al., 2017; p. 12).

South Sudan, which scored the lowest of all East African countries and falls within the bottom ten countries globally on the energy access pillar, received a low score in large part due to the fact that there is no officially approved national electrification plan or framework for grid electrification (Banerjee et al., 2017; p. 69). The RISE report notes that while a plan has been drafted, until a comprehensive, publicly-available plan has been approved, South Sudan will continue to perform poorly on this pillar (Banerjee et al., 2017; p. 71). Similarly, regulatory and access issues in Ethiopia prevent it from scoring well on the energy access pillar. The report mentions that while most countries with high energy access deficits perform relatively well on key RISE indicators, Ethiopia does not. Like South Sudan, Ethiopia could improve its score relatively easily by adopting, monitoring, and scoping an electrification plan (Banerjee et al., 2017; p. 13).

East Africa averaged the lowest scores on the energy efficiency pillar, where Kenya was once again the only country to score higher than the global average of 41.2, and only Tanzania, Uganda, and Ethiopia performed better than the sub-Saharan Africa regional average, 21.54 (Banerjee et al., 2017). East African countries performed better on the renewable energy pillar, where Burundi, Kenya, Rwanda, Tanzania, and Uganda all scored higher than the global average, and only South Sudan performed worse than the sub-Saharan African average. The results of the RISE report illustrate a generally positive outlook for energy policy and regulations in East Africa, with the relatively young country of South Sudan needing the most improvement in all three regulatory pillars (Banerjee et al., 2017).

WATER

Water Resources

Water is a key natural resource in East Africa, particularly given the region's reliance on agriculture for its economy. As of 2014, the latest year with available data, two East African countries provided for 100 percent of their renewable water resource needs internally: Djibouti and Ethiopia (Food and Agriculture Organization of the United Nations [FAO], 2016b). South Sudan stands out as a clear outlier, relying on neighboring countries for 65.8 percent of its water resources in 2014. This is more than double the sub-Saharan African average of 30.4 percent, and nearly three times the global average of 22.7 percent. Uganda and Kenya are both more dependent on neighbors for a greater share of their water supply than the average sub-Saharan African country, at 35.1 percent and 32.6 percent respectively (FAO, 2016b). USAID's fact sheet on climate change adaptation in East Africa highlights the problem with uneven water resource distribution in East Africa, noting that the unbalanced distribution, coupled with climate stresses,

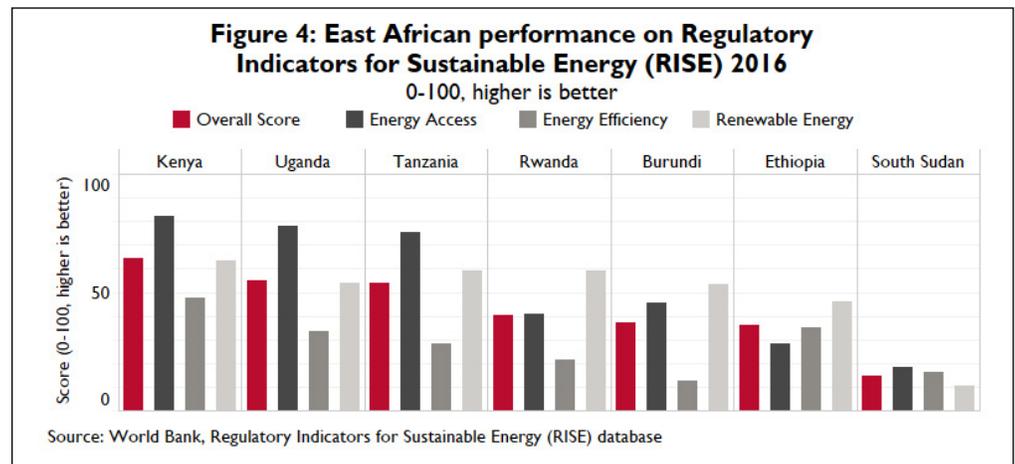
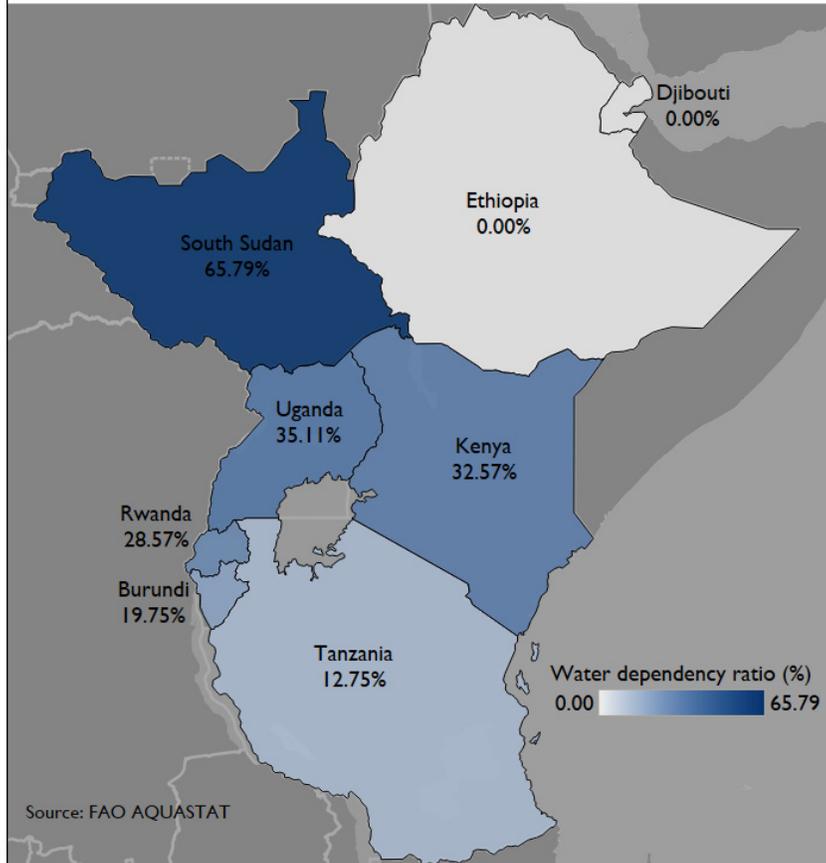


Figure 5: Water dependency ratios in East Africa, 2014
Percentage of total renewable water resources originating outside the country



will contribute to intra-regional competition for water (USAID, 2012; p. 2).

The World Resources Institute measures inter-annual and seasonal variability of water supply by scoring countries with values ranging from 0 to 5, with higher values indicating greater levels of variability.⁴ Greater inter-annual variability means that a country may find it difficult to plan for a consistent water supply from year to year, whereas greater seasonal variability might mean that farmers need to be very precise in the timing of their planting and harvesting. Djibouti has the highest inter-annual variability in water supply (4.3), more than double the sub-Saharan Africa regional average of 2.0 (FAO, 2016b). This indicates that it is difficult to predict the water supply in Djibouti from year to year, though the supply is relatively more consistent from month to month within years. Two other countries score above the sub-Saharan Africa average for inter-annual variability: Kenya and Tanzania (FAO, 2016b).

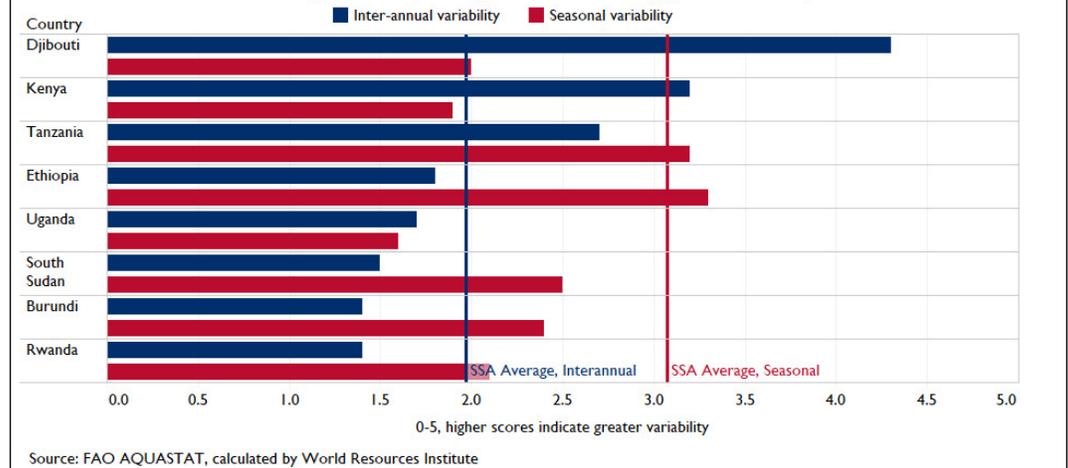
Tanzania was the only country to score above the SSA average on both the inter-annual and

seasonal measures, receiving a score of 3.2 on seasonal variability (FAO, 2016b). This figure is slightly lower than the highest East African country, Ethiopia, which scored 3.3. Although South Sudan relies on its neighbors for the majority of its water supply, it does not experience extreme variability in either its seasonal or inter-annual supply of water; it scores lower than both the East African and sub-Saharan African average on inter-annual supply, and lower than the sub-Saharan African average on seasonal supply (FAO, 2016b).

Variability in water supply is affected significantly by changes to climate and weather events in the region, and is particularly important given East Africa's reliance on rain-fed agriculture (USAID, 2012; p. 2). USAID's fact sheet on climate change adaptation in East Africa notes that annual rainfall throughout Africa has largely decreased since

Figure 6: Variability of water supply scores, 2013

Values range from 0-5, with higher scores indicating greater variability



1960, while variability has increased (USAID, 2012; p. 1). The increased variability, coupled with warmer temperatures and recent prolonged droughts, have already resulted in reduced river flows; dried up regional water sources such as Lakes Tanganyika, Victoria, and Turkana; and portend future water stress in the region (USAID, 2012; p. 2). One result of the more limited water supply is reduced hydropower generation: one report notes that lower rainfall totals led to a reduction in water levels at the Seven Forks Dam power complex in Kenya, which forced the country to resort to more expensive thermal generation and increased tariffs on power bills for Kenyan citizens and businesses (Muchira, 2017).

Drinking Water and Sanitation

Access to clean drinking water has steadily increased in East Africa in recent years, with access to improved sources rising from an average of just over 50 percent in 1990 to 69.5 percent in 2015 (World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF), 2016). A larger proportion of the population in all East African countries have access to clean drinking water in 2015 than did in 1990, with the largest gains being made in Ethiopia: between 1990 and 2015, the proportion of the country's population with access to an improved drinking water source more than tripled to 57.3 percent. However, Ethiopia still lags behind almost every other country in East Africa: only Tanzania provides clean drinking water at a lower rate, at 55.6 percent of the population. East African countries on average perform slightly lower than the sub-Saharan African average of 74.8 percent in 2015, and well below the global average of 89.8 percent (WHO and UNICEF, 2016).

The differences between rural and urban areas of East Africa are not as pronounced for access to drinking water as they are for electricity access. In 2015, East African countries averaged 61.8 percent of their rural populations with access to clean drinking water, compared with 86.2 percent of urban populations. As with the overall access data, East Africa performs slightly lower than sub-Saharan Africa as a whole for both urban and rural access to improved water sources (WHO and UNICEF, 2016).

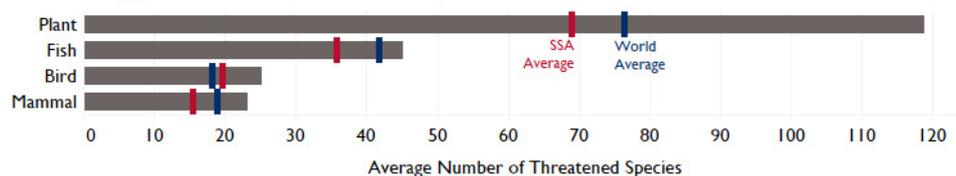
Data on access to sanitation tell a similar story: in 2015, East African countries averaged just 32.1 percent of their populations with access to improved sanitation facilities, slightly lower than the sub-Saharan African average of 37 percent and well below the global average of 74.5 percent (WHO and UNICEF, 2016). The World Bank's Water and Sanitation Program (WSP) has studied the economic costs of poor water and sanitation in countries around East Africa and estimates that East African economies lose close to one percent of GDP annually due to poor sanitation, with total costs ranging from \$177 million annually in Uganda to \$324 million in Kenya (World Bank, 2012). These losses are the result of premature death, excessive healthcare costs, time spent accessing clean sanitation and water facilities, and productivity losses while sick or accessing healthcare (World Bank, 2012).

BIODIVERSITY

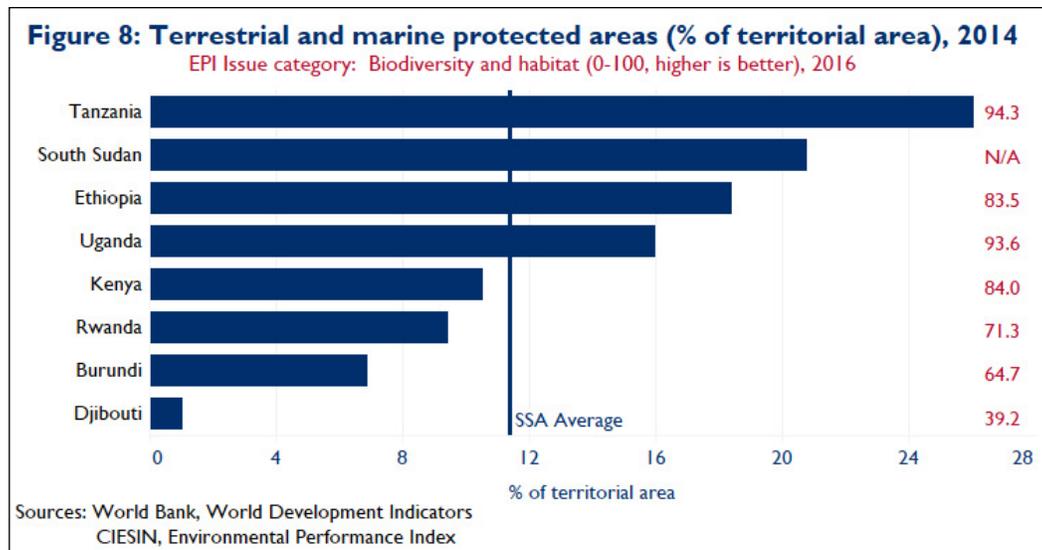
As a highly biodiverse region, particularly within inland water ecosystems, East Africa is home to many of the world's threatened species. Tanzania has more threatened species than any other East African country for all four categories tracked by the International Union for Conservation of Nature (IUCN): bird, fish, mammal, and plant. Tanzania is home to 863 total threatened species, 70 percent of which are plants and 20.4 percent of which are fish (World Bank, 2017). Kenya has the second-highest number of threatened species for East Africa in all four categories, with the majority of species again being comprised of plants. As illustrated in Figure 7, East African countries average more threatened species than both the global and sub-Saharan African averages on all four categories, highlighting the importance that biodiversity plays in the region (World Bank, 2017).

Figure 7: Average number of threatened species in East African countries, 2016

On average, East Africa has more threatened species than the rest of Sub-Saharan Africa and the world



Source: World Bank, World Development Indicators



Yale University and the Center for International Earth Science Information Network (CIESIN) at Columbia University publish the Environmental Performance Index (EPI), which scores countries on their performance towards protecting biodiversity and habitat. The index takes into account the protection of terrestrial and marine areas, and threatened or endangered species. To track critical habitat protec-

tion, the EPI measures the percentage of key sites recognized by the Alliance for Zero Extinction as last remaining refuges of one or more endangered species that are located in protected areas (Hsu, 2016). Tanzania scores the highest of all East African countries covered, at 94.3 out of a possible 100 (Hsu, 2016), and 26 percent of its territorial area is protected, also the highest of any covered East African country (World Bank, 2017). South Sudan, Ethiopia, and Uganda all protect more of their territorial area than the average for sub-Saharan Africa, 11.4 percent. Djibouti stands out as an outlier amongst the countries covered, protecting only one percent of its territorial area (World Bank, 2017), and scoring the lowest on the EPI biodiversity and habitat category, at 39.2 (Hsu, 2016). It is important to note that the performance on the EPI and data on protected areas does not fully capture enforcement of those areas and thus does not paint a complete picture of habitat protection. Despite performing the highest of all East African countries on the EPI, Tanzania, for example, has lost more than 60 percent of its elephant population in recent years, largely due to poaching (International Union for Conservation of Nature [IUCN], 2016).

The threats to biodiversity in East Africa pose several risks to the economies of the region given that wildlife tourism comprises a significant portion of GDP in East African countries (Muruthi, 2015). In 2012, the latest year with the most complete data available, tourism on average contributed to 19.1 percent of East African economies' total exports, compared to an average of 13.5 percent in sub-Saharan Africa in general, and 16.5 percent globally (World Bank, 2017). This was driven largely by countries like Rwanda, Tanzania, and Uganda, all of which attribute at least one-fifth of their exports to tourism. In 2012, tourism accounted for nearly one-third of Ethiopia's exports (World Bank, 2017). Additionally, Kenya recorded more than \$1.8 billion in international tourism receipts in 2011, more than any other East African country in that year (World Bank, 2017).

In addition to tourism, biodiversity contributes to economic growth through ecosystem services. In Kenya, for example, the Mau Forest Complex, which contributes about \$1.3 billion in services annually, and which helps to collect rainwater that irrigates Kenya's tea fields, has declined in size by 40 percent as a result of deforestation (Muruthi, 2015).

Fisheries are another important economic contribution of biodiversity, and fishery production in East Africa has increased 36.9 percent since 1990, reaching 1.2 million metric tons in 2015 (World Bank, 2017). Fisheries on Tanzania's side of Lake Victoria are worth an estimated \$400 million, and in Uganda fisheries comprise at least 6 percent of GDP (Anderson, 2012). Several East African countries have made strides in recent years to modernize their fisheries and make them more economically productive. Kenya, for example, recently announced a national tuna fisheries development and management strategy, which could result in up to 300,000 metric tons of annual output (Under-Current News, 2017). Modernization of fisheries in East Africa has the potential to greatly improve food security,

economic growth, and trade in the region given that about one-quarter of the world's tuna is harvested in the waters of the West Indian Ocean off of East Africa's coast (FAO, 2016b).

However, fisheries in East Africa also face the threat of illegal, unreported, and unregulated (IUU) fishing. The Inter-African Bureau for Animal Resources notes that IUU vessels from distant water fishing nations often target tuna and billfishes off the coast of Kenya and Tanzania, threatening the livelihood of local fisheries and the biodiversity of marine waters (AU-IBAR, 2016; p32). Kenya's government, for example, estimates that the country loses at least \$118 million annually due to illegal fishing and fish poaching and an estimated \$20 million was lost in Tanzania due to IUU in 2001 (AU-IBAR, 2016; p 71).

USAID places a strong emphasis on biodiversity protection in East Africa, especially given that East Africa serves as a hub for illegal wildlife trafficking and environmental crime that 'generates up to \$213 billion each year' (USAID and U.S. Department of the Interior [USAID and DOI], 2017; p. 1). 58 percent of ivory weight seized from 2009-2011 came from three ports in East Africa—Mombasa, Dar es Salaam, and Zanzibar—indicating a shift from Southern Africa to Eastern Africa in illegal ivory shipments (Ewing, Miller, and Vira, 2014; p. 18). In the last five years with complete data, FY2010-2015, more U.S. foreign assistance for general environmental protection in East Africa went to biodiversity than any other purpose (USAID, 2017). USAID, along with the Department of the Interior, is working to foster government-to-government relationships and enhance wildlife management and protection in East Africa. By partnering with wildlife authorities and the Ministries of Environment in the East African countries of Kenya, Tanzania, and Uganda, U.S. foreign assistance has increased awareness and community engagement to counter wildlife crime and strengthened enforcement of agreements made under the Convention on International Trade and Endangered Species (CITES) (USAID and DOI, 2017; p. 1-2).

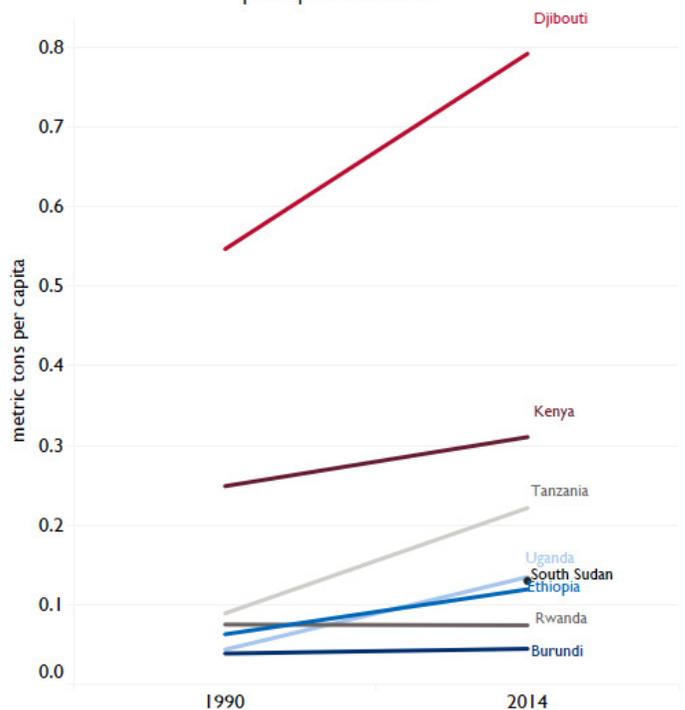
CLIMATE CHANGE

One common measure of a country's contribution to climate change is its carbon dioxide emissions. Figure 9 shows that East African countries with available data increased their per capita emissions of carbon dioxide (CO₂) between 1990 and 2014 with the exception of the second-lowest emitter, Rwanda, which emitted 0.07 metric tons per capita in 2014 (World Bank, 2017). In raw terms, East Africa's CO₂ emissions have increased more than 250 percent from 1990-2014, but their total emissions still make up only about 5.7 percent of sub-Saharan Africa's emissions, and only 0.14 percent of global emissions (World Bank, 2017). While most East African countries have steadily increased their CO₂ emissions in recent years, their contribution to global CO₂ emissions is small.

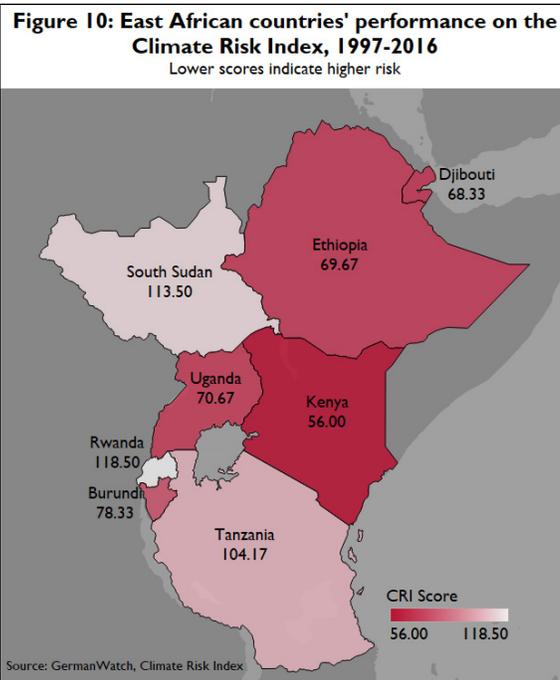
In an attempt to measure the direct impacts of climate change, GermanWatch publishes an annual Global Climate Risk Index, which estimates the human and financial losses from extreme weather events. The index takes into account deaths and monetary losses of extreme weather events from 1997-2016, including in

Figure 9: Carbon dioxide emissions (metric tons per capita), 1990 and 2014*

Rwanda is the only East African country to have reduced CO₂ emissions per capita since 1990



*Note: No data available for South Sudan..

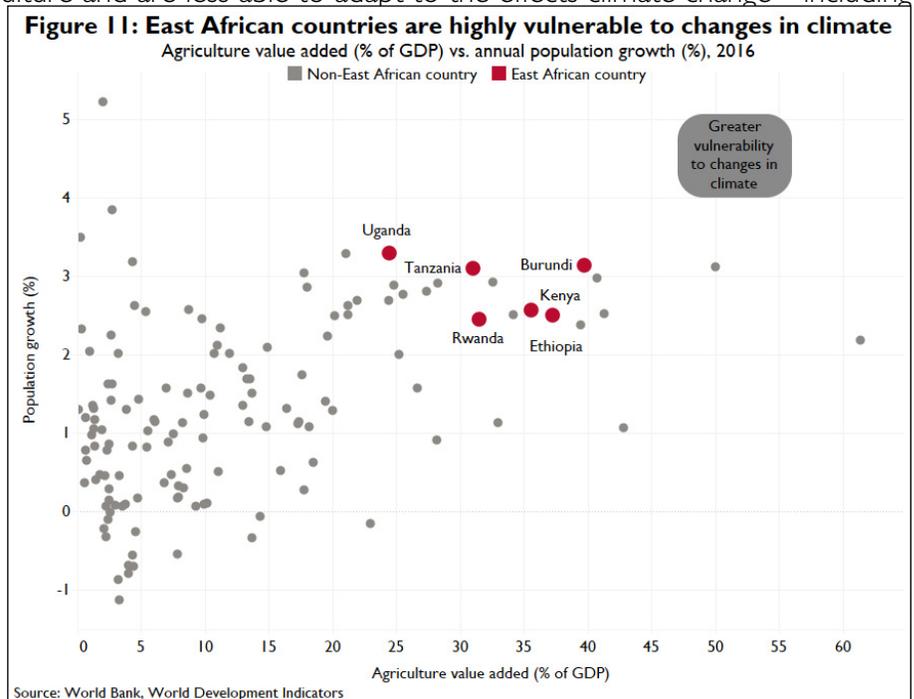


per capita terms and relative to the size of a country's economy. Kenya is deemed as the most affected of all East African countries on this measure, receiving the lowest score of 56 (lower scores indicate greater risk to extreme weather events) (Eckstein, Kunzel, and Schafer, 2017). Rwanda and South Sudan, the only East African countries to receive a higher score than the sub-Saharan African average of 108.1, were deemed to be the East African countries least affected by extreme weather events, scoring 118.5 and 113.5 respectively (Eckstein et al., 2017). When compared to the global average, though, East African countries perform slightly better: South Sudan, Tanzania, and Rwanda all receive scores indicating lower risk than the global average of 91.4, and Kenya is the only East African country to rank in the 50 most affected countries (Eckstein et al., 2017). In another attempt to quantify the impacts of severe weather events, the World Resources Institute calculates an indicator of flood occurrence from 1985-2011. On this measure, all East African countries except South Sudan perform higher than the global and sub-Saharan Africa regional average, indicating higher than average occurrence of floods during the 26 year period (FAO, 2016b).

GermanWatch notes that the Climate Risk Index has its limitations; specifically, it captures only the direct impacts of extreme weather events, not indirect impacts. They warn that indirect impacts, such as 'heat waves—which are a frequent occurrence in African countries—often lead to much stronger indirect impacts (e.g. as a result of droughts and food scarcity)' (Eckstein et al., 2017; p. 4). The International Food Policy Research Institute (IFPRI), in a 2013 report noted several weather events in East Africa which had severe indirect economic impacts, including prolonged droughts in Ethiopia, Kenya, and Tanzania in 2011 and devastating floods in Kenya, Tanzania, and Uganda (Waithaka, Nelson, Thomas, and Kyotalimye, 2013; p. 377). The report outlines the adverse economic impacts—particularly on low-income populations that rely on agriculture and are less able to adapt to the effects climate change—including weather-related crop failures, which can lead to food insecurity.

Fisheries are also threatened by changes to the environment. For example, warmer temperatures and decreased wind speeds around Lake Tanganyika have stabilized the lake and reduced the cycling of nutrients to surface waters, resulting in an estimated 30 percent decline in the productivity of fisheries, which provide as much as 40 percent of the animal protein supply for surrounding countries (USAID, 2012; p. 2).

The agricultural impact of climate change is compounded by high population growth in East Africa. The IFPRI report



explains that eastern and central African countries are particularly vulnerable to climate due to their 'reliance on rain fed agriculture, high population growth rates... and endemic poverty' (Waithaka et al., 2013; p. 32). Figure 11 illustrates this dilemma. Agriculture contributes more to East African economies than the majority of all other countries included in this analysis: every East African country falls above the 84th percentile for agriculture value added as a percentage of GDP in 2016 (World Bank, 2017). Similarly, no East African country falls below the 77th percentile for population growth. Rwanda, the East African economy included in this analysis with the lowest population growth rate, added 2.4 percent to its population in 2016 (World Bank, 2017).

FOREIGN ASSISTANCE

U.S. foreign assistance to East Africa for energy and the environment represented 39.1 percent (\$418 million) of total disbursements to sub-Saharan Africa in those sectors from 2010-2015 (USAID, 2017). Foreign assistance was split relatively evenly between the two sectors in East Africa: 54.8 percent went to energy and 45.2 percent was disbursed for general environmental protection. The vast majority of funding for energy, 83 percent, went specifically to electric power transmission and distribution, in line with the demonstrated need to connect greater numbers of East Africans to electricity. A sizeable amount of energy funding, 5 percent, was designated for hydro-electric plants, primarily through the Millennium Challenge Corporation, which supports the Malagarasi Hydropower project in Tanzania. Although more than \$6 million was disbursed for nuclear energy, this funding was comprised almost exclusively of Department of Energy nuclear threat reduction programs. Smaller portions of U.S. foreign assistance contributed to investments in geothermal, solar, and wind energy in East Africa.

Biodiversity received the most funding for the general environmental protection sector (\$106.6 million), reflecting the strong emphasis that U.S. strategy places on efforts to support wildlife protection and combat wildlife trafficking in the region (USAID, 2017). Biosphere protection, which includes activities related to climate change, including air pollution control and ozone layer preservation, received the second-highest amount, at 36 percent of total funding for environmental protection in the region.

East Africa received 9 percent of U.S. assistance for water supply and sanitation in 2015. South Sudan received 36 percent of 2015 East African funding to the sector, amounting to \$12.2 million. Ethiopia and Kenya each received over \$6 million, or about 20 percent of the total. All other countries (Uganda, Tanzania, Rwanda) received less than 10 percent of the region's funding, and about \$2 million was allocated to the general Eastern Africa region. The vast majority of the funding (72 percent) went to basic drinking water supply and basic sanitation, but significant amounts also went to large systems (14 percent).

CONCLUSION

East Africa presents unique opportunities and challenges for the management of natural resources in sub-Saharan Africa. Although East Africa currently uses a relatively small amount of energy, strong economic and population growth coupled with the exploration of newly-discovered energy sources will likely lead to increased energy production within the region and energy trade throughout sub-Saharan Africa. In terms of biodiversity, every East African country has made progress in increasing protected land area since 2000, and large investments of U.S. foreign assistance have worked to counter the wildlife trade in the region. East African countries are generally not large emitters of carbon dioxide, but extreme weather events and dependence on agriculture mean that the region is particularly vulnerable to some of the long-term effects of climate change, including food insecurity. The U.S. government has sought to mitigate these risks, making significant investments with foreign assistance in biosphere protection. Foreign assistance in the areas of energy and the environment has also focused on improving access to electricity—a need demonstrated particularly in rural parts of East Africa—and exploring new sources of energy production.

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To access the data, please visit the EADS International Data & Economic Analysis (IDEA) website at idea.usaid.gov.

DISCLAIMER: The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development (USAID) or the United States Government.

Endnotes:

¹ Uganda and South Sudan are not included in this analysis due to lack of data.

² According to the International Energy Agency (IEA), biofuels and waste are comprised of solid biofuels, liquid biofuels, biogases, industrial waste, and municipal waste. Biofuels are defined as any plant matter used directly as fuel or converted into fuels (e.g. charcoal) or electricity and/or heat. Included in this definition are wood, vegetal waste, ethanol, animal materials/wastes and sulphite lyes.

³ The Africa Energy Outlook includes Sudan and Eritrea in East Africa and classifies Tanzania as Southern Africa.

⁴ Values are calculated by dividing the standard deviation of annual and monthly blue water supply (i.e. volume of water which flows through a river) for inter-annual and seasonal variability respectively by the mean of total blue water supply from 1950 to 2010 in each country.

References:

African Union Intra-African Bureau for Animal Resources (AU-IBAR). (2016). Economic, Social and Environmental Impact of Illegal, Unreported and Unregulated Fishing in Africa. Retrieved from: https://www.researchgate.net/profile/Merle_Sowman/publication/313529553_A_review_and_assessment_of_the_economic_social_and_environmental_impact_of_illegal_unreported_and_unregulated_fishing_in_Africa/data/589d867c92851c599c9ad0f3/African-IUU-Report-from-AU-IBAR-website.pdf

Anderson, Jim. (2012). Options to Reduce IUU Fishing in Kenya, Tanzania, Uganda and Zanzibar. Food and Agriculture Organization of the United Nations (FAO). Retrieved from: <http://www.fao.org/3/a-az391e.pdf>

Banerjee, Sudeshna Ghosh, Moreno, Alejandro, Sinton, Jonathan, Primiani, Tanya, and Seong, Joonkyung. (2017). Regulatory Indicators for Sustainable Energy: A Global Scorecard for Policy Makers. International Bank for Reconstruction and Development/The World Bank. Retrieved from: <http://documents.worldbank.org/curated/en/538181487106403375/pdf/112828-REVISED-PUBLIC-RISE-2016-Report.pdf>

Eckstein, David; Kunzel, Vera, and Schafer, Laura. (2017). Climate Risk Index 2018. Germanwatch e.V. Retrieved from: <http://germanwatch.org/en/download/20432.pdf>

Ewing, Thomas, Miller, Jackson, and Vira, Varun. (2014). Out of Africa: Mapping the Global Trade in Illicit Elephant Ivory. World Wildlife Fund. Retrieved from: <http://www.wwf.se/source.php/1578610/out%20of%20africa.pdf>

Food and Agriculture Organization of the United Nations (FAO). (2016a). AQUASTAT Main Database. Retrieved from: <http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en>

Food and Agriculture Organization of the United Nations (FAO). (2016b). Fishery and Aquaculture Country Profiles: The Republic of Kenya. Retrieved from: <http://www.fao.org/fishery/facp/KEN/en>

Hsu, Angel et al. (2016). 2016 Environmental Performance Index. Yale University. Retrieved from: <http://epi.yale.edu/data>

International Energy Agency (IEA). (2017). International Energy Statistics Database. Retrieved from: <https://www.iea.org/statistics/statisticssearch/>

International Energy Agency (IEA). (2014). Africa Energy Outlook: A Focus on Energy Prospects in Sub-Saharan Africa.

Organisation for Economic Cooperation and Development (OECD). Retrieved from: https://www.iea.org/publications/freepublications/publication/WEO2014_AfricaEnergyOutlook.pdf

International Union for Conservation of Nature (IUCN). (2016). Poaching Behind Worst Elephant Losses in 25 Years. Retrieved from: <https://www.iucn.org/news/species/201609/poaching-behind-worst-african-elephant-losses-25-years-%E2%80%93-iucn-report>

Muchira, Njiraini. (2017). East Africa: EAC Reels from Effects of Long Drought in High Power Costs. The East African. Retrieved from: <http://allafrica.com/stories/201710310297.html>

Muruthi, Philip. (2015). The Economics of Africa's Wildlife. World Economic Forum. Retrieved from: <https://www.weforum.org/agenda/2015/03/the-economics-of-africas-wildlife/>

Undercurrent News. (2017). Kenya to Modernize Tuna Fisheries. Retrieved from: <https://www.undercurrentnews.com/2017/06/07/kenya-to-modernize-tuna-fisheries/>

U.S. Agency for International Development (USAID). (2017). Foreign Aid Explorer Database. Retrieved from: <https://explorer.usaid.gov/>.

U.S. Agency for International Development (USAID). (2012). Climate Change Adaptation in East Africa. Retrieved from: https://www.climatelinks.org/sites/default/files/asset/document/east_africa_adaptation_fact_sheet_feb2012.pdf

U.S. Agency for International Development/Kenya and East Africa (USAID/KEA). (2016). East Africa Regional Development Cooperation Strategy 2016-2021. Retrieved from: https://www.usaid.gov/sites/default/files/documents/1860/East_Africa_RDCS_July_2021.pdf

U.S. Agency for International Development (USAID) and U.S. Department of the Interior (DOI). (2017). Inter-Agency Agreement to Support Wildlife Conservation and Combat Wildlife Crime. Retrieved from: https://www.usaid.gov/sites/default/files/documents/1860/DOI_PAPA_FACT_SHEET_Oct_2017.pdf

U.S. Energy Information Administration (EIA). (2017). International Energy Statistics Database. Retrieved from: <https://www.eia.gov/beta/international/data/browser/#/>

U.S. Energy Information Administration (EIA). (2016). International Energy Outlook 2016. Retrieved from: <https://www.eia.gov/outlooks/ieo/pdf/industrial.pdf>

Vall, Mohammed. (2017). Egypt-Ethiopia Tensions over New Dam Rise Again. Al-Jazeera News. Retrieved from: <http://www.aljazeera.com/news/2017/11/egypt-ethiopia-tensions-dam-rise-171127143625140.html>

Waithaka, Michael, Nelson, Gerald, Thomas, Timothy, and Kyotalimye, Miriam (2013). East African Agriculture and Climate Change. International Food Policy Research Institute. Retrieved from: <http://www.ifpri.org/cdmref/p15738coll2/id/127923/filename/128134.pdf>

World Bank. (2012). Africa: Economics of Sanitation Initiative. Retrieved from: <https://www.wsp.org/content/africa-economic-impacts-sanitation>

World Bank. (2017). World Development Indicators (WDI). Retrieved from: <https://data.worldbank.org/data-catalog/world-development-indicators>

World Economic Forum. (2012). Energy for Economic Growth: Energy Vision Update 2012. Retrieved from: http://www3.weforum.org/docs/WEF_EN_EnergyEconomicGrowth_IndustryAgenda_2012.pdf

World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF). (2016). Joint Monitoring Programme (JMP) for Water Supply and Sanitation. Retrieved from: <https://washdata.org/data>