

# Effectively regulating foreign fishing to improve food security and fishery sustainability in Africa

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## Analysis

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# Abstract

Africa is the poorest continent with a burgeoning population and experiencing the most severe food insecurity and overfishing in the world. Searching for sustainable development pathways, we systematically analyzed a comprehensive dataset on fish consumption, international trade, production by local and foreign fleets, and fishery resource status available for the last 70 years. Our findings show that Africa relies on imports to supplement the lowest per capita fish consumption among continents while foreign fleets fish legally or illegally in African waters, annually landing approximately 3.3 million tonnes of fish (equivalent to 48% of the total marine catch reported by African countries) outside Africa in 2017. While restoring overfished stocks, Africa should urgently transform the regulation and use of foreign fishing to satisfy various demands for more fish for African people, better profits and social prospects for the fishery sector, and sustainable fish resources as required by the United Nations Sustainable Development Goals.

## Main Text

To address global challenges, all the 193 member states have committed to the United Nations Sustainable Development Goals<sup>1</sup> (SDGs). The SDGs pledge “that no one will be left behind and that goals and targets will be met for all nations and peoples and for all segments of society.”

This requires that the inequality between and within countries and the specific needs of vulnerable countries and sectors be addressed<sup>2</sup>. The world today still has 800 million people living in poverty and inequalities have been pushed to new heights between and within countries<sup>2</sup>. To achieve the SDGs, we need integrated policy frameworks that aim to progressively achieve universal coverage while addressing the specific needs of vulnerable people through targeted policies and programmes and macroeconomic and fiscal instruments that promote inclusive growth, decent work for all, and the reduction of inequalities.

Africa covers 24% of the Earth’s land area<sup>3</sup> and accounts for 16% of the world’s human population<sup>4</sup>. It is the poorest continent, having 70% of the 47 least developed countries classified by the United Nations (UN) and 38% of its population now living in extreme poverty<sup>5</sup>. Fisheries are often characterised by poverty, poor access to social services such as health care and education, and marginalization<sup>6</sup>. An estimated 5.8 million fishers in the world earn less than \$1 per day<sup>7</sup> and are amongst the most vulnerable to shocks and external changes such as natural disasters and climate change<sup>6</sup>. Although plagued with poverty, the fishery sector plays a pivotal role in people’s food security, livelihoods and national economy in Africa. It produced 13.3 million tonnes (mt) of seafood in 2017<sup>8</sup> and employed an estimated 12.3 million people<sup>9</sup>. Fish is an important source of nutrients and the cheapest form of animal protein for the rural poor, providing 20% of the animal protein source in Africa, higher than the world average 17%<sup>10</sup>. Fisheries are essential to Africa’s economies contributing 1.26% to national GDP, higher than the <1% of the global average<sup>7</sup> and provide 19% of agricultural export commodity volumes<sup>11</sup>. As an important sector

but one of the poorest in the currently least developed continent, African fisheries are uniquely positioned to be a touchstone of the pledge “leave no one behind” and at the heart of global success of the SDGs.

This article takes a holistic approach to examine African fisheries, which are often sacrificed in pursuing economic development and marginalized in national policy and planning frameworks despite their social, economic and environmental importance for local communities<sup>6</sup>, in order to provide evidence to inform policymaking and identify pathways within the environmental boundaries that can effectively use available resources to satisfy various demands for more fish for African people, better profits and social prospects for the fishery sector, and sustainable fish resources as required by the United Nations Sustainable Development Goals<sup>1</sup>.

## Results And Discussion

### The low fish consumption in Africa

Fish contains important micronutrients such as iron, zinc, omega-3 fatty acids and vitamins and therefore plays an irreplaceable role in securing sufficient and nutritious food<sup>12</sup>. In Africa, fish is a highly valuable dietary item and available at affordable prices to the rural poor in many areas. However, fish consumption in Africa was merely 9.9 kg per capita in 2017<sup>10</sup>, which is far below the 12.7kg a year recommended by the U.S. Department of Health and Human Services for health reasons<sup>13</sup> and only half of the world average 19.9 kg per capita<sup>10</sup> (Fig.1a), while close to the average (9.3 kg per capita) of the low-income food-deficit countries<sup>10</sup>. These numbers do not reflect the considerable regional differences, for example, from approximately 12 kg per capita in West Africa to 5 kg per capita in East Africa, but overall, the continent has the lowest per capita consumption of fish<sup>8</sup>. The great disparity between Africa and the world average had existed since 1961 when such data was first collected by the UN Food and Agriculture Organization and has widened over the last decades (Fig.1a).

What are the constraints leading to the low fish consumption: insufficient production, cultural and traditional perceptions, or distributional constraints? What can be done to raise fish supply for maximum social, economic and health benefits while maintaining environmental sustainability?

### Import-supplemented fish consumption

Fish production in Africa has developed dramatically, increasing 11 times from 1.1 mt in 1950 to 13.3 mt in 2017<sup>10</sup>, with an accelerating increase rate over the last three decades (Fig.1b). Why has the increased production not led to a similar rise in fish consumption, which only doubled over the same period (Fig.1a)? A central cause of this disparity in growth between production and consumption must be the fast-growing human population on the continent (increased 5 times from 1950 to 2017<sup>4</sup>), but resource allocation from fish production to end uses has also played an important role.

Fish is a healthy, highly pursued food on the international market. Developing countries frequently export high-value seafood for income and hard currency that is needed for, amongst other purposes, importing high-end services and technologies for national development, but

Fig.1 Major factors affecting the current state of African fisheries. a. Comparison of fish consumption between Africa and the world; b. The production history of capture fishery and aquaculture in Africa; c. The net import (import minus export) of fish products to African countries; d. The total amount of fish taken by FVF in African waters through various agreements that are generally legal and reported; e. Percentages of overfished stocks in the world marine fisheries and waters surrounding Africa with the blue shadows indicating one standard error of the mean. For data sources, see Methods.

import cheap products in return to meet their domestic demands (Fig.S4). As a result, nearly 40% of the world fish and fish products are internationally traded, accounting for about 70% of global import value in 2018 with a clear flow of net trade from the developing to developed economies<sup>10</sup>. Against this global trend, Africa has seen more imports than export from 1961 to 2017, with a peak of 2.5 mt in net imports in 2010 (Fig.1c), i.e., 25% of fish consumed in Africa were imported. The import of fish consumes valuable hard currencies, of which developing countries often face a shortage, and import price is usually higher than that of the same product from the domestic market. Therefore, the net import at a relatively high cost in Africa must reflect high demand, and the low current consumption is likely to be constrained by supply shortages.

### **Foreign fishing impeding seafood supply and fishery sustainability**

African coastal waters include some of the world's most abundant fishing grounds<sup>14</sup>. Due to the lack of capacity and infrastructure supporting the exploitation of fish resources before the 1980s, non-coastal states (mostly developed countries) often fished in African waters, largely free or by various agreements after EEZs were declared. The total catch of these foreign vessels fishing (FVF) in African waters reached a peak of 4 million tonnes (Fig.1d), more than the 3.7 mt caught by African fleets in 1977 (Fig.1b). The total catch taken out of the African EEZs by FVF stayed high until 1990 and since then has remained at about 1.5 mt (25% of the reported catch), after a sharp drop in the early 1990s (Fig.1d).

In addition to legal FVF agreed by African countries, another source of fishing pressure is illegal, unregulated and unreported (IUU) fishing. IUU fishing is widespread across the world, but Northwest Africa recorded the highest level in the Eastern Central Atlantic in the early 2000s<sup>15</sup>. The catch of IUU fishing in Africa has fluctuated around the average of 3.5 million tonnes a year since 1967 (Fig.S2) and foreign vessels contributed about 48% of the total IUU catch in 2017 (Fig.S3).

The harvested productivity of Africa's fishery resources in relation to their potential productivity is also an essential factor. Legal African fishers and fleets, FVF and IUU fishing in African waters together exert intense pressure on fishery resources. The FAO<sup>16-19</sup> estimates that the percentage of overfished stocks in waters surrounding Africa has been increasing continuously since 1974 and has been higher than the world average in most years (Fig.1e). Overfishing does not only impair the growth and reproductive

capacity of fish stock to replenish itself and threaten or destroy fishery sustainability but also typically reduces biodiversity and causes adverse impacts on the functioning and services of marine ecosystems. Therefore, SDG Target 14.4<sup>1</sup> requires all States to rebuild overfished populations through effective management for the best balance between sustainable use and conservation of fishery resources.

### **The gap to meet fish demand**

Africa's per capita fish consumption was 9.9 kg in 2017 – the lowest among continents. Even this low consumption was achieved by importing 4.3 million tonnes of fish from abroad. Market demand will expand in the future mainly due to the fast-increasing human population and economic development and consequently, shortages will increase if supply does not increase accordingly<sup>20</sup>. To provide insights on the practical strategies and pathways to strengthen fishery contribution to food security and hunger elimination in Africa, here we examine the potential future perspectives to maintain African fish consumption at the 2017 level by 2030. To be conservative, the upward pressure potentially caused by economic growth will not be considered here.

The United Nations<sup>4</sup> predicts that the African population will reach 1.7 billion by 2030, an increase of 400 million from the 1.3 billion of 2018. This population will require 17.1 million tonnes of fish just to maintain the current, globally low, per capita fish consumption level, which is an increase of 3.2 mt from the 2017 level.

Fish supply for human use comes from fisheries, aquaculture and imports minus exports and non-food uses. If African countries are to avoid any interruption of fisheries' contributions and support to other sectors of the national economies, export and non-food use may need to maintain the status quo (Fig.2). Thus, an increase in supply could only come from increased production and rationalized redistribution of fish products available.

Fig.2 Historical trends of fish supply (blue=fisheries production, purple=aquaculture, and yellow=import, brown=non-food use and green=export) in Africa. The dark red line presents the total fish consumed from 1961-2017. The light colors show projections of each element. The gap indicates the additional quantity of fish needed to meet the current consumption level of 9.9 kg per capita by 2030 under the projections of various elements.

Fishery resources in African waters are currently under more tremendous fishing pressure than the world average (Fig.1e), and there are very few fish stocks that are currently under-utilized and for which production could be increased by fishing harder. Rebuilding the more than 40% of stocks that are overfished to levels capable of producing maximum sustainable yield should lead to increases in sustainable production but require strict regulations and effective compliance and enforcement and would also take some time to produce the desired effects. This should not deter the countries from serious efforts to rebuild stocks, under SDG 14.4, but FAO's latest estimates are that Africa's fishery production will remain little-changed by 2030<sup>10</sup> (Fig.2).

Likely providing more significant opportunity for the increase is African aquaculture, which was at a meagre scale with a total of about 10 thousand tonnes in 1995, but has since developed rapidly, increasing linearly to 2.1 million tonnes, 200 times growth, by 2017 (Fig.1b). If this linear trend continues into the future, aquaculture production could increase by an additional 1.1 million tonnes by 2030<sup>10</sup> (Fig.2). This would still leave a shortage of 2.1 mt to meet the market demand (Fig.2).

Various sources of fish supply amounted to a total of 21.1 million tonnes of fish in 2017, mainly from fishery production, import and IUU fishing (Fig.3). However, the total amount of fish humans consumed was only 14.0 mt, primarily from reported fishery production by local African fleets, import, aquaculture and IUU fishing, which is not accounted in official statistical data. The total IUU catch in Africa was estimated at 3.5 mt in 2017 (Fig.3), of which 48% were landed by foreign vessels outside Africa and considered outsourced as they do not make any contribution to Africa's food supply and 52% were caught by African vessels, which, although not counted in the official per capita consumption, were still channelled to local supply and consumption and were therefore kept in Fig.3.

Fig.3 Flowchart of fish products in Africa from source to end-use in 2017. Aquaculture=total aquaculture production in African countries in a million tonnes (mt); Fishery-FVF=fishery production that is reported and taken out of Africa by foreign vessels fishing (FVF) legally in African waters; Fishery-L=fishery production from local African fleets in both marine and freshwaters; Import=amount of fish African countries imported through international trade; IUU=illegal and unreported catches including both non-African and African vessels; Consumption=amount of fish consumed by African people; Export=amount of fish African countries exported; Non-food use=quantity of fish used for non-human consumption; and Outsourced= amount of fish that are outsourced to non-African countries through legal (FVF) or IUU fishing.

In the face of severe malnutrition, hunger and poverty in Africa, the question for policymakers and managers is how to divert or produce more fish to human consumption within ecological bounds. The African fish flowchart (Fig.3) shows a clear hotspot of the outsourced fish. The 3.3 million tonnes of fish were caught by FVF and IUU fishing of non-African vessels and landed outside Africa. Internalizing the outsourced catch for African consumption can make up the supply shortage of 2.1 mt by 2030 as discussed before but, if the goal is only to retain fish consumption at current per capita rates, the remaining 1.2 mt can also be used to replace part of the fish import. In addition to improving food supply, it will also bring social and economic benefits to local communities along the value chain.

### **The imperative and benefits to achieve fishery sustainability**

The gap between supply and demand may result in two severe consequences if not filled. These are constraining consumption – further troubling the continent plagued by hunger and driving price rises, which will hit the poor consumers hardest as well as making fishing more profitable, consequently motivating more investment in additional uncontrolled inputs and fishing effort, including IUU fishing (Fig.S5). The increased fishing would in turn, deplete fish resources even further and cause more severe

overfishing and lost productivity (Fig.S5). As a result, African fisheries could move further away from the SDG target of zero overfishing, with knock-on effects across the other SDGs, increasing the prospects that Africa as a whole might become the continent left furthest behind in the SDG initiative.

Overfishing has various adverse impacts on biodiversity and the integrity and functioning of ecosystems. However, its most imminent consequence is the vicious circle – overfishing reduces fish stocks and then leads to declines in production and economic benefits, which push fishing fleets to fish even harder to keep afloat, reinforcing overfishing. This cycle eventually leads to the collapse of fish stocks and the fishery they support if no management interventions are introduced. However, different from country to country, overall sustainable development of the fisheries sector across Africa is seriously hindered by weak systems for monitoring, control and surveillance, insufficient management capacity, excess fishing capacity, particularly in artisanal fisheries<sup>11</sup>. We, therefore, argue that African countries should review and strengthen fishery legislation where required and develop an effective management system that can break the vicious circle and achieve sustainable fisheries.

Central to this must be the control of fishing pressure to reduce overfishing and restore over-fished stocks to production levels that can provide more fish to African people, better profits and social prospects for the fishery sector, and sustainable fish resources as required by the SDGs<sup>1</sup>. Fishing pressure consists of three components: local legal fleets, FVF and IUU fishing. Sustainable management of all fish stocks in the EEZ is a primary substantive obligation of all coastal states by the Law of the Sea<sup>21</sup>, and eradicating IUU fishing is further mandated by the Port State Measures Agreement<sup>22</sup> and other international instruments. Agreements for FVF should be reviewed with the participation of all legitimate stakeholders to reduce the risks of abuse, and with the 2063 goal<sup>23</sup> of African fisheries for the benefit of African people firmly in mind.

Addressing FVF and IUU fishing can bring substantial social, economic and environmental benefits. A vital intention of the agreements under which FVFs operate is to increase the benefits that host countries can obtain from their fisheries resources<sup>24</sup>. Although this intention seems materialized on the surface to some extent, FVFs frequently have a range of negative consequences, including unequal distribution of benefits between partners, negative impacts on domestic fisheries, and illegal and over-fishing by the foreign fleets<sup>25,26</sup>. The role of FVFs is an issue that should be reviewed seriously by African nations in the context of national social, economic and environmental consequences. It has been estimated that the FVF catches, if caught by African States, could generate a value of \$3.3 billion, which is eight times higher than the \$0.4 billion African countries were earning from fisheries agreements when these calculations were made<sup>9</sup>.

IUU fishing poses serious threats to the sustainable exploitation of fish stocks and causes enormous social and economic losses. Stopping the IUU fishing in Africa could recover a gross revenue loss of \$10 billion<sup>27</sup> and consequently the IUU fishing's catch by foreign vessels (1.7 mt, Fig.3) could be converted to legal local supply to African fish markets, which could eliminate the need for imports that cost \$2.5 billion

of hard currency, calculated at the import price in 2017 (Fig S4). Further, addressing FVF and IUU fishing will create more employment opportunities and up- and downstream services. The whole supply chain from fish resources to production and consumption can produce significant social, economic and environmental benefits, although difficult to quantify, if managed holistically through national, regional and continent-wide macro-planning.

### **A regional issue deserving global response**

Transforming African fisheries to achieve the SDG 14 targets and for the sector to contribute effectively to many other Goals is a great challenge. Under the UN 2030 Agenda<sup>1</sup>, the primary responsibility for ensuring this transformation resides with the individual countries, and they need to do all they can to fulfil their commitments to the UN Agenda, the AU Agenda 2063<sup>23</sup> and other related agreements and commitments. Although necessary on their own, those efforts are insufficient for achieving the SDGs. Most African countries lack adequate infrastructure, effective governance systems, sufficient implementation capacity and the financial and human resources needed to make the necessary progress along a broad front on their own. As called for in the UN 2030 Agenda<sup>1</sup>, developed countries and the broader international community need to unlock ambitious support to African countries to address the multiple dimensions of the SDGs and pledges, drawing on mutually reinforcing “levers” to examine, empower and enact change.

## **Methods**

### **Data acquisition, description and summary**

All the data used for Fig.1a-c are from the United Nations Food and Agriculture Organization (FAO), mostly downloaded through FishStatJ<sup>8</sup>, which is available to the public. The data for fish consumption (Fig.1a) and net import (Fig.1c) calculated by import minus export and reexport were extracted from the FAO food balance sheets of fish and fishery products (1961-2017). Production data of wild fishery and aquaculture (Fig.1b) were loaded from the FAO global fishery and aquaculture production statistics (1950-2018). Fishery production includes both marine and inland capture fisheries.

We estimated the catches by foreign vessels fishing (FVF) in African waters (Fig.1d) directly from the FAO fishery and aquaculture statistic database by summing up all catches taken by countries geographically outside an FAO Major Fishing Area<sup>28</sup>. With this area-based approach, vessels from a country that belongs to the Fishing Area fishing outside its EEZ but within the same Fishing Area are not considered foreign vessels, so that the FVF landings are somewhat underestimated.

How accurate are our estimates? We compared our estimates with those from a country-based study<sup>9</sup> (Fig.S1) that surveyed the publicly available data from 1950 to 2011 on fisheries agreements between countries such as fisheries agreements between the European Union and African States<sup>29</sup> and reports on distant water fishing from Regional Fishery Bodies (e.g., International Commission for the Conservation

of Atlantic Tunas (ICCAT) and Indian Ocean Tuna Commission (IOTC), and coastal countries (e.g., Guinea-Bissau and Mauritania) and incorporated opinions of local experts from African coastal states<sup>9</sup>. The results show that the two sets of estimates are highly correlated with  $R^2=0.99$  and that overall, our FVF estimates from the area-based method are 10% lower than those from the country-based study (SM), mainly between 1980 and 2000 (Fig.S1). Considering no estimation available from the country-based study after 2011 and the negligible difference between the two methods over the last two decades, we use the area-based estimates for FVF catches in this study.

The comparison of percentages of overfished fish stocks between Africa and the world as a whole (Fig.1e) are based on the FAO estimates<sup>10,16–19</sup>. The mean percentages of overfished stocks in areas surrounding the African continent were weighted by the total landings of each area. There might be higher levels of uncertainty in the early years due to data limitations. However, the consistent trend of higher African percentages from 1974 to 2017 suggests a higher probability that overfishing in African waters is more severe than the world average.

### **Projections of production and consumption by 2030**

Projecting food demand in the future is a critical step for formulating policies that can ensure market demand for fish and fishery products while maintaining environmental sustainability. Fish supply comes from fisheries, aquaculture and import minus export and non-food uses. Examining how the African fisheries can fulfil the market demand requires all the components to be predicted based on scientific models that are highly complicated and costly. Without getting into the technical complexity, we adopt a simple but effective method based on existing analyses to show the potential dynamics of future fish production and consumption to inspire effective fishery policy and strategies for Africa.

Here we use United Nations' data for human population<sup>4</sup> and FAO's projection on fishery production and aquaculture up to 2030<sup>10</sup> to investigate how African states can maintain the 2017 consumption level of 9.9 kg per capita. Fish as a commonly-perceived healthy, luxury product is highly pursued, and its consumption is observed increasing with economic development and rising living standards<sup>30</sup>. Africa's per capita GDP is projected to increase by 15.8% by 2030<sup>31</sup>, which will undoubtedly create upward pressure on fish demand. Without considering this increasing factor, we fixed per capita consumption at the 2017 level, a conservative scenario.

It may be argued that the supply shortage can be filled by reducing export or increasing imports. Unfortunately, both reducing export and increasing import will cost African countries much hard currency and cause negative impacts on domestic economies and infrastructure. To avoid such interruptions, we presume the export and use of fish for non-human purposes maintain the status quo. Therefore, the focus of this paper is to bring FVF and IUU fishing under governance to increase fish supply, produce economic and social benefits and conserve fishery resources.

### **Estimation of IUU catches in African waters**

Estimating IUU catches poses a significant challenge due to scarce data availability<sup>15</sup>, and identifying IUU fishers' country of origin is even more difficult. This study uses data from Pauly et al.<sup>32</sup> to estimate IUU catches in a country's EEZ by foreign and local vessels through the use of 'fishing entity' in the dataset. Discards were counted an unreported catch in the original database but were excluded in our calculation of IUU catch as they were not landed. The annual IUU estimates in African waters from 1950 to 2016 were presented in Fig.S2 and the percentages shared by foreign vessels in Fig.S3.

It is widely accepted that IUU fishing is widespread across the world and at a large scale<sup>15,33,34</sup>. However, most estimates involved great uncertainty. This paper is not focused on absolute values but showing that IUU fishing is another important source of fish and fishery products that coastal countries need to bring under control for social and economic benefits and the sustainability of fisheries and the environment.

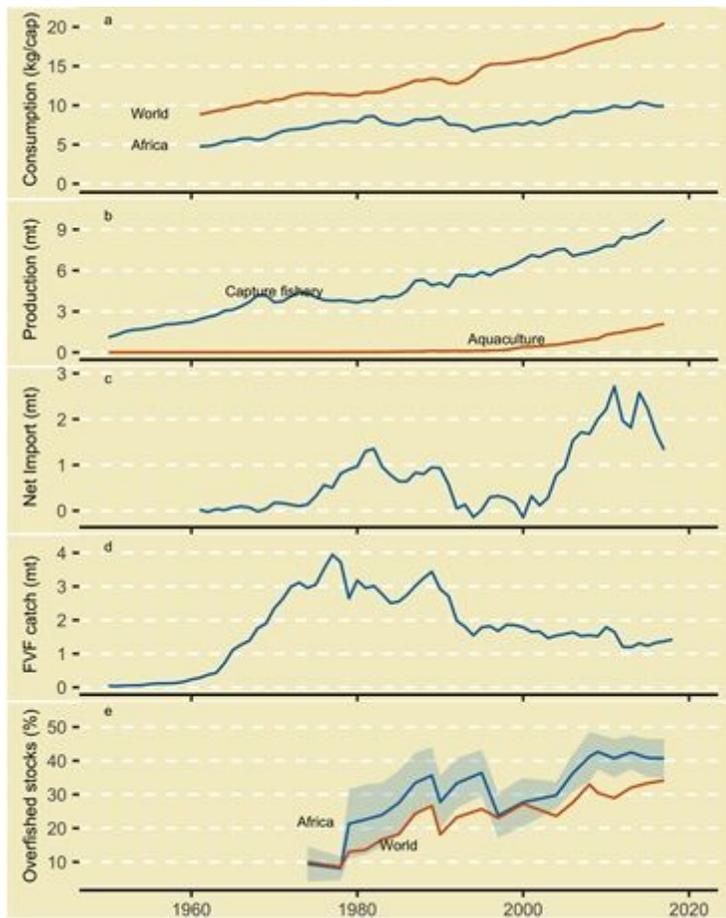
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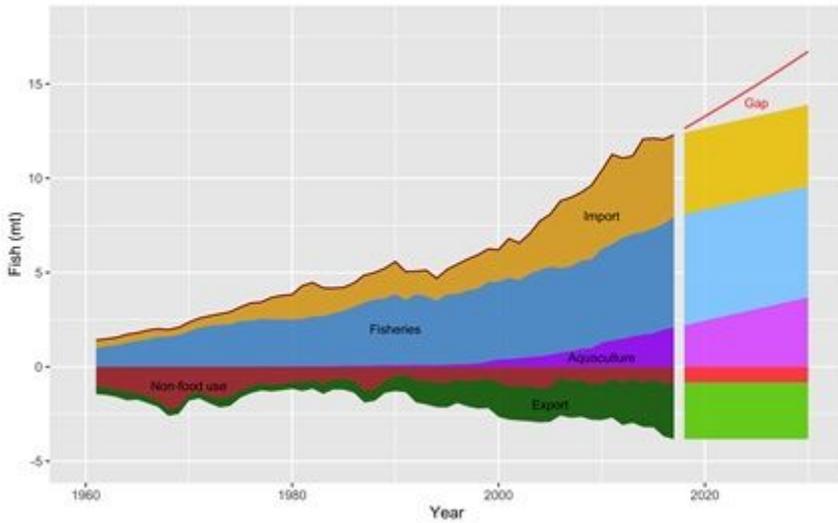
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## Figures



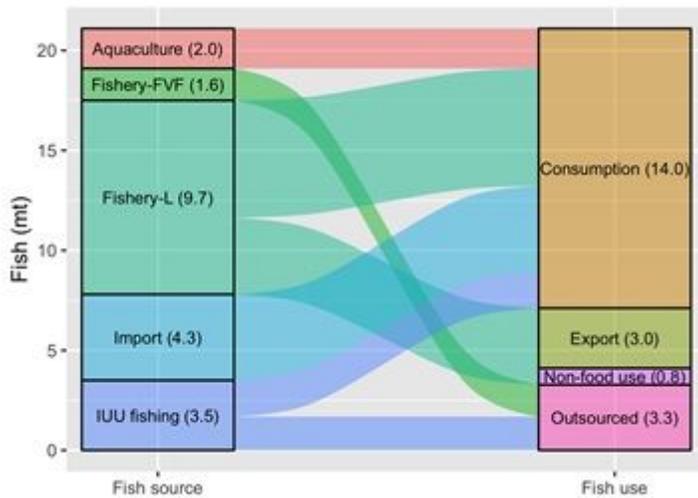
**Figure 1**

Major factors affecting the current state of African fisheries. a. Comparison of fish consumption between Africa and the world; b. The production history of capture fishery and aquaculture in Africa; c. The net import (import minus export) of fish products to African countries; d. The total amount of fish taken by FVF in African waters through various agreements that are generally legal and reported; e. Percentages of overfished stocks in the world marine fisheries and waters surrounding Africa with the blue shadows indicating one standard error of the mean. For data sources, see Methods.



**Figure 2**

Historical trends of fish supply (blue=fisheries production, purple=aquaculture, and yellow=import, brown=non-food use and green=export) in Africa. The dark red line presents the total fish consumed from 1961-2017. The light colors show projections of each element. The gap indicates the additional quantity of fish needed to meet the current consumption level of 9.9 kg per capita by 2030 under the projections of various elements.



**Figure 3**

Flowchart of fish products in Africa from source to end-use in 2017. Aquaculture=total aquaculture production in African countries in a million tonnes (mt); Fishery-FVF=fishery production that is reported and taken out of Africa by foreign vessels fishing (FVF) legally in African waters; Fishery-L=fishery production from local African fleets in both marine and freshwaters; Import=amount of fish African countries imported through international trade; IUU=illegal and unreported catches including both non-African and African vessels; Consumption=amount of fish consumed by African people; Export=amount

of fish African countries exported; Non-food use=quantity of fish used for non-human consumption; and Outsourced= amount of fish that are outsourced to non-African countries through legal (FVF) or IUU fishing.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [AfricaFisherysupplementarymaterials.docx](#)
- [sianon.docx](#)