Review Article

A Comparative Analysis of Inland Fishing in Nigeria and Türkiye

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Abstract

Fishing is an ancient activity with its involvement being traced back to the Stone Age; it is also an important economic activity in the nations of the world, supplying about 60% of the world's protein as well as creating jobs and income revenue, especially in developing nations. Three sources of fishery exist in the world: inland, marine, and aquaculture. Global aquaculture being different from capture fisheries of marine and inland has experienced rapid growth in global fishery production since 2007, producing 85.5 million metric tons in 2021, with capture fishery producing 92.6 million metric tons. While different species of fish exist in the nation's waters, only a few are of economic value, with most of the fish caught for food gotten from inland fishing, some are food for animals, also inland fishing of ancient times are for recreational purposes. This study focuses on drawing comparisons between inland fishing in Nigeria and Turkiye. Secondary quantitative method was used in the data collection process which was in the form of the scientific and common names of the fish species in the inland waters of the countries, their status/occurrence in the waters, their location(s), fishing practices of the countries and a ten- year rate of capture fishery production of the inland waters between the years 2011 and 2020. The inland fishing in both countries was compared based on these elements to conclude that just as the countries up for comparison are far apart based on their location (existing on two different continents), so is the inland fishing of both countries, having very few similarities. The inland fishing of both nations differs in great magnitude, having different kinds of species in their waters, as well as different fishing practices, and different rates of capture inland fishing production.
Keywords: Freshwater, Capture fishing, Mariculture, Fisheries

Introduction

Fishing is defined simply as the act of catching fish, it is a diverse, widespread activity that is engaged in for food, trade and/or sports (Keating et al., 2021). Fishing is a very old form of food acquisition, dating back to as early as the stone age. Archaeological evidence shows the very first fishers as *Homo erectus* and *Homo habilis* about 500.000 years ago, with fishing being initially used to procure food for the people, but gradually evolved into a means of commerce and even recreation (Gartside and Kirkegaard, 2010). Instruments such as the spear, net, rod, line and even the hands were used to catch fish to satisfy the immediate need of hunger. The activity became widespread as a form of trade for commercial purposes in the 15th century, although certain communities in the Roman Empire were already involved in fishing for commercial purposes before then (ANF, 2009). Engaging in fishing for sports or fun, known as recreational fishing or angling, can also be traced back to the 15th century when instruments such as the reel, hook, bait, and lines were used to catch various fish species, not for trade or food, but mostly for pleasure and competition (Globefish, 2017). While the term 'fishing' paints the image of a line hook or net being used in the open waters (oceans, seas, rivers, lakes, etc), literature and history shows the rearing and cultivation of fish species in artificial waters such as ponds to fall under the umbrella term of fishing; this is regarded as fish farming or aquaculture, and its existence can be traced back to ancient China, Rome, and Egypt, with the farming of oysters and fish (Isabella and Hunt, 2020).

Fishery, a term that is often used interchangeably with fishing, is defined as a system made up of the interaction of the aquatic biota, aquatic habitat, and human users of the aforementioned items (Lackey, 2005). With this definition, it is safe to argue that the use of both words interchangeably is misleading as the term 'fishery' seems to encompass more than the act of catching fish, this is not to say that both concepts differ, but rather that 'fishery' includes fishing and every other thing that relates to it, including the nature of the waters, that is the habitats of the fish. Habitat of a fish, refers simply to the area where a fish resides, and while in general terms this could be said to be water, the specific answer is more complex than that as the fish habitats include more than just the water, it relates also to the type of the water (fresh, saline or estuarine), the flow of the water, its bed substrate (sand, gravel, mud, coral and so on), water body topography (that is, the shape and nature of the water, for example, pool and riffles) and the type of vegetation present in the water (Kalatsiz and Baker, 2010). Fish tend to change their habitats as they evolve, requiring a different habitat for spawning as many species migrate to find mating partners, lay eggs and even to seek protection and shelter from predators (Kalatsiz and Baker, 2010). The major organic (or natural) fish habitats are, therefore, kelp forests, coral reefs, bay, rivers,

wetlands, and deep seas (NOAA, 2022). Fish habitats can also be classified in terms of the nature or type of water the fish resides in; fresh water, saline water (containing a high level of salt or fluctuations in salinity), or brackish water (a mixture of fresh and saline water) (Kalatsiz and Baker, 2010). The kinds of fish living in these waters differ in terms of their internal cell osmoregulation, while the fish living in saline waters lose salt through their skin, the fishes residing in freshwater, absorb the salt, likewise, the fishes in freshwater can absorb water through their skin and gills, while those in saline waters lose them. This classification of habitats leads to the general classification of fishes into saltwater and freshwater fishes, with freshwater fishes living in lakes and rivers and sometimes brackish waters such as estuaries and mangroves, and saltwater fish living in the ocean and brackish waters, depending on the level of salinity of the water, as brackish waters tend to fluctuate in terms of salinity (Kalatsiz and Baker, 2010).

Inland fishing is defined as fishing activities taking place in natural or semi-natural limnetic ecosystems such as rivers, lakes, ponds, gravel pits, and so on, it is used mainly as a means of subsistence farming or for commercial purposes and comprises four main categories; commercial capture food fisheries, noncommercial fisheries exploited for leisure or subsistence, and upstream or downstream services (Arlinghaus et al., 2002; Finlayson, 2011). Inland fishing takes place in these inland waters, playing a major role in the provision of the world's food and being a major source of income, especially in developing countries (Payne, 2000; Phuong and Gopalakrishnan, 2004; Welcomme et al., 2010; Rad and Rad, 2012). It is defined as the capture of wild stocks which are mainly freshwater fish, including that migrating between the ocean and freshwater (Allan et al., 2005), and is known to bring about poverty alleviation through the creation of jobs, food security, and gender empowerment. cultural services, ecosystem function and biodiversity, and so on (Funge and Bennet, 2019). Inland fishing is often engaged mainly for subsistence farming, that is as a means to satisfy the immediate need of hunger for the fisher, however, there are occasions where it is undertaken for commercial or recreational purposes (Smith et al., 2005; Welcomme et al., 2010; Funge and Bennet, 2019), and according to Welcomme et al, (2010), due to economic development, the reliance on inland fishing as a source for food depreciates as it is now seen to be used more for recreational activities, especially in developed nations (Allan et al., 2005; Funge and Bennet, 2019). Despite the importance of inland fishing in the world's economy, being a major source of protein, the concept tends to be neglected, compared to the amount of attention given to its counterpart; marine fishing (Welcomme et al., 2010; Funge and Bennet, 2019). Less attention has been given to inland waters and their fisheries in the UN Sustainable Development Goals (SDG), and according to the Goals, it is the main reason for the little/lack of consideration of inland waters in policy decision making which has resulted in lack

of support from nation's governments. As a result, the manifestation of inland fishing problems, since there are hardly any regulations curbing the excess use of the inland waters, which lead to low productivity of inland fisheries (Welcomme et al., 2010; Suuronen and Bartley 2014; Funge and Bennett, 2019).

According to the World Economic Forum, the world faces a water predicament (WEF, 2015), with over 80% of the world experiencing a high level of water risk in form of major biodiversity loss and ecosystem collapse, extreme weather events, failure of climate change mitigation and so on (Vorosmarty et al., 2010; Mouw and Greb, 2012, Skold, 2020), and with inland fishing occurring in these waters, it is, therefore, prone to many threats as well. Suuronen and Bartley (2014) stipulate that one of the major threats inland fishing is exposed to is the competition of freshwater resources with other human activities such as agriculture and hydroelectric power plants. Other threats include overfishing, tight linkages, pollution, runoff, the introduction of non-native species, habitat degradation, climate change, inadequate government systems, and so on (Suuronen and Bartley, 2014; Funge and Bennett, 2019). Many of these threats such as pollution, alternative usage of freshwater resources, and habitat degradation can be brought under the umbrella threat of environmental pressures (Suuronen and Bartley, 2014) which have caused a massive decline in inland fishery resources (Allan et al., 2005; Dudgeon et al, 2006; Nguyen and Silva 2006; FAO, 2010) especially the aquatic habitat which sees a loss of spawning ground and nursery areas and thus leads to less production of aquatic species, as well as a change in the quality and quantity of the inland catch (Allan et al., 2005; Suuronen and Bartley, 2014).

Climate change is another threat to inland fishing. According to Suuronen and Bartley (2014) it is the most important factor plaguing the waters as aquatic ecosystems tend to be very vulnerable to climate change (Mouw and Greb, 2012). Changes in the atmosphere in terms of weather conditions affect the state of the waters in terms of water level, evaporation, temperature, and ice cover, and as a result, the whole aquatic ecosystems which may cause changes to the productivity, existence, and composition of the aquatic species, although this depends greatly on the ability of the aquatic ecosystem to adapt to change (Mouw and Greb, 2012; Suuronen and Bartley, 2014). Overfishing and overexploitation of the inland waters also occur when the fishers either harvest or capture young fishes at an average size that is smaller than the size that would usually produce maximum yield (Growth Overfishing), or the amount of parent fish available for a particular specie is so low that it is unable to produce enough offspring to maintain itself (Recruitment Overfishing) or the efficiency of the aquatic ecosystem is greatly altered due to a drastic change in the distribution of aquatic species within the niche (Assemblage or Ecosystem Overfishing), or when the cost of fishing efforts greatly outweighs the revenue generated (Economic

Overfishing) (Allan et al., 2005; Olopade et al., 2017). The introduction of alien or invasive species to inland waters can also be seen as a threat to inland fishing, although it can also be used to increase the production and value of inland ecosystems (Suuronen and Bartley, 2014). The aquatic ecosystems are sensitive to species alterations which are caused as a result of changes in their physical and biogeochemical characteristics, and this in turn leads to the loss of native species as these alien or invasive species have the tendency to harm the ecosystems as well as the recreational, commercial, and agricultural activities that depends on them (Mouw and Greb, 2012). Even though the Nile perch (*Lates niloticus*) and Nile tilapia (*Oreochromis niloticus*) is introduced to many lakes and rivers for fishing purposes, such as in Lake Victoria located in Tanzania and Uganda, it resulted in the extinction of half of the native fish species present in the lake (Kolding et al., 2008; Suuronen and Bartley, 2014).

Although the number of research carried out on inland fishing is limited, the activity is quite important, being a major supplier of fish which makes up over 60% of the world's protein (Olaoye and Ojebiyi, 2018). This study focuses on inland waters and fishing in these waters in the nations of Nigeria and Turkiye and finally, analyzes the assemblages of fishes in the waters. The choice of Nigeria and Turkiye is due to their strategic locations; both countries are first located on two different continents and as such would have different climate conditions which would affect the fish habitats differently; Turkiye is located between the continents of Europe and Asia, but mainly the latter, is surrounded by four major seas; the Mediterranean Sea, the Aegean Sea, the Sea of Marmara and the Black Sea (Karatas and Karatas, 2016), and the Bosporus strait which lies in the northwest of Turkiye harbors an ecosystem which makes up 15% of Turkiye's total fishing economy and thus makes Turkiye commercially fit in the fishing industry as the pelagic fish migrates through the strait (Bereketli, 2021). Nigeria, on the other hand, is a developing country that is also surrounded by the major rivers Niger and Benue and others such as the Cross River, Oshun River and so on, and due to its location, is regarded as a maritime state with many fishing activities (Olaoye and Ojebiyi, 2018). Both countries are in the two continents which are important contributors of the World's total inland fishing production (Figure 1).
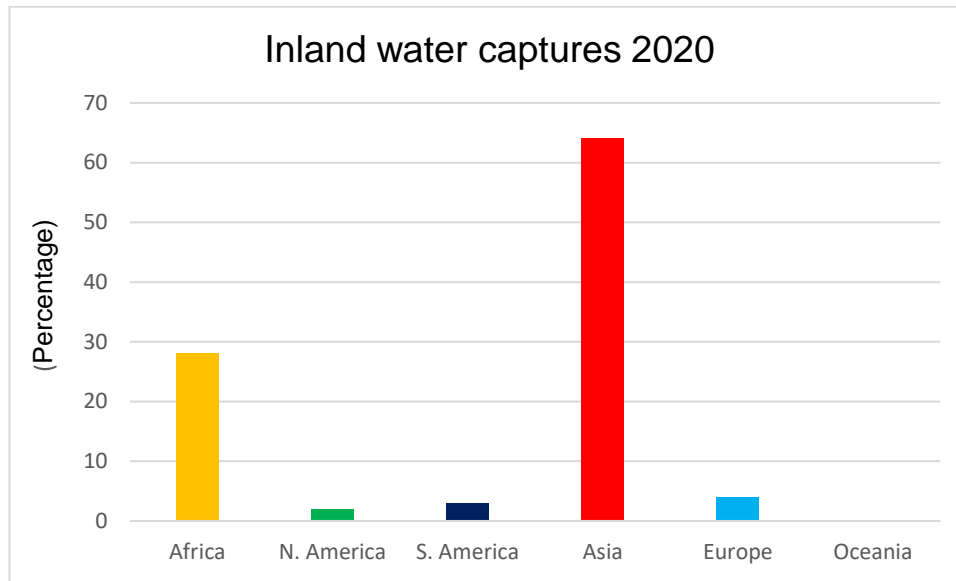
Figure 1. Inland capture fishing in the world by continent, compiled from FAO (2021).

In this study, (i) comparisons of the operations of inland fishing in both countries; (ii) the analysis of the differences of species in the inland waters of the two countries along with the regulations and legislations guiding the catches; and (iii) fish production quantitative analyses are carried out. The focus is on inland fishing in both countries, specifically; inland capture fishing, comparing the fish species present in the inland waters of both nations, their fishing practices, the rate of capture production in the countries between the years 2011 and 2020 and the structure and dynamics of the inland waters of these countries are analyzed. Other aquatic animals such as frogs or mollusks are excluded from the comparison with the analysis focusing only on bony fish species from the Superclass Osteichthyes.

Materials and methods

Data in the form of the fishing practices in the countries, scientific and common names of the fish species, the locations of the fish species in the inland waters, their status in the inland waters (that is, if they are endemic, native, introduced and so on), the rate of production of inland fishing in the countries within the year 2011 and 2020, that is a ten-year period, the most caught fish species in the inland waters of the countries, that is the countries' catch assemblage and the topography and climate conditions of the inland waters in both countries were obtained. The data collection process involved a search of the official website of Turkiye (TUIKSAT) and the FISHBASE (ref?) website as well as the Food and Agriculture Organization website - a special agency of the United Nations where all countries report their yearly fishing data (FAO, 2021). These three websites were chosen because by their status, they have the most accurate data of the

fishing sector in their country and for the world. Other academic articles were used to support the data obtained from the websites.

The majority of the obtained data would be in statistical or numerical form, quantitative research was used as the research method, specifically, descriptive qualitative research. Quantitative research is defined as research used to explain situations by the collection of numerical data which are analyzed using statistically based methods (Creswell, 1994; Sukamolson, 2007). It is used mostly to look at causal relationships but can also be used to assess relationships between variables (Hall and Rousell, 2017). There are five main categories of quantitative research: experimental, quasi-experimental, descriptive, epidemiologic, and predictive correlational design (Hall and Rousell, 2017). As mentioned earlier, the paper is making use of descriptive quantitative research which has the aim to provide relevant information about variables, but do not test hypotheses (Hall and Rousell, 2017) this design fits the research to be carried out as it is merely comparing the data of inland fishing in Nigeria and Turkiye.

Results

The inland waters of Turkiye consist of 200 Natural Lakes, 159 Dam Lakes (or Reservoirs), 750 Ponds and 33 Rivers, which are categorized into 25 basins (Celikalle,1990). Information pertaining to the topography and climate conditions of the major basins in the country would be presented, starting with the Buyuk Menderes River basin, which is in the Aegean region of Turkiye, it has an average annual rainfall of 635 mm and is described as a graben which forms two major fault outcrops extending in the west-east direction. It is generally dry and warm in the summer period and warm and rainy in winter (Ozcan and Akay, 2018).

Turkiye's inland fishing is engaged more for commercial purposes than subsistence, with capture fishing carried out mostly on a small scale with basic fishing gears such as trammel nets and longlines and on vessels that must be licensed for a period of two years and renewed within a three-year period (FAO, 2008; Unal and Goncuoglu, 2012). The number of fish species present in the Turkish inland waters were discovered to be a total of 409, with a higher percentage of the species being endemic to Turkiye. Despite this number, only a few of these are of economic value to the country. The catch assemblage of Turkiye includes the fish, Northern pike (*Esox lucius*) European perch (*Perca fluviatilis*), Pike perch (*Sander lucioperca*), European Eel (*Anguilla anguilla*), Common Carp (*Cyprinus carpio*), European Catfish (*Silurus glanis*), Brown Trout (*Salmo trutta*) and the crustacean, Crayfish (*Ponastacus leptodactylus*) (TSI, 2021).

The inland waters of Nigeria comprise of 8 rivers and 13 major lakes and reservoirs, which encompasses the eight main river basins of Benue, Delta, Cross River, Imo-Anambra, Hadejia-Chad, Sokoto-Rima, Niger, Owena and Ogun-Osun basins. The topography and climate of these
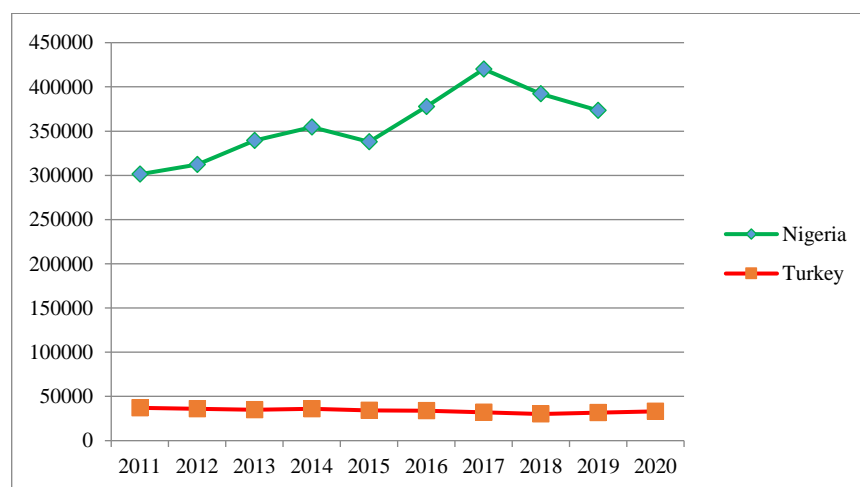
river basins will be discussed in order (Ita, 1993). The Benue River Basin has topography with elevation varying between 90m to a maximum of 2367m above mean sea level. This topography affects the climate of the region, causing an annual rainfall of 700 mm to over 1800 mm with majority of the downpour occurring in the monthly period between May and October, and having a mean annual temperature of 26 degrees (Saludeen et al., 2021). Moreover, the inland fishing practices in Nigeria have been described to be unorthodox, obnoxious, and unsustainable as the artisanal fishers tend to make use of explosives, poisons, electrofishing, and gears with small meshes as their fishing methods to shock, kill or daze the fishes (Eyo and Ahmed, 2005; Sogbesan and Kwaji, 2018) The fishing gears used includes clap and cast nets, fishing traps, beach seine nets, gill nets, trawl nets, and Atalla lift net (Eyo and Ahmed, 2005). The majority of the inland fishers in Nigeria are artisanal, engaging more in subsistence farming (for the consumption of the fisher's household) than commercial (Eyo and Ahmed, 2005). The fishers make use of paddling, polling, and motorized canoes as their fishing vessels.

There are 331 species of fish present in the inland waters of Nigeria, with the native species having the highest number. One thing specific to the fish species was the lack of a global common name for the fishes, many of them were seen to have similar native names as such can only be distinguished from a layman's perspective by their scientific names. Just like with the inland fishes of Turkiye, not all fish species in the inland waters of Nigeria are of economic value, as such out of the 331 fish species found in the inland waters of Nigeria, only about nineteen (19) fish species make up the inland catch assemblage of Nigeria, that is, majority of the fish species caught in the inland waters of the country. This includes; Mormyrids (*Mormyrus rume*), Nile Perch (*Lates niloticus*), North African Catfish (*Clarias gariepinus*), African Bonytongue (*Heterotis niloticus*), Upside Down Catfish (*Synodontis batensoda*), Moon Fish (*Citharinus citharus*), Characin (*Alestes dentex*), Silver Catfish (*Bagrus filamentos*), Bagrid Catfish (*Chrysichthys nigrodigitatus*), Grass Eater (*Distichodus rostratus*), Aba (*Gymnarchus niloticus*), Elephant Snout (*Mormyrus hasselquistii*), Silver Catfish (*Schilbe intermedius*), Nile Tilapia (*Oreochromis niloticus*), Blue Tilapia (*Oreochromis aureus*), Electric Catfish (*Malapterurus electricus*), Wide Head Catfish (*Clarotes laticeps*), Catfish (*Auchenoglanis biscutatus*), and the fish species in *Hydrocynus, Heterobranchus* and *Labeo* Genera (Ita, 1993; Abiodun et al., 2005; Welcomme, 2011). Table 1 shows the species compositions of fish in the inland waters of Turkiye and Nigeria.

Table 1. Species composition in Turkish and Nigerian inland waters

	Türkiye	**Nigeria**
Total number of endemic species	198	5
Total number of other native species	175	312
Miscellaneous	27 Introduced 5 Extinct in Turkiye 1 Lessepsian	6 Introduced 8 Questionable
Total number of fish species	409	331

The catch yield of inland fishing in Turkiye and Nigeria between the years 2011 and 2020 is presented below. A steady decrease occurred in the catch production of Turkiye in the year 2012 and 2013, with a slight increase occurring in 2014 followed by a steady decrease from the year 2015 up to 2020 when a slight increase occurred again. Analysis of this data shows a general slow decline in the production rate of inland capture fishing in Turkiye as the increases which occurred during the ten-year period, did not match or exceed the initial starting production rate of 2011 which is 37.097 tons. The inland capture production rate of Nigeria within the same years, a difference is drawn firstly with the amount of the yearly catch in tons which amounts to hundreds of thousands, as opposed to the yearly catch in Turkiye which is in tens of thousands. The second difference to be drawn is that while Turkiye's production rate is in a steady decline, that of Nigeria is mostly increasing, with the highest amount of catch production being in the year 2017 after being preceded by a steady growth in catch amount, and then afterward (2017), a decline which however, is still higher than the initial starting capture rate of 2011 (Figure 2).

Figure 2. Inland capture production rate; Turkiye & Nigeria

Discussion

Considerable amount of data used in this study is limited and might be questionable, as many of the world nations, such as Nigeria, which has been charged with reporting their yearly fishery catch to the Food and Agriculture Organization of the United Nations, fail to do so, due majorly to the lack of equipment to record such catch and the fact that inland fishing is undertaking mostly as a means of subsistence farming. This results in the FAO making certain estimations on the nations' catch report. This means that the official data made available, may not be the actual representation of real-life occurrences as there is a probability of the data overestimating or underestimating these occurrences. This analysis gives an outlook on the operations of inland fishing; Governmental organizations and public bodies should concentrate on gathering adequate fishing sector data as this is an important sector in the economies of the world.

It was discovered that while Turkiye has a higher number of inland fish species in its waters, fish species in the two countries are quite different, with just a few as 28 species, such as the Common Carp (*Cyprinus carpio*) and Nile Tilapia (*Oreochromis niloticus*) being present in both waters. It is concluded that although the countries of Nigeria and Turkiye are similar in that they both have fishing communities and vast areas of inland waters, they mostly differ in their fishing practices as well as species composition. The catch assemblage of inland capture production rate also differs in both countries. The inland waters of a country are very important to the country as it provides fresh water for irrigation purposes, flood mitigation, nutrient recycling, waste treatment, etc. However, this sector is considered to be in neglect not just by the governments of different nations, but by world policies and this has resulted in low productivity in these waters. Furthermore, Nigeria's fishing practices have been characterized as unsustainable and obnoxious due to the various destructive fishing methods such as explosives and poisoning the fishers engage in, that of Turkiye has been described as sustainable, being carried out majorly for commercial purposes albeit, on a small scale. Inland fishing in Nigeria on the other hand is engaged mainly as a means of subsistence farming with traditional vessels such as canoes and calabash still being used in the capture of the fishes.

The aquatic ecosystems are sensitive to species alterations which is caused as a result to changes in their physical and biogeochemical characteristics, and this in turn leads to the loss of native species as these alien or invasive species has the tendency to harm the ecosystems as well as the recreational, commercial, and agricultural activities that depends on them (Mouw and Greb, 2012). For example, the introduction of the Nile perch and Nile tilapia in Lake Victoria located in Tanzania and Uganda, resulted in the extinction of half of the native fish species present in the lake (Kolding et al., 2008; Suuronen and Bartley, 2014). Inland fish assemblages make up a high

proportion of freshwater fish species, with the assemblage of the fish being different in each waterbody, that is, the fish assemblage found in the different inland water bodies of Turkiye differs from one another just as those found in the different inland water bodies of Nigeria. This can be attributed to the different environmental factors surrounding the inland waters, as such, most of the fish species which thrive in some of Turkiye's inland waters, may not thrive in others, likewise Nigeria. A survey in the Majidun Creek in Lagos, Nigeria, has recorded 517 fish species from 18 families, 8 orders 20 genera and 23 species of inland shell fishes with the dominant species being *Sardinella aurita, Elopslacerta, Caranx hippos* and *Mugil cephalus* (Lawson et al., 2013). This is in contrast with the fish assemblage of the Onu-Iyi-Ukwu Stream (another inland water body in Nigeria) found in the southeastern part of Nigeria, which has 17 fish species belonging to 15 genera and 11 families, and this amount were noticed to change based on seasons, with 11 fish species from 7 families being recorded in the rainy season (Sikoki and Anyanwu, 2008).

Conclusion

Overfishing is a rampant occurrence in today's inland waters although it is hardly noticeable due to the lack of attention and research conducted in this aspect. Changes in biodiversity are not immediately made apparent since fishers can consume a succession of aquatic species with the yield remaining constant (Allan et al., 2005). Its impact is felt greatly in the alteration of aquatic species and their assemblage which in turn begins to cause a reduction in the total catch of aquatic species (Allan et al., 2005). Therefore, all fish catch records should be quantified and the situation should be scientifically assessed, continuously monitoring invasive species and species under threat.

References

Abdullahi, S. A., Muhammad, M. M., Adeogun, B. K., & Mohammed, I. U. (2014). Assessment of water availability in the Sokoto Rima River Basin. Resources and Environment, 4(5), 220-233. https://doi.org/10.5923/j.re.20140405.03

Abiodun, J. A., Alamu, S. O., & Miller, J. W. (2005). Assessment of inland waters fisheries in Nigeria with implications for improved freshwater fish production, poverty alleviation and food security. http://hdl.handle.net/1834/21697

Allan, J. D., Abell, R., Hogan, Z. E. B., Revenga, C., Taylor, B. W., Welcomme, R. L., &Winemiller, K. (2005). Overfishing of inland waters. BioScience, 55(12), 1041-1051. https://doi.org/10.1641/0006-3568(2005)055[1041:OOIW]2.0.CO;2

ANF, Alimentarium Nestle Foundation, 2009 (Alimentarium Documentary). A History of Fishing Practices.https://www.alimentarium.org/en/knowledge/history-fishing

Anko, E. O., &Eyo, A. A. (2003). Fisheries development in Nigeria with special reference to Cross River State. http://hdl.handle.net/1834/21349

Arlinghaus, R., Mehner, T., &Cowx, I. G. (2002). Reconciling traditional inland fisheries management and sustainability in industrialized countries, with emphasis on Europe. Fish and fisheries, 3(4), 261-316. https://doi.org/10.1046/j.1467-2979.2002.00102.x

Aturamu Adeyinka, O., Ojo Adebayo, O., Adebayo Olajide, F., & Akinyemi Segun, A. (2015). Palynostratigraphic analysis of the Agbada formation (Nep-1 well) offshore, eastern Niger-Delta basin, Nigeria. British Journal of Environmental Sciences, 3(5), 19-31.

Awachie, J.B. and Ezenwaji, G.M.H. (1982). Management of Fisheries in River and Lake Basins: Basic and Applied Studies for Fishery Management Information Acquisition.In J.M. Kapetsky (Ed.), Seminar on River Basin Management and Development.CIFA Technical Paper No.8

Ayanda, J. O., &Tafida, A. A. (2007). Inland fisheries in Nigerian economy: issues and challenges. http://hdl.handle.net/1834/37741

Babatolu, J. S., &Akinnubi, R. T. (2014). Influence of climate change in Niger River Basin development authority area on Niger Runoff, Nigeria. Journal of Earth Science & Climatic Change, 5(9), 1. https://doi.org/10.4172/2157-7617.1000230

Bereketli, E. (2021, February 4th). A Fishing Crisis in Turkiye. ATMOS https://atmos.earth/fishing-crisis-Turkiye-covid

Bostock, J., McAndrew, B., Richards, R., Jauncey, K., Telfer, T., Lorenzen, K., ... & Corner, R. (2010). Aquaculture: global status and trends. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1554), 2897-2912. https://doi.org/10.1098/rstb.2010.0170

Brussard, P. F., Reed, J. M., & Tracy, C. R. (1998). Ecosystem management: what is it really?. Landscape and Urban Planning, 40(1-3), 9-20. https://doi.org/10.1016/S0169-2046(97)00094-7

Cavus, Y., & Aksoy, H. (2019). Spatial drought characterization for Seyhan River basin in the Mediterranean region of Turkiye. Water, 11(7), 1331. https://doi.org/10.3390/w11071331

Çelik, A., Metin, İ., &Çelik, M. (2012). Taking a photo of Turkish fishery sector: a SWOT analysis. Procedia-Social and Behavioral Sciences, 58, 1515-1524. https://doi.org/10.1016/j.sbspro.2012.09.1138

Çiçek, E., Sungur, S., & Fricke, R. (2015). Freshwater fishes of Turkiye; a revised and updated annotated checklist. http://hdl.handle.net/20.500.11787/2446

Çolak, M. A., Öztaş, B., Özgencil, İ. K., Soyluer, M., Korkmaz, M., Ramírez-García, A., ... &Akyürek, Z. (2022). Increased Water Abstraction and Climate Change Have Substantial Effect on Morphometry, Salinity, and Biotic Communities in Lakes: Examples from the Semi-Arid Burdur Basin (Turkiye). Water, 14(8), 1241. https://doi.org/10.3390/w14081241

Creswell, J. W. (1994). Research Design: Quali-tative& Quantitative Approaches SAGE Publications. Inc. USA.

Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z. I., Knowler, D. J., Lévêque, C., ... & Sullivan, C. A. (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. Biological reviews, 81(2), 163-182. https://doi.org/10.1017/S1464793105006950

Durduran, S. S. (2010). Coastline change assessment on water reservoirs located in the Konya Basin Area, Turkiye, using multitemporal landsat imagery. Environmental monitoring and assessment, 164(1), 453-461. https://doi.org/10.1007/s10661-009-0906-9

Eyo, A. A. (1986). The significance of fish handling, preservation and processing in the development of Nigeria inland fishery with special reference to Kainji Lake. http://hdl.handle.net/1834/21167

Eyo, A. A., & Ahmed, Y. B. (2005). Management of inland capture fisheries and challenges in fish production in Nigeria. http://hdl.handle.net/1834/21741

Eyo, A.A. (2003). Food and Poverty Alleviation in Nigeria. Fish Network: A Quarterly Publication of Fisheries Society of Nigeria (FISON)**,** 10(1)**:** 3.

FAO (2008, March). The Republic of Turkiye. https://www.fao.org/fishery/docs/DOCUMENT/fcp/en/FI_CP_TR.pdf

FAO (2009). Transboundary River Basin Overview-Asi-Orontes. FAO Aquastat Reports

FAO (2010). The State of the World Fisheries and Aquaculture. Sustainability in Action. Rome. https://doi.org.10.4060/ca9229en

FAO. 2021. FAO Yearbook. Fishery and Aquaculture Statistics 2019/FAO annuaire. Statistiques des pêches et de l'aquaculture 2019/FAO anuario. Estadísticas de pesca y acuicultura 2019. Rome/Roma. https://doi.org/10.4060/cb7874t

Fasipe, O. A., &Izinyon, O. C. (2021). Exponent determination in a poorly gauged basin system in Nigeria based on flow characteristics investigation and regionalization method. SN Applied Sciences, 3(3), 1-20. https://doi.org/10.1007/s42452-021-04302-3

Finlayson, C. (2011). Managing aquatic ecosystems. In Treatise on water science (pp. 35-59). Elsevier. https://doi.org/10.1016/B978-0-444-53199-5.00004-X

Funge-Smith, S., & Bennett, A. (2019). A fresh look at inland fisheries and their role in food security and livelihoods. Fish and Fisheries, 20(6), 1176-1195. https://doi.org/10.1111/faf.12403

Gartside, D.F., &Kirkegaard, I.R. (2010) A History of Fishing. Interactions: Food, Agriculture and the Environment, 2:70-105.

Globefish (2017, February). The Role of Recreational Fisheries in the Sustainable Management of Marine Resources. Food and Agricultural Organization of the United Nations [FAO] https://www.fao.org/in-action/globefish/fishery-information/resource-detail/en/c/101331/

Government of Japan (October 1969). Report on Reconnaissance Study of Berke Hydroelectric Power Project in Ceyhan River Basin Comprehensive Development Plan.

Hall, H.R. and Rousell, L.A. (2017). Evidence Based Practice: An Integrative Approach to Research, Administration and Practice. (2nd ed.)Burlington:Jones& Bartlett Learning.

https://openjicareport.jica.go.jp/pdf/10510246.pdf

Isabella, J. & Hunt, S. 2020. A short history of Aquaculture innovation, Hakai Magazine, 1168 https://www.hakaimagazine.com/features/a-short-history-of-aquaculture-innovation/

Ita, E. O. (1993). Inland fishery resources of Nigeria.

Karataş, E., &Karataş, A. (2017). The importance of fishery production as an income source in Turkiye. Survey in Fisheries Sciences, 4(1), 38-53. https://doi.org/10.18331/SFS2017.4.1.5

Keating, Frank E., Thomas, Terence Barrington and Petri, Robert Lee. "fishing". Encyclopedia Britannica, 21 Jan. 2021, https://www.britannica.com/topic/fishing-recreation. Accessed 29 June 2022.

Kolding, J., Zwieten, P. V., Mkumbo, O., Silsbe, G., and Hecky, R., (2008). Are the Lake Victoria fisheries threatened by exploitation or eutrophication? Towards an ecosystem-based approach to management. The ecosystem approach to fisheries, 309-354.

Lackey, R. T. (2005). Fisheries: history, science, and management. Water encyclopedia: surface and agricultural water, 121-129.

Lawson, E. O., Doseku, P. A., &Ajepe, R. G. (2013). Fish assemblage of majidun creek, lagos, nigeria. Journal of Biological Sciences, 13(7), 577.

Mouw, C.B and Greb, S.(2012). Inland and Coastal Waters. Eos Transactions American Geophysical Union, 93(39): 375

Neumann, R. P., Biodiversity, R. K., & Thrift, N. (2009). International Encyclopedia of Human Geography.

Nguyen, T. T., & De Silva, S. S. (2006). Freshwater finfish biodiversity and conservation: an Asian perspective. Biodiversity & Conservation, 15(11), 3543-3568. https://doi.org/10.1007/s10531-005-0312-8

Nguyen, T. T., & De Silva, S. S. (2006). Freshwater finfish biodiversity and conservation: an Asian perspective. Biodiversity & Conservation, 15(11), 3543-3568.https://doi.org/10.1007/s10531-005-0312-8

NOAA, National Oceanic and Atmospheric Administration (2022). Understanding Essential Fish Habitatshttps://www.fisheries.noaa.gov/insight/understanding-essential-fish-habitat

Ogarekpe, N. M., Obio, E. A., Tenebe, I. T., Emenike, P. C., & Nnaji, C. C. (2020). Flood vulnerability assessment of the upper Cross River basin using morphometric analysis. Geomatics, Natural Hazards and Risk, 11(1), 1378-1403. https://doi.org/10.1080/19475705.2020.1785954

Oke, M. O., Martins, O., Idowu, O. A., &Aiyelokun, O. (2015). Comparative analysis of groundwater recharge estimation value obtained using empirical methods in Ogun and Oshun River Basins. Ife Journal of Science, 17(1), 53-63.

Olaoye, O. J., &Ojebiyi, W. G. (2018). Marine fisheries in Nigeria: A review. Marine ecology-Biotic and abiotic interactions.

Olopade, O. A., Taiwo, I. O., &Dienye, H. E. (2017). Management of overfishing in the inland capture fisheries in Nigeria. LimnoFish, 3(3), 189-194. https://doi.org/10.17216/LimnoFish.335549

Ovie, S. I., & Raji, A. (2006). Fisheries Co–Management in Nigeria: An Analysis of the underling Policy Process. Food Security and Poverty Alleviation through Improved Valuation and Governance of River Fisheries in Africa Project: Report, (3).

Ozcan, O., &Akay, S. S. (2018, July). Modeling morphodynamic processes in meandering rivers with UAV-based measurements. In IGARSS 2018-2018 IEEE International Geoscience and Remote Sensing Symposium (pp. 7886-7889). IEEE. https://doi.org/10.1109/IGARSS.2018.8518221

Pauly, D., et al (2005). Marine Fisheries Systems. In R. Hassan, R. Scholes and N. Ajah (eds.)Ecosystems and Human Well-being: Current State and Trends, Volume 1. Island Press

Payne, I. (2000). The changing role of fisheries in development policy. London, UK: Overseas Development Institute. https://hdl.handle.net/10535/4334

Phuong, D. M., & Gopalakrishnan, C. (2004). Optimal management of water for sustainable fisheries and aquaculture. International Journal of Water Resources Development, 20(4), 493-506. https://doi.org/10.1080/07900620412331319144

Rad, F., & Rad, S. (2012). A comparative assessment of Turkish Inland fisheries and aquaculture using economic sustainability indicators. Turkish Journal of Fisheries and Aquatic Sciences, 12(2). https://dergipark.org.tr/en/pub/trjfas-ayrildi/issue/13269/160269

Salaudeen, A., Ismail, A., Adeogun, B. K., Ajibike, M. A., &Zubairu, I. (2021). Evaluation of ground-based, daily, gridded precipitation products for Upper Benue River basin, Nigeria. Engineering and Applied Science Research, 48(4), 397-405. https://ph01.tcithaijo.org/index.php/easr/article/view/242405

Sikoki, F. D., Zabbey, N., & Anyanwu, I. N. (2008). Fish Assemblages of Onu-Iyi-Ukwu Stream in Southeastern Nigeria. Tropical freshwater biology, 17(2), 41-51.

Skold, M. (2020, January 15). The World's Top Five Risks are all Water-Related. SIWI https://siwi.org/latest/the-worlds-top-5-risks-are-all-water-related/

Smith, L. E., Khoa, S. N., & Lorenzen, K. (2005). Livelihood functions of inland fisheries: policy implications in developing countries. Water policy, 7(4), 359-383. https://doi.org/10.2166/wp.2005.0023

Sogbesan, O.A. and Kwaji, B.P. (2018). Sustainable Artisanal Fisheries Practices in Nigeria. Oceanography and Fishes Open Access Journal, 6(1). https://doi.org/10.19080/OFOAJ.2018.06.555677

Stephanou, D. (1990). Twenty years of experience in managing Cyprus reservoirs for angling. WLT Van Densen, B. Steinmetz and RH Hughes, Management of freshwater fisheries, Wageningen (Netherlands), Pudoc, 1-13.

Sukamolson, S. (2007). Fundamentals of quantitative research. Language Institute Chulalongkorn University, 1(3), 1-20.

Suuronen, P., & Bartley, D. M. (2014). Challenges in managing inland fisheries—using the ecosystem approach.

Tokatli, C. (2020). Pesticide residues in water and sediment of ergene river and tributaries in Turkiye. Sigma Journal of Engineering and Natural Sciences, 38(1), 361-370.

TSI, Turkish Statistical Institute. (2021 June 4th). Quantity of Freshwater Products Caught https://data.tuik.gov.tr/

Tsujimoto, M., Kajikawa, Y., Tomita, J., & Matsumoto, Y. (2018). A review of the ecosystem concept—Towards coherent ecosystem design. Technological Forecasting and Social Change, 136, 49-58. https://doi.org/10.1016/j.techfore.2017.06.032

Udo, R. (2020). The Cross River Basin.InGeographical Regions of Nigeria. (Berkeley: UCP)

Ulman, A., Zengin, M., Demirel, N., & Pauly, D. (2020). The lost fish of Turkiye: a recent history of disappeared species and commercial fishery extinctions for the Turkish Marmara and Black Seas. Frontiers in Marine Science, 7, 650. https://doi.org/10.3389/fmars.2020.00650

Umar, D. U. A., Ramli, M. F., Aris, A. Z., Jamil, N., & Tukur, A. I. (2019). Surface water resources management along Hadejia River Basin, northwestern Nigeria. H2Open Journal, 2(1), 184-199. https://doi.org/10.2166/h2oj.2019.010

Unal, V., &Göncüoğlu, H. (2012). Fisheries management in Turkiye. The State of the Turkish Fisheries, Publication, (35).

Varol, M., Gökot, B., Bekleyen, A., &Şen, B. (2013). Geochemistry of the Tigris River basin, Turkiye: spatial and seasonal variations of major ion compositions and their controlling factors. Quaternary International, 304, 22-32. https://doi.org/10.1016/j.quaint.2012.12.043

Vieira, T. B., & Tejerina-Garro, F. L. (2020). Relationships between environmental conditions and fish assemblages in tropical savanna headwater streams. Scientific Reports, 10(1), 1-12. https://doi.org/10.1038/s41598-020-59207-9

Vorosmarty, C., et al, (2010). Global Threats to Human Water Security and River Biodiversity. Nature,467:555-561.

WEF, World Economic Forum (2015). Global Risks. http://www3.weforum.org/docs/WEF_Global_Risks_2015_Report15.pdf

Welcomme, R. (2011). Review of the state of the world fishery resources: inland fisheries. FAO Fisheries and Aquaculture Circular, (C942), I.

Welcomme, R. L., Cowx, I. G., Coates, D., Béné, C., Funge-Smith, S., Halls, A., & Lorenzen, K. (2010). Inland capture fisheries. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1554), 2881-2896. https://doi.org/10.1098/rstb.2010.0168