SOME CONTEMPORARY ISSUES IN THE GULF OF GUINEA AND THEIR ENVIRONMENTAL IMPLICATIONS

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THE GULF OF GUINEA

- This region is located in the Atlantic Ocean in the south-west of Africa.

- According to the International Hydrographic Organization (Bassou, 2016), it extends from Guinea-Bissau to Angola

- and covers the EEZs of 16 countries bordering the coast (extending over 7000 km):

- Guinea-Bissau (GNB), Guinea-Conakry (GIN), Sierra Leone (SLE), Liberia (LBR), Côte D'Ivoire (CIV), Ghana (GHA), Togo (TGO), Benin (BEN), Nigeria (NGA), Cameroon (CMR), Equatorial Guinea (GNQ), Sao Tome and Principe (STP), Gabon (GAB), Republic of the Congo (COG), Democratic Republic of the Congo (COD), and Angola (AGO) (Figs. 1a&b). (Najoui *et al.*, 2022)

Figure 1a: Satellite image of GoG (McGlade *et al*., 2002)

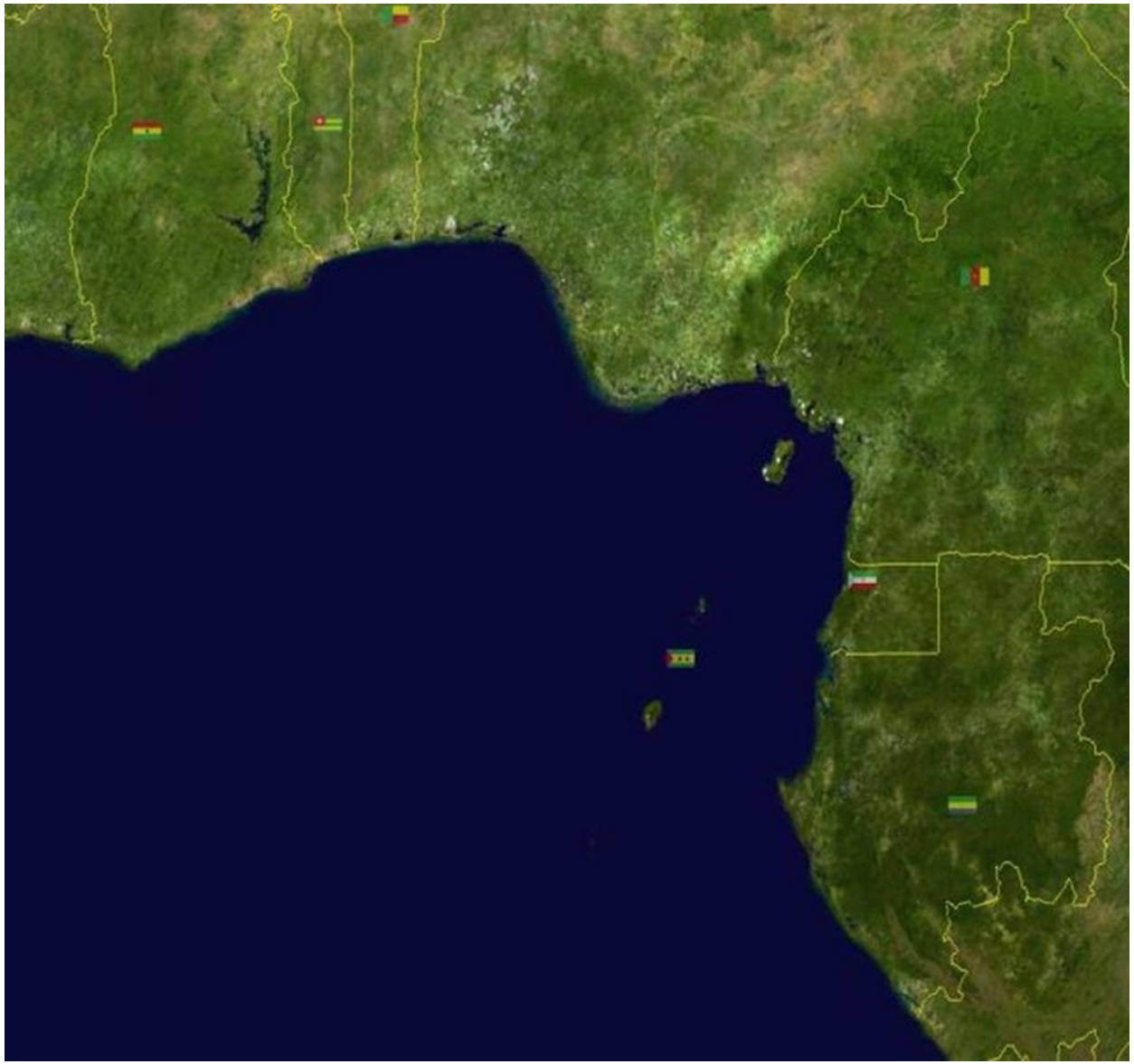
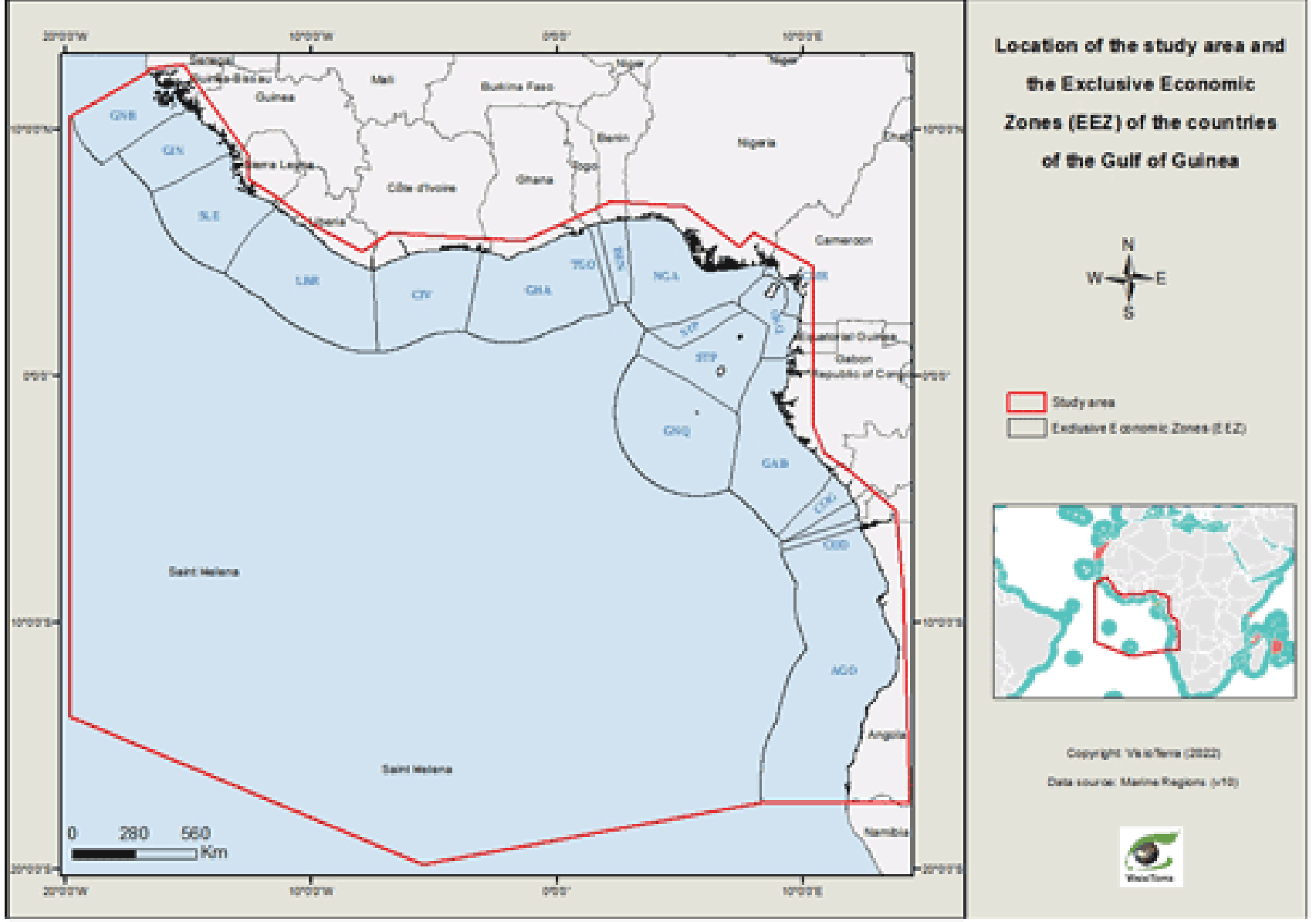


Figure 1b: A map of the Gulf of Guinea (Najoui *et al.*, 2022)



GoG (Hydrology and Ecology)

The Gulf of Guinea has a narrow continental shelf that widens to only 160 km from Sierra Leone to the Bijagós Archipelago of Guinea-Bissau.

The warm Guinea Current washes the northern coasts of the Gulf.

The tropical waters of the gulf are separated from the cool Canary and Benguela currents by a sharp coastal frontal area of the Senegal River and the Congo River.

The Gulf of Guinea has warm tropical waters with relatively low salinity because of the rivers that drain into it and also due to the high rainfall in the region.

This warm water is separated from the colder, more saline waters by a thin layer of water (thermocline) between the lower and upper levels.

The coastal region of the Gulf of Guinea is mostly low-lying and is interspersed with mangrove swamps, marshes, and lagoons.

Among the major rivers that drain into the Gulf of Guinea include the Volta and Niger rivers. The Bight of Bonny and the Bight of Benin regions are located along the coast of the Gulf of Guinea.

GoG (Hydrology and Ecology)

- These bights form the western edge of Africa's tectonic plate.
- Four main productive zones are found in the Gulf of Guinea due to coastal upwelling.
- These are the Gabon-Congo area, the Senegal-Liberia area, Cote d'Ivoire–Ghana, and the Congo River outflow.
- The islands of the Gulf of Guinea form a part of the Cameroon line of volcanoes.
- The largest of these islands extend for some 450 miles from southwest-northeast.
- Some of these islands include Annobon (Pagalu), Corisco, Bioko, and the Small and Great Elobeys (all in Equatorial Guinea), Bobowasi Island in Ghana, and the island nation of São Tomé and Principe.

- The islands in Equatorial Guinea are covered by mangroves and tropical moist forests.

GoG (Trade)

- The Gulf of Guinea in West Africa is home to some of the world's most dynamic economies.
- Nigeria, the region's largest economy and most populous state with some 232.6 million people, is overcoming recent problems, but is nevertheless set for GDP growth of 2.7% in 2022, according to the IMF's latest forecasts.

- Several of its neighbours are set for highly impressive growth rates: Côte d'Ivoire (6.5%), Ghana (6.2%), Togo (5.9%), Benin (6.5%), and Cameroon (4.6%).

- Trade data is often cited by economists as a leading growth indicator, while other measures of economic activity are often lagging.

- With recent improvements in ship-tracking technology from both satellites and land-based receivers, trade data can now be derived real-time.
- The Gulf of Guinea is an interesting case in point, where dry bulk and containerized trade data yields some useful insights.

GoG (Trade)

- It is of geostrategic value as it is rich in oil and gas

- and accounts for 40% of Europe's and 30% of the USA's energy supplies.

- The GoG's maritime domain is also valuable to both the global and regional economies as it offers potential for sea transportation due to lack of choke-points as well as for fishing and mining (Agyekum, 2024).

RESOURCES IN THE GoG

- Fish, crustaceanscephalopods, shell fishes
- Mammals (whales, dolphins, pinnipeds, sirenians,
- Physical resources - minerals, pearls, Ivory, gem stones, salt,
- Chemical resources – crude oil/petroleum
- Nuclear

ECONOMIC ACTIVITIES IN THE GoG

- Fishing
- Aquaculture/mariculture (fauna and flora)
- Mining (Petroleum, minerals, corals, sand,
- Transport (cargo, merchant, fuel tankers, ferry, cruise ships, research, warships)
- Building and construction of ships
- Trade and commerce (fish, rice, grains, sugar, cooking oil, salt,

THREATS IN THE GoG

- IUU, Overfishing/depleting of stocks/bycatch/discards/destruction of seabed and corals/blasting of corals **(as explored in the *Seaspiracy*),**
- Displaced nets (ghost fishing)
- Large pelagics such as sharks, pelagics and mammals dying from seismic operations, collision of vessels, oil spills, chemical pollution, plastic pollution
- Pollution (air, Plastic, chemical, oil spill, nuclear)
- Ocean dumping
- Destruction and death/bleaching of corals
- Habitat loss and degradation
- Coastal erosion
- Algal blooms
- TNOCs (piracy, armed robbery, weapons and drug trafficking, human trafficking, money laundering)

IUU FISHING

Concept of IUU Fishing

The term “IUU fishing” has three but interrelated components namely:

- illegal fishing
- unreported fishing and
- unregulated fishing.

When is fishing illegal, unreported, unregulated

- Illegal fishing takes place where vessels operate in violation of the laws of a fishery (No fishing days, closed season, Protected areas, unapproved gears, etc.).
- This can apply to fisheries that are under the jurisdiction of a coastal state or to high seas fisheries regulated by regional organizations.

- Unreported fishing is fishing that has been unreported or misreported to the relevant national authority or regional organization, in contravention of applicable laws and regulations.

- Unregulated fishing generally refers to fishing by vessels without nationality, or vessels flying the flag of a country not party to the regional organization governing that fishing area or species.

What is IUU causing?

- Illegal, unreported and unregulated fishing is jeopardizing the very foundation of the Common Fisheries Policy (CFP) and the EU's international efforts to promote better ocean governance.

- Under the European Green Deal and pursuing the United Nations SDG for conservation and sustainable use of the oceans, sea and marine resources, the EU Commission has committed to a zero-tolerance approach to IUU fishing.

- The fight against illegal, unreported and unregulated fishing is also an important aspect of the EU Biodiversity Strategy's objective to protect the marine environment.

- The Strategy for Africa highlights the fight against IUU fishing as one of the key issues to address with our African partners.

EU and IUU

- The EU is the world's biggest importer of fisheries products.
- The global value of IUU fishing is estimated at 10-20 billion euros/year.
- Between 11-26 million tonnes of fish are caught illegally every year, corresponding to at least 15% of world catches.
- Today's Commission Decision is based on the EU's 'IUU Regulation', which entered into force in 2010.

- One of the pillars of this Regulation is the catch certification scheme that ensures that only legally caught fisheries products can access the EU market.

- The Regulation also provides for specific dialogue mechanisms with the countries that are not complying with their obligations as Flag, Coastal, Port and Market State under international law.

EUC and IUU

- While failure to cooperate in the framework of the dialogue can lead to an identification of the country (a so-called “red card”).
- The IUU dialogues are based on cooperation and support to countries and are an important step in tackling IUU fishing, with sanctions, including trade prohibition being only a last resort measure.

- Since November 2012, the Commission entered in formal dialogues with 27 third countries, i.e. officially warned them of the need to take effective action to fight IUU fishing.
- In most cases, significant progress was observed and therefore the Commission could satisfactorily close the formal dialogue phase and lift the yellow card.

- Only a few countries have not shown the necessary commitment to reforms until now.
- The EU is working to support Ghanaian population with several capacity building projects.

IUU Fishing - Seaspiracy

- Created by British filmmaker Ali Tabrizi,
- *Seaspiracy* takes us to destinations from Japan to Scotland to West Africa to the Faroe Islands as it examines the commercial fishing industry.
- Along with uncovering problems such as the horrifically dangerous and unethical working conditions in the fishing industry,
- the documentary reveals that the most problematic challenge facing our oceans and in turn, our planet, is something that most sustainability movements fail to acknowledge: **commercial fishing**.
- There are a number of issues that result from fishing; the documentary highlights issues such as plastic pollution, bycatch and misleading sustainability labels.

Seaspiracy - Overfishing and bycatch

- Seaspiracy explains that commercial fishing is wildlife poaching on a mass scale.
- 2.7 trillion fish are killed every year, and 5 million are killed every single minute.
- No other industry on Earth has killed as many animals as this trade, leading global fish populations to plummet to near extinction.
- If current fishing trends continue, the documentary states that we will see nearly empty oceans by 2048.

- Seaspiracy also exposes the massive problem of bycatch, such as unintentionally trapping dolphins while tuna fishing.

- Over 300,000 whales and dolphins are killed every single year

Seaspiracy - Overfishing and bycatch (cont'd)

- Not only is this horrifically unjust for our beautiful marine life, the implications also affect our entire planet.

- Each species is interconnected and plays a role in maintaining our ecosystems and atmosphere—whales and dolphins fertilize photoplankton, which absorb carbon dioxide (four times as much as the Amazon Rainforest, according to Seaspiracy).

- and they also regulate the physics, chemistry and biology of the oceans.
- Removing these key members (keystone sp) of our oceans has a crucial impact on every single part of our planet.

MARINE AND COASTAL POLLUTION

Marine Pollution: Causes, Effects and Prevention

- Marine pollution is a significant environmental issue that poses a serious threat to the health and well-being of our planet.
- Oceans account for 70 percent of the surface of planet Earth and play a pivotal role in the health of our ecosystem — including land-dwelling animals like ourselves.
- According to the National Oceanic and Atmospheric Administration (NOAA), billions of pounds of trash and other pollutants enter our oceans every year.
- The consequences of marine pollution are far-reaching; marine pollution is now tied to negative health outcomes in human health and marine ecosystems.
- Let’s take a look at some details

MAIN SOURCES OF MARINE AND COASTAL POLLUTION

1. Nonpoint source pollution (runoff)

- Nonpoint source pollution is the accumulation of pollution from small sources that can't be exactly pinpointed. Examples include the pollution created by individual cars, boats, farms and construction sites.

- Nonpoint source pollution typically becomes marine pollution via runoff, which occurs ….
- For instance, after a heavy rainstorm, water flows off roads into the ocean, taking oil left on streets from cars with it.
- But wind can transfer dirt and other debris from nonpoint sources and deposit these pollutants on the ocean's surface.

MAIN SOURCES OF MARINE AND COASTAL POLLUTION (cont'd)

2. Intentional discharge

- Manufacturing Plants in many areas of the world release toxic waste into the ocean, including mercury. While it has been banned in the US and other parts of the world, sewage also contributes to marine pollution. Meanwhile, **plastic waste** poses a particularly tough challenge; according to the Ocean Conservancy, 8M metric tons of plastic go into our oceans every year.

3. Oil spills

- Ships are major contributors to marine pollution, especially when crude oil spills occur. You can find a history of oil spills on the NOAA site, but the largest one in recent history was, by far, the 2010 Deepwater Horizon well blowout in the Gulf of Mexico, which spilled approximately 134 million gallons of oil into the ocean.
- Oil spill is a common fallout of oil exploration and exploitation in the Niger delta region, with an estimated total of over 7000 oil spill incidents reported over a 50-year period.

MAIN SOURCES OF MARINE AND COASTAL POLLUTION (cont'd)

4. Littering

- Atmospheric pollution — a type of marine pollution where objects are carried by the wind to the ocean is often caused by littering. It includes single-use plastics (such as plastic bags) and Styrofoam containers which can take *hundreds* of years to biodegrade. It is estimated that 1 trillion plastic bags are used worldwide per year.

5. Ocean mining

- Deep-sea ocean mining causes marine pollution and ecosystem disruption at the lowest levels of the ocean. Drilling for substances such as cobalt, zinc, silver, gold and copper creates harmful sulphide deposits deep in the ocean.

TYPES, SOURCES AND IMPACTS OF COASTAL AND MARINE POLLUTION ON ECOSYSTEMS AND HUMAN HEALTH.

Type	Primary Source/Cause	Effect
Nutrients	Runoff approximately 50% sewage, 50% from forestry, farming, and other land use. Also airborne nitrogen oxides from power plants, cars etc.	Feed algal blooms in coastal waters. Decomposing algae depletes water of oxygen, killing other marine life. Can spur algal blooms (red tides), releasing toxins that can kill fish and poison people.
Sediments	Erosion from mining, forestry, farming, and other land-use; coastal dredging and mining	Cloud water; impede photosynthesis below surface waters. Clog gills of fish. Smother and bury coastal ecosystems. Carry toxins and excess nutrients.
Pathogens	Sewage, livestock.	Contaminate coastal swiming areas and seafood, spreading cholera, typhoid and other diseases.
Alien Species	Several thousand per day transported in ballast water; also spread through canals linking bodies of water and fishery enhancement projects.	Outcompete native species and reduce biological diversity. Introduce new marine diseases. Associated with increased incidence of red tides and other algal blooms. Problem in major ports.
Persistent Toxins (PCBs, Heavy metals, DDT etc.)	Industrial discharge; wastewater discharge from cities; pesticides from farms, forests, home use etc.; seepage from landfills.	poison or cause disease in coastal marine life, especially near major cities or industry. Contaminate seafood. Fat-soluble toxins that bio-accumulate in predators can cause disease and reproductive failure.

Source: Compiled by WorldWatch Institute

TYPES, SOURCES AND IMPACTS OF COASTAL AND MARINE POLLUTION ON ECOSYSTEMS AND HUMAN HEALTH. (cont'd)

Type	Primary Source/Cause	Effect
Oil	46% from cars, heavy machinery, industry, other land-based sources; 32% from oil tanker operations and other shipping; 13% from accidents at sea; also offshore oil drilling and natural seepage.	Low level contamination can kill larvae and cause disease in marine life. Oil slicks kill marine life, especially in coastal habitats. Tar balls from coagulated oil litter beaches and coastal habitat. Oil pollution is down 60% from 1981.
Plastics	Fishing nets; cargo and cruise ships; beach litter; wastes from plastics industry and landfills.	Discard fishing gear continues to catch fish. Other plastic debris entangles marine life or is mistaken for food. Plastics litter beaches and coasts and may persist for 200 to 400 years.
Radioactive substances	Discarded nuclear submarine and military waste; atmospheric fallout; also industrial wastes.	Hot spots of radio activity. Can enter food chain and cause disease in marine life. Concentrate in top predators and shellfish, which are eaten by people.
Thermal	Cooling water from power plants and industrial sites	Kill off corals and other temperature sensitive sedentary species. Displace other marine life.
Noise	Supertankers, other large vessels and machinery	Can be heard thousands of kilometers away under water. May stress and disrupt marine life.

OIL EXPLOITATION IN THE GULF OF GUINEA

- The Gulf of Guinea is a very active area with respect to maritime traffic as well as oil and gas exploitation.
- Due to the failure of some actors to comply with environmental standards, this region has been subject to a large number of oil pollution episodes.
- This anthropogenic oil pollution is in addition to natural oil seepage from the ocean floor.
- Najoui *et al*., 2022, this study is the first to achieve a global statistical analysis based on 10 years of radar images covering 17 exclusive economic zones (EEZs) in the Gulf of Guinea.
- The present study is based on a database of 3644 SAR images collected between 2002 and 2012 by the Advanced Synthetic Aperture Radar (ASAR) sensor onboard the European Spatial Agency (ESA) Envisat mission, and these images allowed the identification of 18,063 oil slicks.
- The spatial distribution of these oil slicks is available from Zenodo: https://doi.org/10.5281/zenodo.6470470 (Najoui *et al*., 2022b).
- The oil slicks detected in this work encompass both oil spills of anthropogenic origin and oil seeps of natural origin (natural oil reservoir leaks).

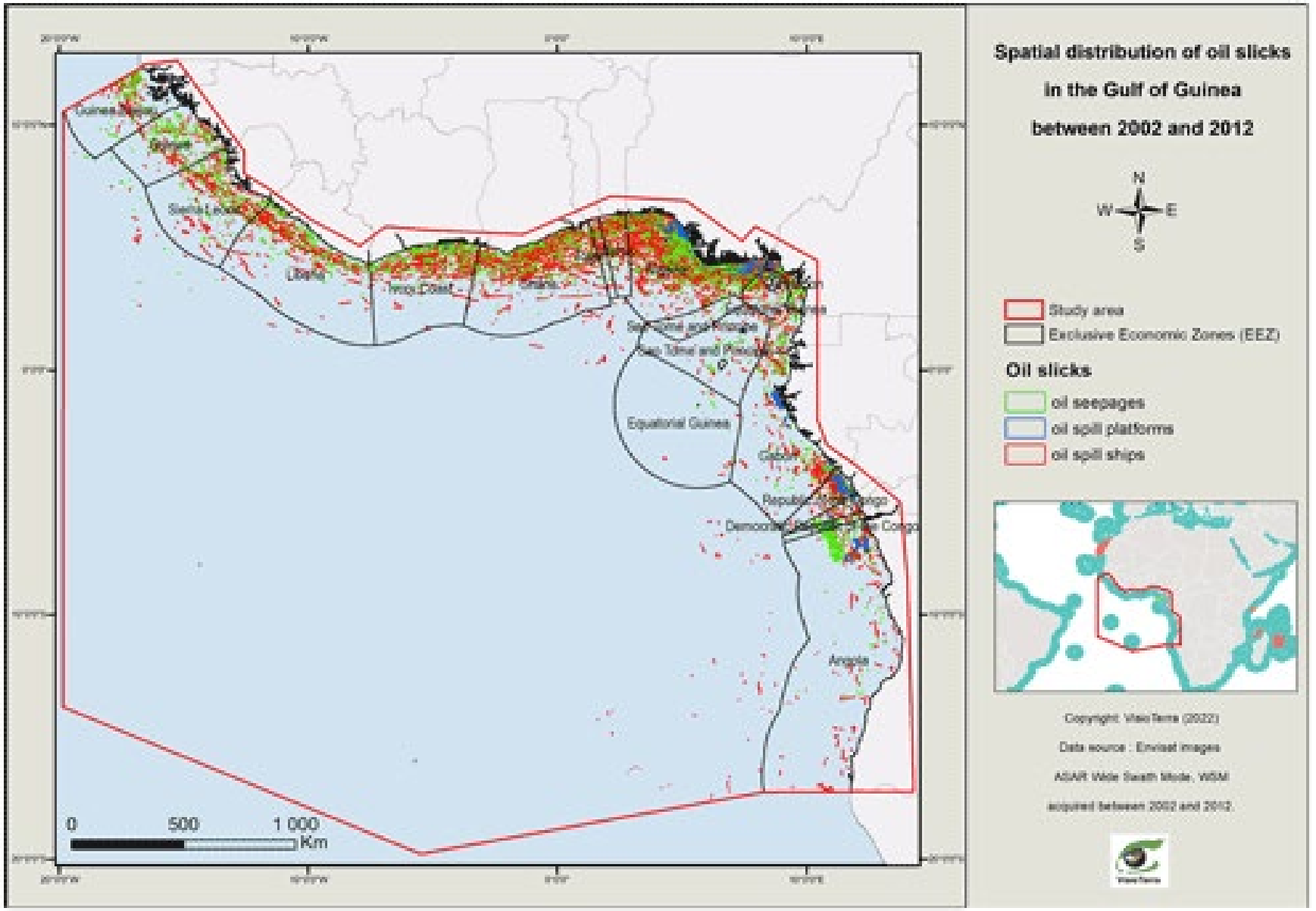


FIGURE 2: spatial distribution of oil slicks (18,063) in the GoG between 2002-2012 (Najoui *et al.*, 2022)

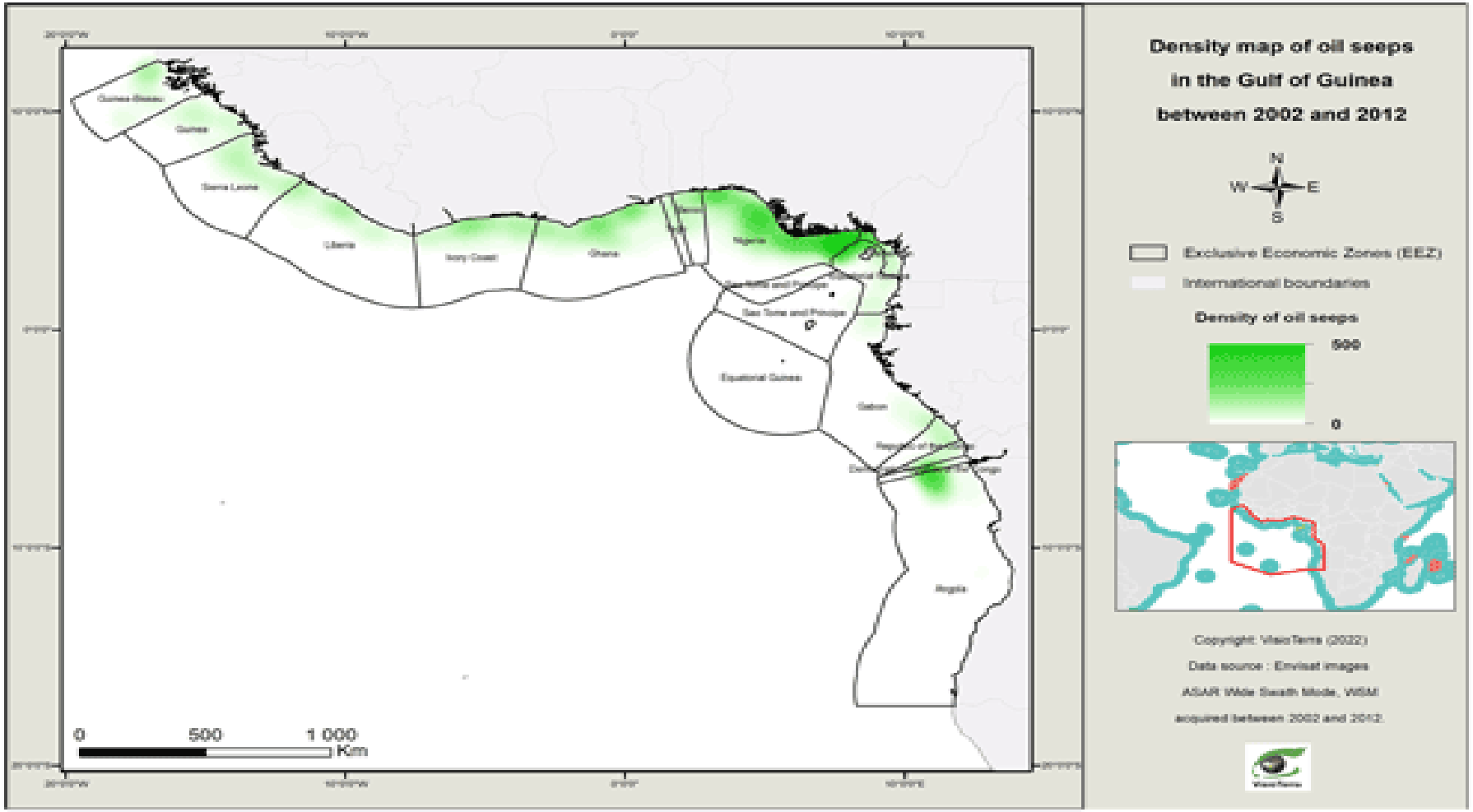


Figure 3: Density map of oil seeps in the GoG from 2002-2012 (Najoui *et al.*, 2022)

Around 40-50% of all oil released into the oceans stems from natural seeps from seafloor rocks.
This corresponds to approximately 600,000 tons annually on a global level.
While natural seeps are the single largest source of oil spills, they are considered less problematic because ecosystems have adapted to such regular releases.
For instance, on sites of natural oil seeps, ocean bacteria have evolved to digest oil molecules

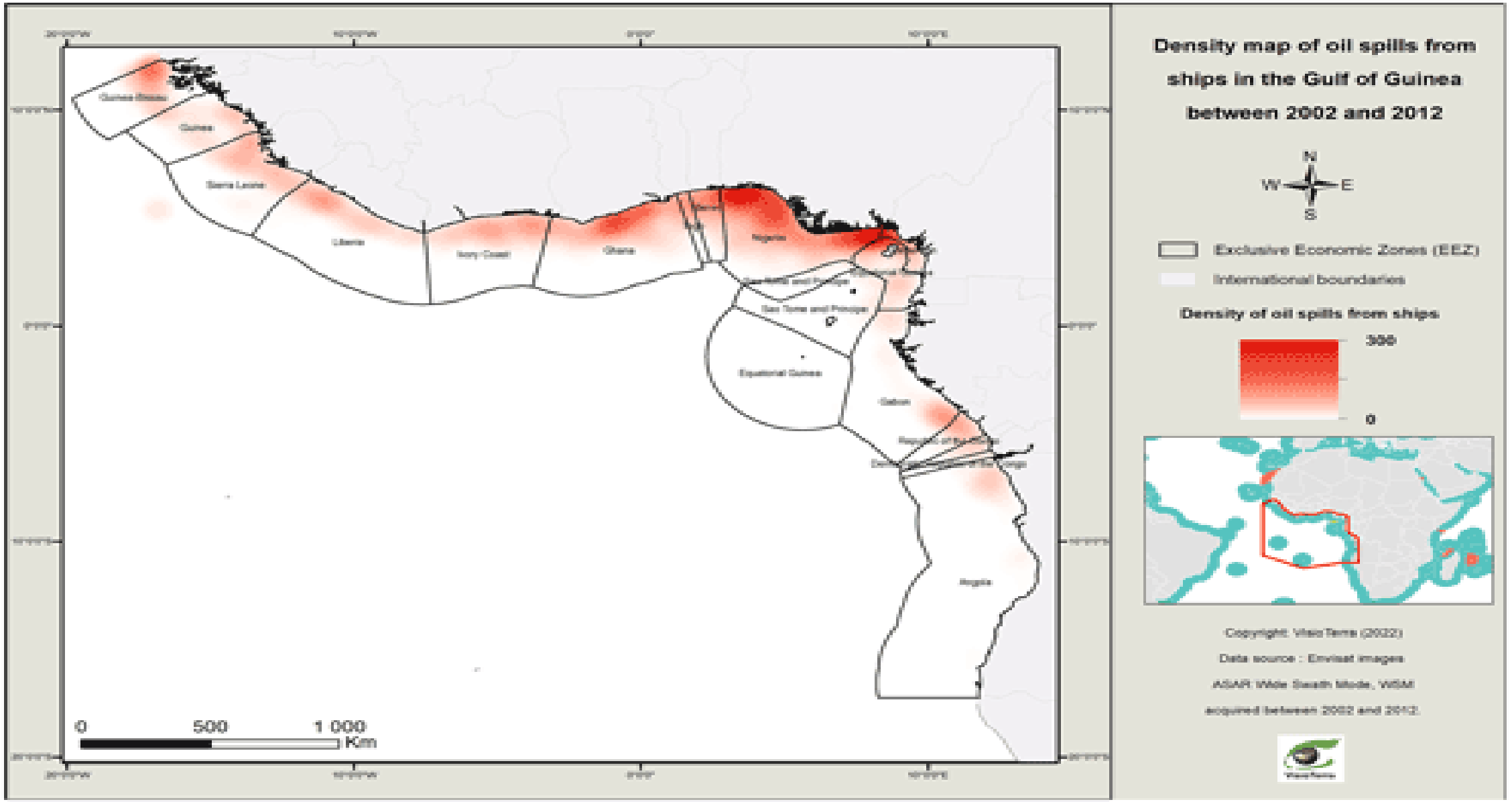


Figure 4: Density map of oil spills from ships in the GoG from 2002-2012 (Najoui *et al.*, 2022)

SOURCES AND RATE OF OCCURRENCE

- Oil spills can be caused by human error, natural disasters, technical failures or deliberate releases. It is estimated that 30–50% of all oil spills are directly or indirectly caused by human error, with approximately 20–40% of oil spills being attributed to equipment failure or malfunction.

- Causes of oil spills are further distinguished between deliberate releases, such as operational discharges or acts of war and accidental releases. Accidental oil spills are in the focus of the literature, although some of the largest oil spills ever recorded, the Gulf War Oil Spill (sea based) and Kuwaiti Oil Fires (land based) were deliberate acts of war.

- The academic study of sources and causes of oil spills identifies vulnerable points in oil transportation infrastructure and calculates the likelihood of oil spills happening. This can then guide prevention efforts and regulation policies.

OIL TANKERS AND VESSELS

- Vessels can be the source of oil spills either through operational releases of oil or in the case of oil tanker accidents. As of 2007, operational discharges from vessels were estimated to account for 21% of oil releases from vessels.
- They occur as consequences of failure to comply with regulations or arbitrary discharges of waste oil and water containing such oil residues.
- Such operational discharges are regulated through the MARPOL convention.
- Operational releases are frequent, but small in the amount of oil spilled per release and are often not in the focus of attention regarding oil spills.
- There has been a steady decrease of operational discharges of oil, with an additional decrease of around 50% since the 1990s.
- Spills may take days, weeks, months or even years to cleanup …

OIL TANKERS AND VESSELS

- As of 2007, accidental oil tank vessel spills accounted for approximately 8–13% of all oil spilled into the oceans.
- The main causes of oil tank vessel spills were collision (29%), grounding (22%), mishandling (14%) and sinking (12%), among others.
- Oil tanker spills are considered a major ecological threat due to the large amount of oil spilled per accident and the fact that major sea traffic routes are close to Large Marine Ecosystems.
- Around 90% of the world's oil transportation is through oil tankers, and the absolute amount of seaborne oil trade is steadily increasing.
- However, there has been a reduction of the number of spills from oil tankers and of the amount of oil released per oil tanker spill.
- In 1992, MARPOL was amended and made it mandatory for large tankers (5,000 dwt and more) to be fitted with double hulls.
- This is considered to be a major reason for the reduction of oil tanker spills, alongside other innovations such as GPS, sectioning of vessels and sea lanes in narrow straits.

OIL TANKERS AND VESSELS

- In 2023, the International Tanker Owners Pollution Federation (ITOPF) documented a significant oil spill incident of over 700 tonnes and nine medium spills ranging between 7 and 700 tonnes. The major spill occurred in Asia involving heavy fuel oil, and the medium spills were scattered across Asia, Africa, Europe, and America, involving various oil types.

- The total volume of oil released from these spills in 2023 was approximately 2,000 tonnes. This contributes to a trend of decreased oil spill volumes and frequencies over the decades. Comparatively, the 1970s averaged 79 significant spills per year, which drastically reduced to an average of about 6.3 per year in the 2010s and has maintained a similar level in the current decade.

- The reduction in oil spill volume has also been substantial over the years. For instance, the 1990s recorded 1,134,000 tonnes lost, mainly from 10 major spills. This figure decreased to 196,000 tonnes in the 2000s and 164,000 tonnes in the 2010s.
- In the early 2020s, approximately 28,000 tonnes have been lost, predominantly from major incidents

OIL SPILL IN THE NIGER DELTA

- There are no consistent figures of the quantity of crude oil spilled in the Niger delta, but it is widely estimated 13 million barrels (1.5 million tons) of crude oil have been spilled since 1958 from over 7000 oil spill incidents;

- a yearly average of about 240,000 barrels.

- Inconsistency in the quantity of crude oil spilled has been attributed to a number of reasons, including the difficulty in accessing some spill sites (due to swamp conditions and remoteness);

- security concerns limiting access; some spills occurring away from community locations;

- a long time-lag between the initiation of a spill and its detection; the high volatility of the Nigerian crude oil, causing an estimated 50% to evaporate within 24-48 h;

- intentional company and government under-reporting; and inadequate government oversight.

Oil spill at a shell facility in Ogoniland, Niger Delta, Nigeria contaminated farmlands, river, estuary, mangroves causing air pollution and hunger in June 2023. The National Oil Spill Detection and Response Agency, or NOSDRA, told The Associated Press that the spill came from the Trans-Niger Pipeline operated by Shell that crosses through communities in the Eleme area of Ogoniland, a region where the London-based energy giant has faced decadeslong local pushback to its oil exploration. While spills are frequent in the region due to vandalism from oil thieves and a lack of maintenance to pipelines, according to the U.N. Environmental Program, reporters say this has been the worst in 16 years.

In December 2011, SkyTruth observed the impacts of a Shell oil spill that caused up to 40,000 barrels (1.7 million gallons) of oil to spill into the Atlantic Ocean, off the coast of Nigeria. The spill has had a significant impact on fish stocks in deeper ocean waters, which are critical to the region’s food resources. Nigerian coastal communities rely on fishing for up to 80% of their animal protein, and shocks to fish populations can suspend people’s livelihoods.

OIL SPILL IN THE NIGER DELTA

- The oil spills affected at least 1500 communities in the 8-crude oil-producing states in Nigeria,
- and were mainly from the 5284 oil wells that were drilled (as at 2006)
- and the 7000 km of crude oil pipeline that crisscrosses the Niger delta region.
- Table 1 (next slide) shows the causes of the crude oil spill.
- More than 30% of the spills were due to unknown causes, while 20.74% were attributed to third party activity (Achebe *et al*., 2012).

TABLE 1: CAUSES OF OIL SPILL BETWEEN 1999-2005 IN NIGERIA (Achebe *et al*., 2012)

Cause	Number (*N*=135)	Percentage
Mechanical failure	23	17.04
Corrosion	21	15.56
Operational error	17	12.59
Third party activity	28	20.74
Natural hazard	3	2.22
Unknown	43	31.85

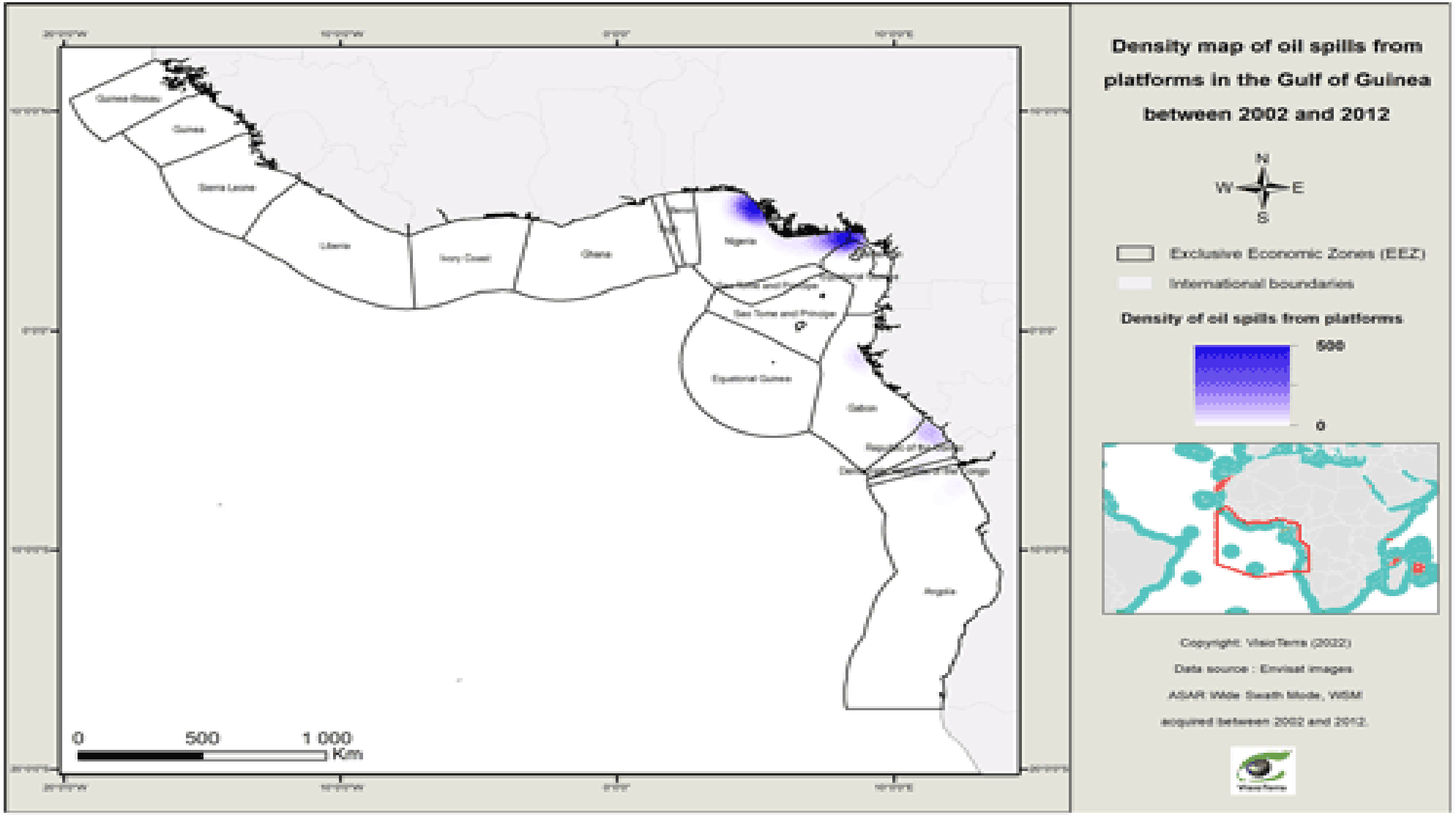


Figure 5: Density map of oil spills from platforms in the GoG from 2002-2012 (Najoui *et al.*, 2022)

OFFSHORE OIL PLATFORMS

- Chemical dispersants may be deployed from boats, planes, and underwater vehicles in response to an offshore oil spill
- Accidental spills from oil platforms nowadays account for approximately 3% of oil spills in the oceans.
- Prominent offshore oil platform spills typically occurred as a result of a blowout. They can go on for months until relief wells have been drilled, resulting in enormous amounts of oil leaked.
- Notable examples of such oil spills are Deepwater Horizon and Ixtoc I. While technologies for drilling in deep water have significantly improved in the past 30–40 years, oil companies move to drilling sites in more and more difficult places.
- This ambiguous development results in no clear trend regarding the frequency of offshore oil platform spills.

PIPELINES

- As of 2010, overall, there has been a substantial increase of pipeline oil spills in the past four decades.
- Prominent examples include oil spills of pipelines in the Niger Delta.
- Pipeline oil spills can be caused by trawling of fishing boats, natural disasters, pipe corrosion, construction defects, sabotage, or an attack, as with the Caño Limón-Coveñas pipeline in Colombia.

- Pipelines as sources of oil spills are estimated to contribute 1% of oil pollution to the oceans.

- Reasons for this are underreporting, and many oil pipeline leaks occur on land with only fractions of that oil reaching the oceans.

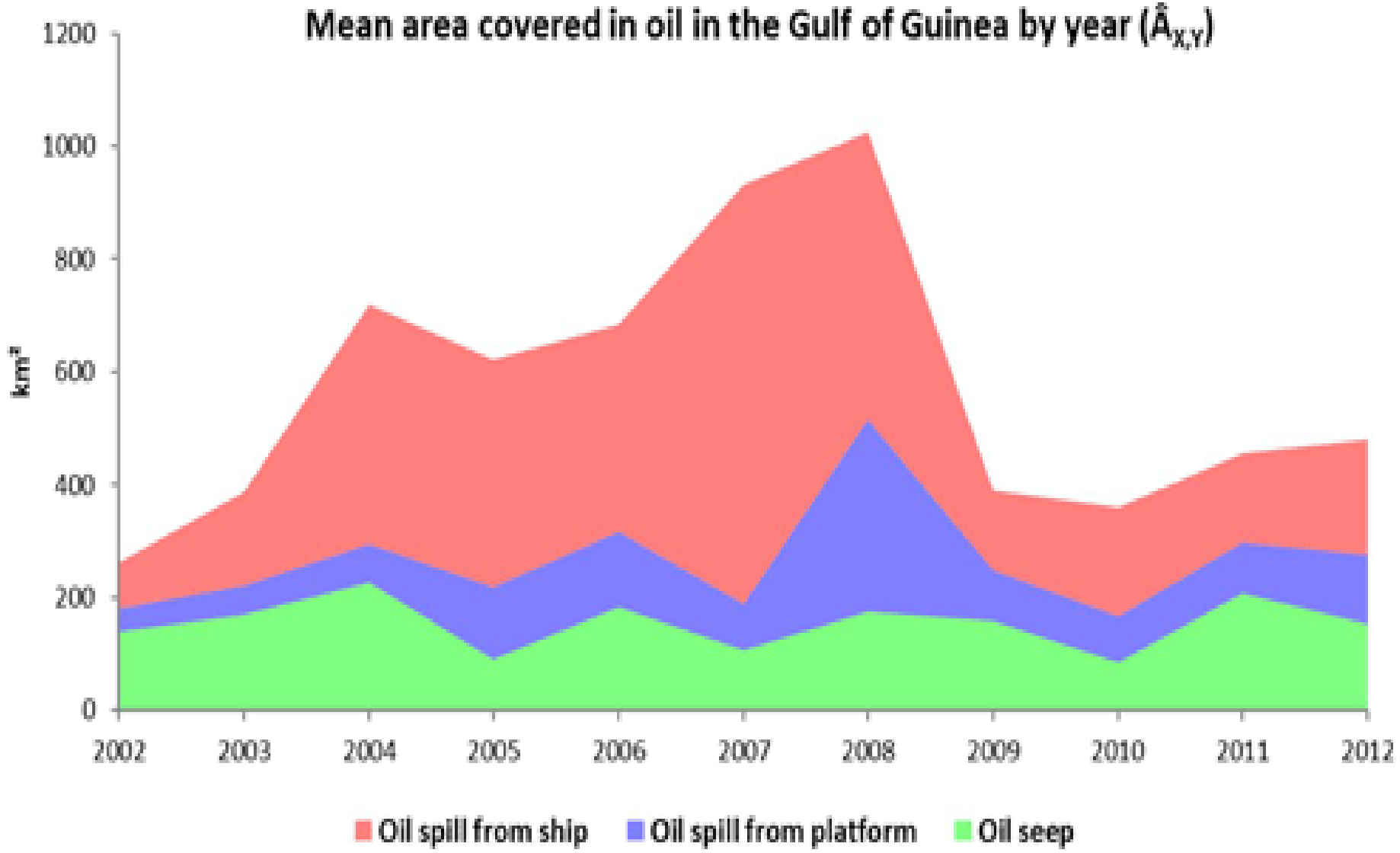


Figure 6: Mean area covered in oil in the GoG from 2002-2012 (Najoui *et al*., 2022)

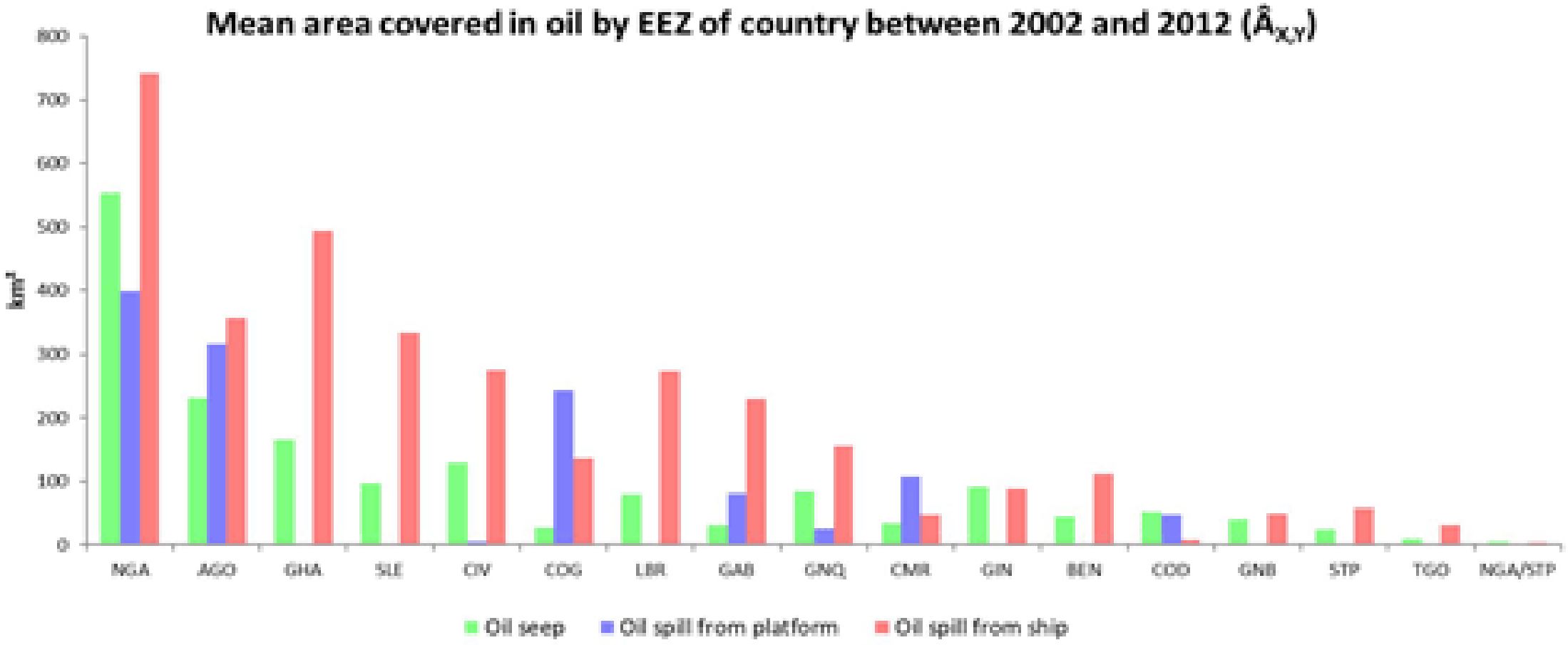


Figure 7. Mean area covered by oil in EEZs of countries (ÂX;Y) in the Gulf of Guinea between 2002 and 2012 (Najoui *et al*., 2022).

IMPACTS OF OIL SPILLS ON HUMANS

- An oil spill represents an immediate negative effects on human health, including respiratory and reproductive problems as well as liver, and immune system damage.
- Oil spills causing future oil supply to decline also affects the everyday life of humans such as the potential closure of beaches, parks, fisheries and fire hazards.
- The Kuwaiti oil fires produced air pollution that caused respiratory distress.
- The Deepwater Horizon explosion killed eleven oil rig workers.
- The fire resulting from the Lac-Mégantic derailment killed 47 and destroyed half of the town's centre.

- Spilled oil can also contaminate drinking water supplies. For example, in 2013 two different oil spills contaminated water supplies for 300,000 in Miri, Malaysia; 80,000 people in Coca, Ecuador.
- In 2000, springs were contaminated by an oil spill in Clark County, Kentucky.

- Ballsh, Mallakaster, Albania 2019 – Crude Oil
- Contamination can have an economic impact on tourism and marine resource extraction industries. For example, the Deepwater Horizon oil spill impacted beach tourism and fishing along the Gulf Coast, and the responsible parties were required to compensate economic victims.

IMPACTS OF OIL SPILL ON AQUATIC FAUNA

IMPACTS OF OIL SPILLS ON AIR QUALITY

- In addition, oil spills can also harm air quality. The chemicals in crude oil are mostly hydrocarbons that contains toxic chemicals such as benzenes, toluene, poly-aromatic hydrocarbons and oxygenated polycyclic aromatic hydrocarbons.
- These chemicals can introduce adverse health effects when being inhaled into human body. In addition, these chemicals can be oxidized by oxidants in the atmosphere to form fine particulate matter after they evaporate into the atmosphere.
- These particulates can penetrate lungs and carry toxic chemicals into the human body. Burning surface oil can also be a source for pollution such as soot particles. During the cleanup and recovery process, it will also generate air pollutants such as nitric oxides and ozone from ships. Lastly, bubble bursting can also be a generation pathway for particulate matter during an oil spill.
- During the Deepwater Horizon oil spill, significant air quality issues were found on the Gulf Coast, which is the downwind of DWH oil spill.
- Air quality monitoring data showed that criteria pollutants had exceeded the health-based standard in the coastal regions

ECOSYSTEMS AND HABITATS

- The majority of oil from an oil spill remains in the environment, hence a spill from an operation in the ocean is different from an operation on tundra or wetland.

- Wetlands are considered one of the most sensitive habitats to oil spills and the most difficult to clean.

OTHER SOURCES

- Recreational boats can spill oil into the ocean because of operational or human error and unpreparedness. The amounts are however small, and such oil spills are hard to track due to underreporting.

- Oil can reach the oceans as oil and fuel from land-based sources.
- It is estimated that runoff oil and oil from rivers are responsible for 11% of oil pollution to the oceans.
- Such pollution can also be oil on roads from land vehicles, which is then flushed into the oceans during rainstorms.
- Purely land-based oil spills are different from maritime oil spills in that oil on land does not spread as quickly as in water, and effects thus remain local.

MARINE PLASTIC POLLUTION

The research highlights that countries with smaller land areas, lengthier coastlines, increased rainfall, and inadequate waste management infrastructures are more prone to having their plastic waste end up in the ocean. (Science Advances, 2021)

Plastic Pollution (cont'd)

According to the World Population Review,

the US ranks first in the top 10 countries that generate the most plastic waste – producing 34 billion kilograms annually.

India comes at second place with 26.3 billion kilograms of plastic waste,

China (21.6 billion kilograms),

Brazil (10.6 billion kilograms),

Indonesia (9.1 billion kilograms),

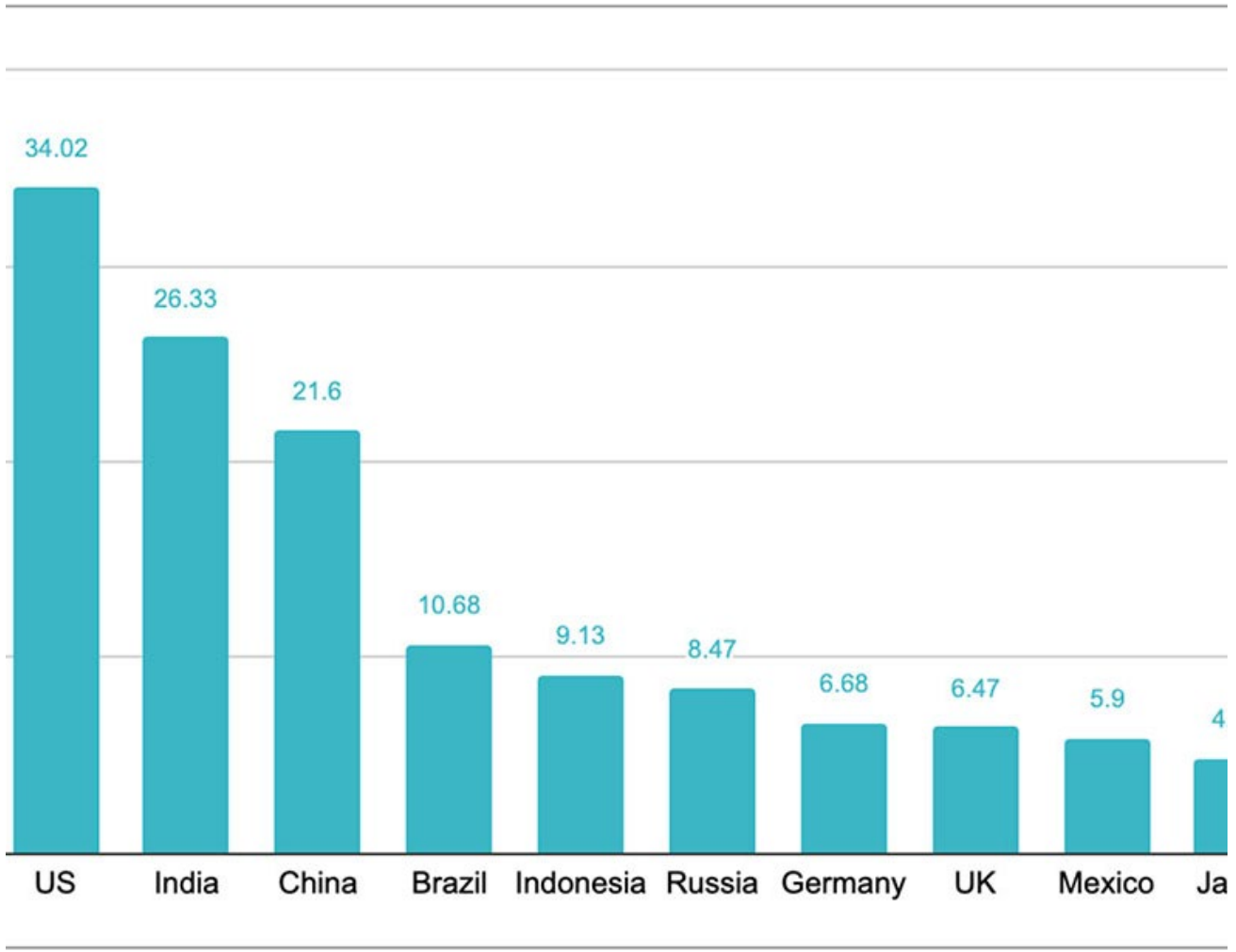
Russia (8.4 billion kilograms),

Germany (6.6 billion kilograms),

the UK (6.4 billion kilograms),

Mexico (5.9 billion kilograms) and

Japan (4.8 billion kilograms)

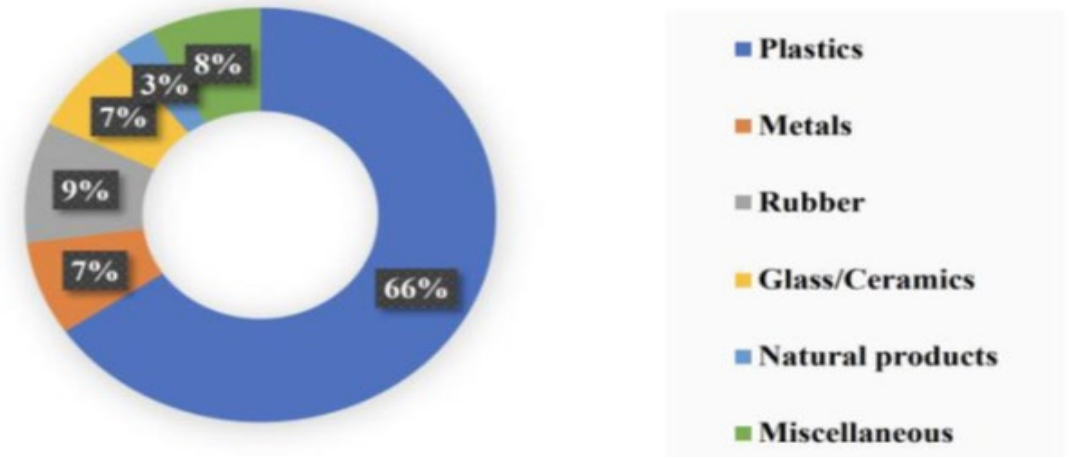


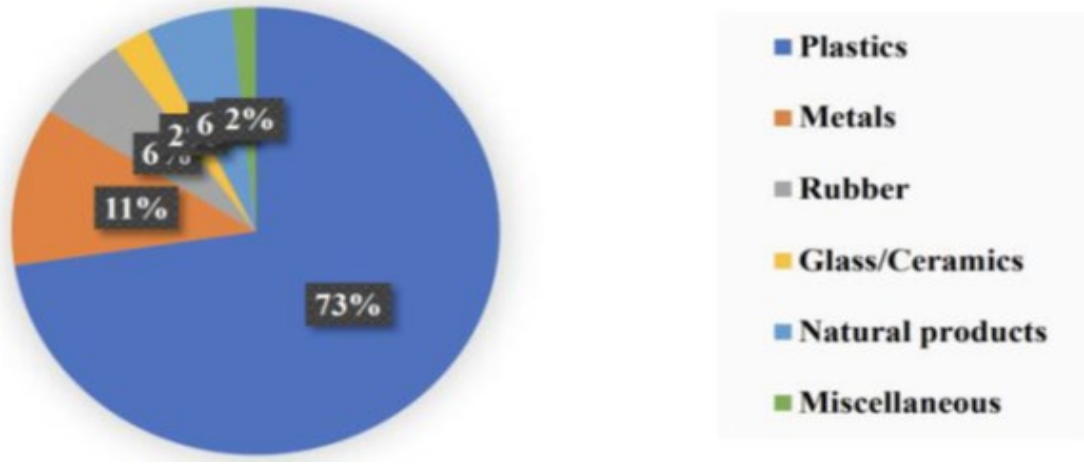
PLASTIC POLLUTION IN PRINCIPÉ

- A total of 71 beach surveys (111 transect and 287 sediment samples) were carried out from 11 beaches on the island of Príncipe between September 2022 and April 2023.
- A total of 13,196 debris items were collected from transect surveys with macroplastics constituting 64.5% of all items (n = 8506),
- metal (11.4%, n = 1501)
- cloth (10.4% n = 1374).
- All other litter types (glass, 5.10%; pottery, 2.18%; wood, 1.68%; paper,
- 1.52%; sanitary waste, 1.38%; rubber 1.15%; medical waste, 0.74%) (Ramilo-Henry *et al*., 2023)

PLASTIC POLLUTION IN GHANA

- Ghana has a difficult time managing waste, especially in the cities. Sakumono and La Pleasure Beaches in the Greater Accra Region served as the sites for this study.
- A total of 2,697 litter items were collected from the two beaches. During the survey, 50.07 kg from both sites comprised the entire weight of the litter collected. Plastics accounted for 72.56% of the total composition for both beaches, or 1,975 items, and 65.53% of the total composition, or 32.81 kg, respectively.
- Ongoing monitoring, intensive education, and sensible policy initiatives are still essential to address the beach litter problem along Ghana's coasts (Adjei and Lamptey, 2021)





MICROPLASTIC POLLUTION IN GHANA

- Microplastics (MPs, <5 mm) accumulate in marine environments, impacting marine organism health.
- This study examined MPs in sediments and two pelagic fish species (*S. maderensis* and *I. africana*) in Ghana's GoG.
- The study found an average concentration of 0.144 ± 0.061 items/g (dry weight) in the sediment, with pellets and transparent particles being the most common types.
- The concentration of MPs in fish 8.35 to 20.95, with fibers and pellets being the most abundant plastic-type in fish.
- In fish gills, concentrations ranged from 1 to 26 MPs/individual for *I. africana* and 1–22 MPs/individual for *S. maderensis*.
- Concentrations in the fish guts ranged from 1 to 29 MPs/individual for *I. africana* and 2–24 MPs/individual for *S. maderensis*.
- Results from the study highlight the importance of both gills and guts as important organs in terms of MP contamination and emphasize the significance of monitoring microplastic contamination in fish gills and guts.
- This offers valuable insight into the impact of MPs on the marine environment and human health (Nuamah *et al*., 2023)

Marine Pollution Prevention

- Further information: Offshore oil spill prevention and response
- Secondary containment – methods to prevent releases of oil or hydrocarbons into the environment.
- Oil Spill Prevention Control and Countermeasures (SPCC) program by the United States Environmental Protection Agency.
- Double-hulling – build double hulls into vessels, which reduces the risk and severity of a spill in case of a collision or grounding. Existing single-hull vessels can also be rebuilt to have a double hull.
- Thick-hulled railroad transport tanks.
- Spill response procedures should include elements such as;

- A listing of appropriate protective clothing, safety equipment, and cleanup materials required for spill cleanup (gloves, respirators, etc.) and an explanation of their proper use;
- Appropriate evacuation zones and procedures;
- Availability of fire suppression equipment;
- Disposal containers for spill cleanup materials; and
- The first aid procedures that might be required.

CLEANUP AND RECOVERY

- Cleanup and recovery from an oil spill is difficult and depends upon many factors, including the type of oil spilled, the temperature of the water (affecting evaporation and biodegradation), and the types of shorelines and beaches involved.
- Physical cleanups of oil spills are also very expensive. Until the 1960s, the best method for remediation consisted of putting straw on the spill and retrieving the oil-soaked straw manually.
- Chemical remediation is the norm as of the early 21st century, using compounds that can herd and thicken oil for physical recovery, disperse oil in the water, or facilitate burning the oil off.
- The future of oil cleanup technology is likely the use of microorganisms such as Fusobacteriota (formerly Fusobacteria), species demonstrate potential for future oil spill cleanup because of their ability to colonize and degrade oil slicks on the sea surface.

- There are three kinds of oil-consuming bacteria. Sulfate-reducing bacteria (SRB) and acid-producing bacteria are anaerobic, while general aerobic bacteria (GAB) are aerobic. These bacteria occur naturally and will act to remove oil from an ecosystem, and their biomass will tend to replace other populations in the food chain. The chemicals from the oil which dissolve in water, and hence are available to bacteria, are those in the water associated fraction of the oil.

Marine pollution solutions

- Given the long-term, disastrous effects of ocean pollution, anything we can do to avoid contaminating our seas is a good idea. With a few small changes to our daily routines, we can all do our part to help reduce the amount of pollution going into our oceans. Here are some marine pollution solutions that **you** can do to make a difference.
- Reduce chemical fertilizer use
- Excess chemical fertilizer eventually makes its way into the oceans. Choose organic fertilizers, which tend to be lower in nutrients, and use them at half strength or half as often as suggested.
- Opt for re-usable bottles and utensils
- Single-use plastic bottles, eating utensils and straws, are massive marine pollutants.
- Rather than contributing to the threat to marine life, opt for reusable bottles and utensils. When using reusable bottles, BPA-Free or glass bottles are best. Re-usable straws made from silicone or metal or bamboo are great options to use as well. They get the job done, can be used multiple times and stay out of our landfills and oceans.

Research

- Adaptation of the oil bee's, e.g. *Macropis fulvipes*', mechanism for harvesting flower oils has led to the biomimetic development of an additional oil spill recovery method.

- Oil bees have oleophilic properties in their hair-like protrusions that collect and store oil. This technique has been applied to textiles that can be used to remove oil from sea water.

Environmental Sensitivity Index (ESI) mapping

- Environmental Sensitivity Indexes (ESI) are tools used to create Environmental Sensitivity Maps (ESM).

- ESM's are pre-planning tools used to identify sensitive areas and resources prior to an oil spill event in order to set priorities for protection and plan clean-up strategies.

- It is to date the most commonly used mapping tool for sensitive area plotting.
- The ESI has three components: A shoreline type ranking system, a biological resources section, and a human-use resource category.

Pollution monitoring techniques

- Conventional methods - Sampling water and sediments using water samplers and sediment corers respectively. These are analysed in the lab to estimate the physico-chemical parameters concentrations.

- Collection and quantification of plastics/debris physically on the field

- Sampling of gut content of fish, seabirds, sea turtles, mammals and other marine organisms

- Satellite Remote sensing (GoogleEarth, SARS, ARCGIS, AIS data, VTMIS, Radar Imagery with high spatial resolution)

Some International conventions and agreements related to conservation of marine resources and the ocean.

- UNCLOS
- UNCBD
- UNCMS
- UN CITES
- RAMSAR CONVENTION
- MARPOL
- SOLAS
- BALLAST WATER CONVENTION
- ABIDJAN CONVENTION
- LOMÉ MARITIME CHARTER
- Various Laws, Acts, Maritime strategies, Management Plans and Policies - Nationally

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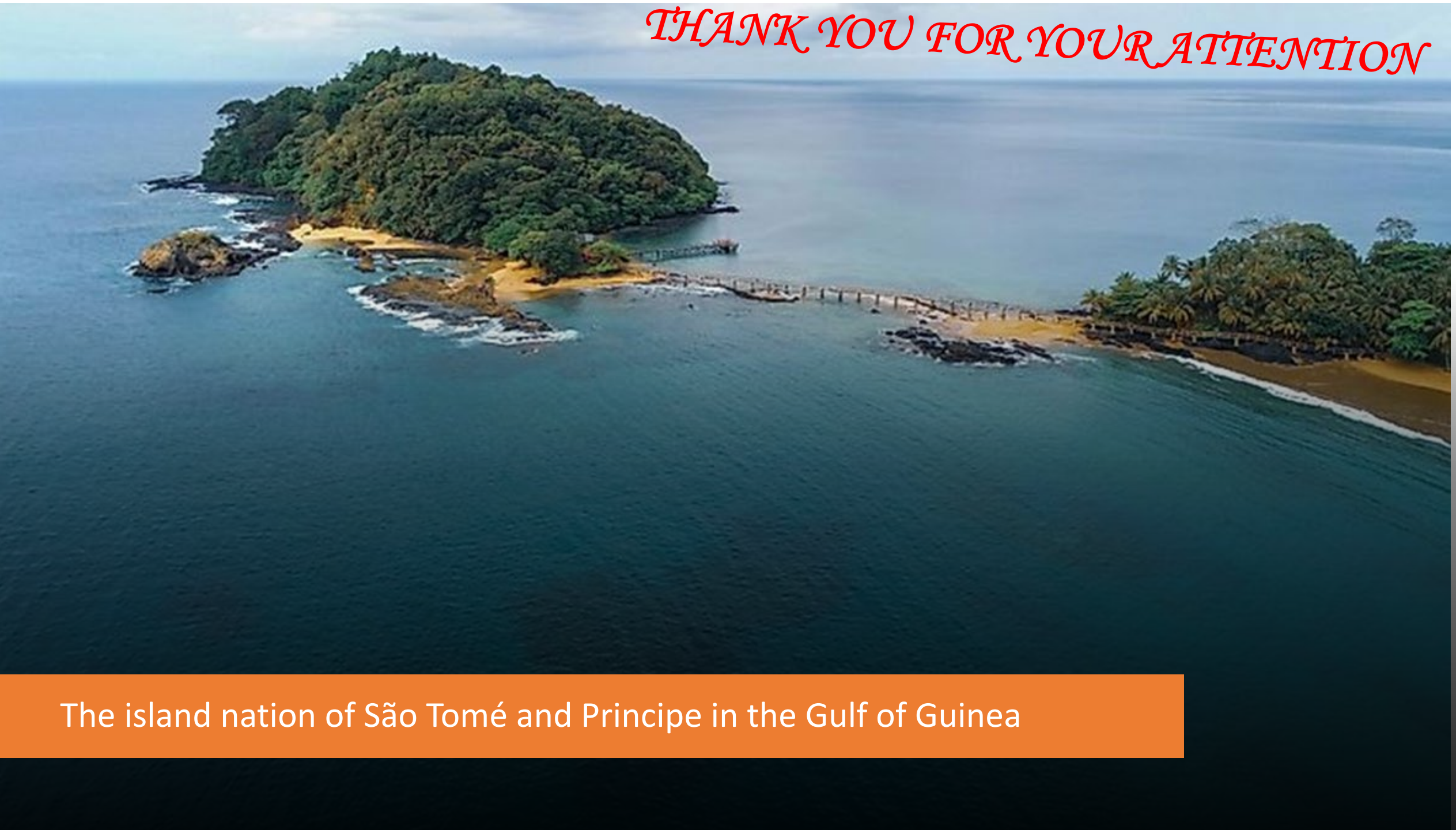

The island nation of São Tomé and Principe in the Gulf of Guinea

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