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INDIAN OCEAN RIM ASSOCIATION

IORA YOUTH PUBLICATION

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First Edition

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Plastic marine debris: The Silent Killer - Implications for Indian Ocean Rim Association (IORA) countries and the way forward.

Winner of the 2022 YWC Edition: Mr. MUSTUN Zuhayr, Mauritius

Abstract

With global population set to reach a whopping 10.9 billion by the end of this century (Roser, 2019), the natural environments surrounding mankind are expected to be continuously plundered of their ephemeral resources, which signals accumulated pressures on the already heavily threatened ecosystems, unless rapid and adequate measures are set in place by stakeholders across the board to curb the devastating effects of human activities on earth. One such anthropogenic challenge, which has raised itself to the notorious status of a global problem throughout the decades, is unarguably marine debris. Essentially, marine litter consists of items that have been deliberately discarded, unintentionally lost, or transported by winds and rivers, into the sea and on beaches (EU, 2010). While marine debris have been recognized as a highly complex and multi-dimensional phenomenon with far-reaching adverse impacts, marine biota bears the biggest brunt of this ecological nuisance. Bearing testimony to this, is the bulk of videos present on social media platforms and notably on YouTube, where random beach-goers, divers, rescue teams and environmental activists are seen helping entangled seals in ropes or turtles having their limbs stuck in plastic buckets and even whales swimming with fish nets wrapped tightly around their waist. Such a miserable plight for many marine faunae, are the visual consequences of marine debris, which show how harmful haphazard and irresponsible littering can be. Given the nomadic nature of plastic marine debris, they move across vast oceanic regions, from shores to shores and possibly from continent to continent, thereby reaching Areas Beyond National Jurisdiction (ABNJ), and hence it is impossible to trace back their sources and infer accountability. Nonetheless, this very capacity of aimless navigation and movement make marine debris a global responsibility since they can make any marine ecosystem, coastline, beach or harbour port their permanent residence. Extending over 30% of the global ocean area, and rimmed by 36 littoral and 11 hinterland countries, the Indian Ocean is a cradle of biodiversity which is home to 30% of the global coral reef cover, 40,000 km^2 of mangroves, some of the world's largest estuaries, and 9 large marine ecosystems (Wafar et al., 2011). The Indian Ocean Rim Association (hereafter IORA) hosts a membership of 23 nations bordering the Indian Ocean, whose geographical location engenders a natural exposure to marine debris. The literature has achieved consensus that coastal nations, in this case IORA member states, are doubly concerned by the plastic debris conundrum, since one hand they are increasingly vulnerable to marine debris drifting from off-shore sources, and on the other hand, with their extended coastlines, they are heavily responsible for the leakage of plastic from terrestrial sources to the open seas.

1. Introduction.

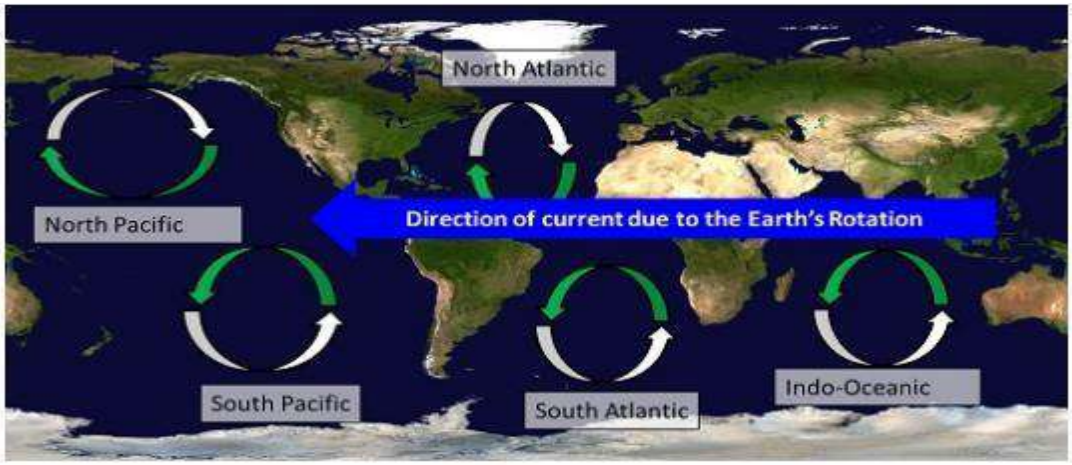
1.1 Plastic marine debris: A global mess.

According to Tangora Blue Foundation, an NGO in Australia which is at the fore against marine debris prevention, over 7 million tons of plastic find their way into the oceans annually, representing 8 million pieces per day, and amount to 3 times as much as

rubbish as the weight of fish caught in a year. With such an impressive volume of plastic pieces and garbage entering the open seas, it is clear that plastic consists the largest share of marine debris. Marine litter get disposed off either from inland sources or from activities occurring on seas, and these get whirlpooled in the gigantic oceanic gyres, as shown in Figure 1 below, which act as carriers for the debris through water currents, and finally buddle up in a large "garbage patch" or "plastic soup". It is extremely likely that such patches exist in every ocean, but by far the largest and most documented one is the "Great North Pacific Garbage Patch".

The mammoth floating debris island is located between Hawaii and California and is the biggest oceanic junkyard for marine plastic litter of all sorts, and it is estimated to contain 1.8 trillion of plastic, weighing around 80,000 tons (The Ocean Cleanup, 2021). With its impressive size which is 3 times that of France (Lebreton et al., 2018), the "Great North Pacific Garbage Patch" is unquestionably one of the foremost examples of how human induced activities have the dramatic potential of creating a vicious entity, which has the ability to sting back, given the plentitude of negative effects marine debris can have on marine ecosystems and even on human beings.

Figure 1. Oceanic gyres.



Source: (https://askabiologist.asu.edu/anatomy-open-ocean).

2. Plastic marine debris and IORA member states: How worried should we be and what does it entail for IORAs' Blue Economy?

The IORA recognizes the potency of plastic marine debris as an ecological and environmental stressor within the Indian Ocean region. With the conjoint burdens of responsibility and vulnerability, IORA member states have been subject to research in order to uncover the sources of and the potential outcomes of plastic marine debris in that part of the world. The table below, synthesizes some of the main reported findings or highlights (extracts) from recent publications based on studies on each IORA member state.

Table 1. Main findings and highlights from some publications across IORA member states.

Author(s)/year	Paper title	Country	Main findings and highlights
Verlis et al., (2013)	*Ingestion of marine debris plastic by the wedge-tailed shearwater Ardenna pacifica in the Great Barrier Reef, Australia.*	Australia	• Plastics were found within sampled chicks which indicate that adults of this species are taking up plastics and feeding it to their young either directly or indirectly.
Hossein et al., (2019)	*Microplastics in fishes from the Northern Bay of Bengal*.	Bangladesh	• A total of 443 micro plastic items were found in the intestines of Bombay-duck, White Bombay-duck and gold-stripe sardines, averaging in the range of 3.20–8.72 items per species. Such findings provide evidence for possible human contamination through the food web.
Lachmann et al., (2017)	*Marine plastic litter on small island developing states: Impact and measures.*	Includes Comoros	• SIDS are exposed to concentrations of plastic litter that are disproportionate to their own consumption and populations. • SIDS are believed to be exposed to long-range transported marine plastic litter more than many other coasts.
Cartraud et al., (2019)	*Plastic ingestion in seabirds of the western Indian Ocean.*	France/Reunion	• 50% of the birds analyzed had plastic in their gizzard or proventriculus, with strong variation in relation to species and age. • Results show a higher number and a higher mass of plastic particles in juvenile Barau's petrels, compared to adults and a higher mass of plastic particles in juvenile tropical shearwaters compared to adults. These differences are most probably due to food regurgitation from the adults to feed the chicks.
Kumar et al., (2016)	*Preliminary study on marine debris pollution along Marina beach, Chennai, India.*	India	• The major contributing factor for the debris abundance in Marina beach is the local recreational activity. • Most of the debris accumulated is of local origin and indicates its inflow due to human activities and through storm rather than the ocean deposition.

Suteja et al., (2021)	*Stranded marine debris on the touristic beaches in the south of Bali Island, Indonesia: The spatiotemporal abundance and characteristic.*	Indonesia	• Plastic category was the most common marine debris in all sampling periods, both by abundance and weight. • It seems that recreational and tourism activities were making a significant contribution to marine debris.
Mehdinia et al., (2020)	*Identification of microplastics in the sediments of southern coasts of the Caspian Sea, north of Iran.*	Iran	• Sampling sites with higher micro plastic concentration were located in the regions with higher level of recreational and tourism activities. • The Caspian Sea's hydrodynamics facilitate the distribution of micro plastic as floating particles on water and get entrapped in the sediments toward Iranian coasts in south of Caspian Sea.
Okuku et al., (2020)	*Marine macro-litter composition and distribution along the Kenyan Coast: The first- ever documented study.*	Kenya	• A significant amount of litter encountered in the beaches was of local origin (88%). • Low occurrence of foreign products was reported on beach areas despite fairly high tourism activities. This could be an indication that beach hotels are running a relatively efficient waste management system.
Gjerdseth, (2017).	*Quantitative Analysis of Debris and Plastic Pollution on Beaches in Northern Madagascar.*	Madagascar	• The general trend for the debris recorded at the backshore seemed to originate from the nearby inhabited areas due to poor or lacking rubbish disposal sites and infrastructure, unconscious or conscious dumping, and dispersal by wind.
Fauziah et al., (2015)	*Plastic debris in the coastal environment: The invincible threat ? Abundance of buried plastic debris on Malaysian beaches.*	Malaysia	• Findings indicated that beach activities are contributing to plastic debris deposition. • The presence of pellets on the beaches highlights the fact that the coast is susceptible to the influence of shipping activities from which pellets would most likely be sourced.

Stelfox et al., (2020)	*Minimum drift times infer trajectories of ghost nets found in the Maldives.*	Maldives	• Ghost nets drifting less than 30 days remained inside the exclusive economic zone of the Maldivian archipelago highlighting potential illegal, unreported and unregulated fishing activities. • For drift times longer than 10 days the simulations suggest that purse seine fisheries (Korea, Mauritius, Philippines, Spain, France and Seychelles) and gill nets from Sri Lanka are 'high k' fisheries (with regard to possible source of lost nets).
Seeruttun et al., (2021)	*First assessment of anthropogenic marine debris in mangrove forests of Mauritius, a small oceanic island.*	Mauritius	• The uninhabited mangrove site (Ferney) has almost no human activities nearby yet pollution from anthropogenic debris prevailed. • Most debris originated from shoreline and recreational activities.
Pereira, (2006)	*National overview and assessment on marine litter related activities: Mozambique*	Mozambique	• Marine littering in Mozambique has been rather neglected both in terms of research and management. • Plastics, aluminium cans and glass are the main items found, while in areas under oceanic influence tar pellets and high-density foams are also found, from high-seas shipping activities.
van Hoytema et al., (2020)	*Fishing gear dominates marine litter in the Wetlands Reserve in Al Wusta Governorate, Oman.*	Oman	• 58.1% (by weight) of the litter sampled consisted of discarded or lost fishing nets. • The discarded or lost fishing nets observed were of both "woven" construction and monofilament nets which are illegal in Oman.
Dunlop et al., (2020)	*Plastic pollution in paradise: Daily accumulation rates of marine litter on Cousine Island, Seychelles.*	Seychelles	• Over the 10-year study period there was a significant increase in the amount of litter deposited on Cousine Island's beach. • The vast majority of the bottles were from Asia, presumably mostly dumped by ships, many of the bottles were also from brands that were bottled and distributed within the Seychelles.

Nor et al., (2014)	*Microplastics in Singapore's coastal mangrove ecosystems.*	Singapore	• Micro plastics were found at all the seven mangrove sites sampled in Singapore. • Plastic bags, food wrappers, drink cartons and plastic bottles found between the aerial roots of the mangrove plants. This highlights the intensity of recreational and leisure activities in nearby parks which become pathways for litter to reach the mangrove areas.
van der Mheen et al., (2020)	*Beaching patterns of plastic debris along the Indian Ocean rim.*	Includes Somalia	• Simulations show that Somalia and the Maldives are consistently affected by beaching particles, even though they have no or few river sources of plastics of their own. • Somalia is among the top 15 countries affected by beaching particles in all simulations.
Chitaka, & von Blottnitz, (2019).	*Accumulation and characteristics of plastic debris along five beaches in Cape Town.*	South Africa	• Food and beverage related items were the most frequent type of plastic litter across all beaches, ranging from 40%–63% of all plastic debris by count. • Nine of the top ten identifiable items were associated with foods commonly consumed on-the-go, including polystyrene packaging, snack packets and straws.
Dharmadasa et al., (2021)	*Microplastics pollution in Marine Protected Areas of Southern Sri Lanka.*	Sri Lanka	• At Bundala National Park, micro plastics were recorded in all turtle nesting areas with high abundance, also in the dune area where turtles tend to nest. • Most of the micro plastics in Bundalal National Park are probably arriving on ocean currents, while in Hikkaduwa National Park local input of micro plastics appear to be dominant.
Maione, (2021)	*Quantifying plastics waste accumulations on coastal tourism sites in Zanzibar, Tanzania.*	Tanzania	• The results show that plastic litter surveyed at one of the sampling site was primarily linked to tourism consumption. • Plastic was a persistent pollutant on all sites during the high tourism season.
Pradit et al., (2020)	*Marine debris accumulation on the beach in Libong, a small island in Andaman sea, Thailand.*	Thailand	• The debris from shoreline and recreational activities was found the most prevalent of followed by fishing and sailing activities.

Yaghmour et al., (2018)	*Marine debris ingestion of green sea turtles, Chelonia mydas, (Linnaeus, 1758) from the eastern coast of the United Arab Emirates.*	UAE	• The results show that debris was found in the esophagus of 50% of sampled turtles. • The plastics encountered by the turtles examined are mostly composed of threadlike user plastics (rope monofilaments, weaved plastic bag monofilaments, fishing line and fishing nets) and sheet-like user plastics (plastic bags and food wrapping)
Al-Shwafi, & Ahmed, (2011).	*Litter on the beaches of the Red Sea of Yemen.*	Yemen	• Most of the litter is plastic, including food bags, oil and water bottles, bait, bags, and vehicles tires. • Most of the litter on the beach come from the sea, which indicates sea born pollution from the ships, due to the heavy traffic and from the nearby fishing vessels.

Source: (Author's compilation).

The above brief literature review gives an insightful eye into the realm of plastic debris in aquatic environments and the extent of its consequences within the IORA community, and the findings are in accordance to what has been equally revealed in other studies in different regional contexts. In fact, as can be observed, beachgoer or tourism recreational activities are one of the most prevalent ways through which beach littering potentially metamorphoses into marine debris [refer to table above for: India, Iran, Indonesia, Kenya, Malaysia, Mauritius, Singapore, South Africa, Tanzania and Thailand] especially in countries where the coastal line is vast and represent a substantial component of economic activities (Pawar et al., 2016; Portman et al., 2020). Moreover, an increasing stream of studies have echoed the possibilities for illegal rubbish dumping by passing ships in the open seas [refer to table above for: Malaysia, Maldives, Mozambique, Oman, Seychelles, Thailand and Yemen]. To ascertain this, Ryan et al., (2016) investigated the bottles drifting on the coast of Inaccessible Island, an inhabited island situated in Central South Atlantic Ocean. It was inferred from their samplings that most plastic bottles were newly manufactured and were not much fouled by goose barnacles, which means that the littered items have not been loitering for a long time in seawater; reinforcing the hypothesis that they come from nearby commercial vessels or cruise ships.

Furthermore, when speaking of derelict fishing equipment, its release is deemed to be more pronounced in cases of Illegal, Unreported and Unregulated (IUU) fishing due to rampant opportunistic and unethical practices. Eventually, such plastic debris are hazardous to marine organisms through what is popularly known as "ghost fishing", whereby aquatic faunae continue to get caught in discarded fishing cages, nets, ropes and other lost fishing tools. Similar confirmations can be gathered within a panel of IORA member states, such as Malaysia, Maldives, Oman, Seychelles, Thailand and Yemen. The recent work of Baneli et al., (2020) provides conclusive results on the lethality of "ghost fishing" on marine environments, and present evidence of increased coral mortality due to entangled fishing lines, which consequently impacted feeding frequency attempts in certain herbivore fish species.

While research endeavours studying the emergence and possibilities for the sources of

marine debris are critical, assessing the bearing of littering on marine biodiversity in fact complements the understanding on the life cycle of plastic from "bin to biota". The ramifications of marine debris, notably plastic, especially in the context of aquatic life, are extensively catalogued in a broad body of scientific reporting. Ingestion and entanglement due to plastic marine debris pose considerable threats to aquatic wildlife with dire consequences jeopardizing their survival, including reduced mobility leading to failure in catching prey and increasing possibility of being ambushed, starvation, intoxication, suffocation through digestive or respiratory track blockage, infection and eventually compounded effects trigger un–natural deaths. Overall, long term serious implications arise when the aggregate repercussions are considered from the lenses of reproduction and fertility, which foretell a dwindling of species population especially within already frail environments and among most at risk categories. These deleterious effects on surrounding fauna have been documented in the studies of Verlis et al., (2013), Hossein et al., (2019), Cartraud et al., (2019) Dharmadasa et al., (2021) and Yaghmour et al., (2018) [refer to table above] for IORA member states such as Australia, Bangladesh, France/Reunion, Sri Lanka and the UAE. Simultaneously, scholarly interests have sparked further investigations, in view to probe the routes by which humans might face the toll of marine debris, especially in the form of micro or nano-sized plastic particles. Digged deeper, matters related to marine debris as a potential hazard to human health suggest that chemicals and pollutants present in plastic debris can biomagnify and potentially grow in potency at various trophic stages of the marine food web, where subsequently the toxic effects may reach humans through consumption of those contaminated or chemically bloated marine species. The results of Hossein et al., (2019) bring validity to this, when micro plastics were found in the intestines of highly consumed fish species like Bombay-ducks, White Bombay-ducks and gold- stripe sardines. Consequently, anthropogenic and environmental pressures related to plastic debris formation, accumulation and impact are countless among IORA member states, especially for SIDS like, Comoros, Reunion, Maldives, Mauritius and Seychelles, who in reality contribute the least in terms of littering.

The pernicious nature of plastic marine debris is no longer speculative, and its consequences are multi- directional within a larger conceptual sphere known as the Blue Economy, which is one of the cornerstone of IORAs' Focus Areas. Blue Economy means the use of sea and its resources for sustainable economic development (Bari, 2017), and is continuing to garner momentum amidst political, scientific and entrepreneurial communities. In order to effectively harness the cornucopia of resources and promises offered by the Ocean Economy, the IORA has prioritized six pillars, as shown in Table 2. However, the issue of plastic marine debris is strongly associated with all the subsets within the Blue Economy, either directly or indirectly, as elaborated in Table 3.

Table 2. IORA Priority Pillars in the Blue Economy

1. Fisheries and Aquaculture
2. Renewable Ocean Energy
3. Seaports and Shipping
4. Offshore Hydrocarbons and Seabed minerals
5. Marine Biotechnology, Research and Development

6. Tourism

Source: (IORA's website).

Table 3. Association of Blue Economy pillars with plastic marine debris.

IORA Blue Economy priority pillars	Association with plastic debris	Evidence
1. Fisheries and Aquaculture	1. Fisheries and aquaculture have been shown to be significant drivers of plastic marine debris.	1. Sea-based activities (mussel farming and salmon aquaculture) are responsible for most FMD (Floating Marine Debris) in the fjords, gulfs and channels of southern Chile for the period 2002 to 2005 (Hinojosa et al., 2009).
2. Renewable Ocean Energy	2. Intensive activities on oceans can potentially leak plastic into aquatic ecosystems.	2. All types of boats, ships and offshore industrial platforms are potential sources of marine debris (Pawar et al., 2016).
3. Seaports and Shipping	3. Widespread maritime trade and traffic can promote illegal waste dumping in seas.	3. Most foreign PET (Polyethylene Terephthalate) drink bottles found on South African beaches have been discarded by ships, since many of these items were crushed to expel air to be resealed again, a practice common in ships to reduce volume of trash onboard (Ryan et al., 2021)
4. Offshore Hydrocarbons and Seabed minerals	4. Extensive seabed exploration and offshore activities can cause plastic items to consciously or unconsciously reach oceanic areas.	4. Undersea exploration and resource extraction also contribute to marine debris (Pawar et al., 2016)
5. Marine Biotechnology, Research and Development	5. Plastic marine debris is a burgeoning area of research with tremendous opportunities for research and development, both for scientific advancement and policy formulation.	5. The current understanding of plastic fluxes, pathways and fate is incomplete (Van Sebille et al., 2020). Research and understanding are presently narrow in plastic debris as vectors for pathogen and parasites ("Plastisphere" centered-research).
6. Tourism	6. Tourism and recreational activities are heavily blamed for coastal littering and marine environment pollution.	6. Sediments in public tourist hotspots areas are characterized by higher magnitudes of micro plastics (Rahman et al., 2020).

Source: (Author's compilation).

Hence, it is evident that plastic marine debris have significant implications for IORAs' core objectives as outlined in the IORA charter and the sub pillars within the Blue Economy agenda. For instance, the promotion of maritime transport, fisheries trade and aquaculture (objective 2) can be detrimental to the regions' marine environments, especially when increased connectivity becomes a pathway for marine debris to flow from one-member state's oceanic economic activities, to another. This has been evidenced by way of spatial simulations by Stelfox et al., (2020) in the Maldivian scenario which suggest that purse seine fisheries and gills nets have origins outside Maldives' territories [refer to Table 1]. At the same time, trade liberalization and enhanced flow of goods across oceanic routes (objective 3 and objective 4), might be vectors for illegal dumping by passing vessels in the open seas, [refer to Table 1 and Table 3].

Thus, it is sine-quanon that the right balance between plastic marine debris formation and the pursuit of ambitious Blue Economy objectives is maintained effectively and efficiently, whereby oceanic sustainable development do not occur at the cost of marine environments, and trade-offs are maintained at the minimum level possible. In other words, plastic marine debris should not be a resultant of the adventurous endeavours in the oceanic kingdom, for marine pollution on one side and environmental sustainability on the other side would mean an incoherent discourse. In fact, strategy and policy paths for marine debris and Blue Economy should be unified and comprehensive. Congruently, the IORA commenced the first workshop in December 2021 to initiate a declaration and an action plan to address the concerns related to plastic marine debris, under the overarching thematic of the Blue Economy.

3. Recommendations and conclusion.

The literature review has unveiled the protagonist role played by off-shore sea activities such as fisheries, estuaries, trans-oceanic shipping and trade, in dispersing marine litter either consciously or unconsciously, and the resulting consequences do not only endanger nearby biota, but also faraway lands and ecosystems [refer to Table 1 for Maldives and Somalia]. Efforts to meet IORAs' Blue Economy objectives relating to Fisheries and Aquaculture, and Seaports and Shipping should be accompanied by measures to curb the possible negative externalities, more so in the context of IUU fishing. The different concerned functional bodies of the IORA, namely: the Working Group Maritime on Safety and Security, the Working Group on the Blue Economy and the Core Group on Fisheries Management are expected to synergize to address the marine litter problem. For instance, different indices can be created to measure the level of IUU fishing, the regions with highest risk of marine debris formation and those most under marine litter threats. This will serve as baseline to sectorialise specific zones across the Indian Ocean rim, where eventually appropriate measures can be adapted for each area of focus. For example, maritime zones with the highest index of IUU fishing will entail policies such as rigorous control, inspection, certification and marking of vessels to deter the prevalence of marine debris. While those areas estimated to be under threats of exogenous marine debris, the response would be conservation and preservation of aquatic ecosystems through protected marine parks or artificial reefs. Furthermore, tourism and recreational activities are despicably a catalyst to beach litter [refer to Table 1] and for that reason,

comprehension of beachgoer behaviours, level of understanding, social drivers and perceptions of littering need to be assessed by IORA's Core Group on Tourism. Social experiments and observations can unveil underlying aspects of marine littering on coastal areas, such as frequency, degree of impact and the barriers to impactful marine litter sensitization and education campaigns.

Moreover, the recent UNEP 2021 report titled: "From Pollution to Solution: A global assessment of marine litter and plastic pollution", recommends the mapping of the full life cycle for key plastic products from source to the sea with environmental, health, social, economic and food safety impacts. With this in mind, the IORA can foster a grouping of scientific resource persons to systematically document the sources, impacts and associated risks of marine litter within the Indian Ocean region. This will aid in the building of an extensive master database for the entire region, especially useful for the identification of research gaps. The rationale is that research on plastic marine debris is scarce for the Indian Ocean region (Gall and Thompson, 2015). Also, the search for the Indian Ocean "garbage patch" can be a vital data source for the understanding of litter origins, toxicity, persistence and threats. With scientific research and development as one the pivotal axes of IORA's Blue Economy concept, the Indian Ocean Academic Group and the Working Group on Science Technology and Innovation are significantly concerned by evolving areas of interests for research.

For instance, understanding is presently narrow in plastic debris as vectors for microbes and parasites, where human pathogens such as bacteria can raft on plastic pieces and form a colony, known as the "plastisphere" which serve as a thriving ground for the transmission of infections and diseases to marine and land organisms, to be then passed on to humans [Barboza et al., (2018); Vethaak & Leslie, (2016)]. Other potential areas which beckon investigations include: marine debris formation in the seabed and impact at the benthic level, demographic alterations of species and movement of plastic pollution across the trophic stages amongst others. The Indian Ocean region offers a remarkable territory for the answering of those scientific queries.

Conclusively, marine littering is definitely one of the most pressing issues of present times and in many sense is a threat-multiplier across marine environments. Hence, there is an urgent call for action which engages the wider society in considering a more environmentally-friendly lifestyle. At the same time, regional coordination and sharing of scientific resources to address key research gaps are critical in promoting cleaner, more sustainable and pristine aquatic biosystems. Noteworthy, the tricky nexus between IORA's Blue Economy and plastic marine debris would require offsetting measures, to balance off any probable adverse results from oceanic development.

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Preventive Measures for Climate Shocks Affecting the Indian Ocean: Role of IORA

Second Winner of the IORA YWC: Mr. Sharad Mitra, Bangladesh

In today's growing world, climate change has become a serious issue. From natural disasters, to agricultural detriment, it has been posing threats to humanity's basic sources. More than anything else, Climate Change has been affecting oceans. As human activities induce greenhouse gas into the environment, the ocean has helped moderate the effects, by absorbing more than 90% of excess heat and approximately 30% of excess carbon emissions. In this essay, the particular focus will be on the Indian Ocean. The Indian Ocean is the third-largest of the world's five oceanic divisions, covering 70,560,000 km² or approximately 20% of the water on Earth's surface. The ocean stretches 6,200 miles between the southern tips of Africa and Australia. The Indian Ocean also contributes to world trade. Oil deposit accounts for 40% of world production. According to some reports, the Indian Ocean is warming at a higher rate than other oceans. This means the relative sea level can also increase over the regions. The first part will consist of the problem definition, while the second part will explain the proposed solution, as well as IORA's involvement with its mission.

The primary problem due to Greenhouse gas is the problem of Ocean Acidification. Ocean Acidification occurs due to excess amounts of Carbon Dioxide in the air. As the ocean absorbs more carbon dioxide, the pH of the water decreases, making it more acidic. This is a problem, especially in the Indian Ocean, since it's a big threat to the survival of marine organisms. It also hinders coastal settlements, since lots of small islands rely on the Indian Ocean for their basic needs. Next, extreme CO2 emissions lead to reduced oxygen levels. Warmer ocean surfaces lead to ocean stratification, which prevents the ocean from mixing freely, thereby limiting oxygen delivery to the surface. This not only reduces oxygen for humans, but also marine creatures living close to the surface. Some affected species include those that we eat or depend upon for livelihood. Oxygen is vital for the survival of animals. Scientists estimate that around 50% to upto 80% of the oxygens come from under the ocean. Third, Marine Heatwaves are another threat. An increased marine temperature disrupts the ecosystem, hampering marine life. Some creatures need to stay at a certain temperature to stay alive. Hot climate is often unsuitable for many organisms, killing them in the process. Changing ocean temperatures and ocean chemistry threaten global food security, particularly devastating to developing countries that heavily depend on seafood as a vital source of protein. Fourth, Marine Debris. Marine Debris is marine littering or human created waste that goes to the ocean, whether it be deliberately or accidentally. Marine debris injures and kills marine life, interferes with navigation safety, and poses a threat to human health. Our oceans and waterways are polluted with a wide variety of marine debris ranging from soda cans and plastic bags to derelict fishing gear and abandoned vessels. Lastly, rising sea levels are an issue. Seal level rising causes erosion of beaches as well as flooding in coastal areas. Countries such as Bangladesh are heavily influenced due to the flooding.

There can be many proposed solutions towards helping to save the environment. In the next few paragraphs, a wide variety of solutions will be explored, while in the following ones a comprehensive way of how IORA can fight will be proposed.

Number one on the list is adaptation. The healthier an ocean is the better chance it has of surviving and rebounding from climate change impacts. Adaptation planning includes trying out alternative livelihood, food sources, and better preparing locals for impacts. Adaption is really important, since the environment is constantly changing and the atmosphere is shifting. My second point is Mitigation. Mitigation can be performed in various ways, including the enhancement of Marine ecosystems, development of “Blue Carbon” complex markets, as well as ocean renewables, depending on the location. Marine ecosystems can store a significant amount of carbon, which could help offset carbon emissions while industries transition to zero-emission practices. Third is protection. Ocean protection enables marine ecosystems to better endure ocean changes, such as ocean acidification, reduced oxygen and increased heat, so these systems can continue to provide the resources we depend on to live. Protecting marine and coastal ecosystems are therefore crucial. Fourth, there’s an option of Strengthening Resilience. As the private sector evaluates supply chain vulnerabilities, climate risk exposure and the value of long-term resilience, the benefits of healthy coastal ecosystems will shine. Developing more coastal ecosystems, from mangroves to coral reefs, helps to strengthen our own resilience to climate change impacts, giving us more access to natural defenses. Lastly, the promotion and support of sustainable fisheries. Sustainable fisheries is managing a complex level of control so that it guarantees ocean population and freshwater wildlife for the future. Sustainable fishing avoids overfishing, as well as loss of marine biodiversity. Loss of marine biodiversity is a serious threat, since more than 3 billion people in the world live off of seas and coasts. Sustainable fishing also helps protect marine fauna, avoids waste, contributes to food security, as well as reduces pollution. As evident through this paragraph, there are many ways to use the Indian Ocean to our advantage in helping fight Climate Change and preserve the quality of the ocean.

One of IORA(Indian Ocean Rim Association)’s primary priority and focus areas is Disaster Risk Management. The Indian Ocean Region is sometimes called “World’s Hazard Belt", since it is prone to natural and manmade disasters. According to the website of IORA, “Natural disasters under the group of Climatological (cyclones and droughts), Geological and Tectonic (earthquakes and tsunamis) and Hydrological (floods and tidal surges) origins are very common and recurring phenomena in the region.” As reiterated multiple times in this essay, a lot of life, both animals and humans, depend on the well being of the Indian Ocean. Therefore Disaster management is a very important goal. Disaster Risk Management also means preventing the problem from occurring in the first place.

Another of IORA’s focus areas is the “Blue Economy”. Oceans cover two thirds of the global surface, in turn providing a substantial part of the global population with food and livelihood. According to their website, “The objective of the Blue Economy is to promote smart, sustainable and inclusive growth and employment opportunities within the Indian Ocean region’s maritime economic activities.”

Now for the comprehensive and proposed solution. Based on everything that has been mentioned above, it is evident that the need for the Indian Ocean is high. Lives and economies heavily rely and depend upon it. Therefore it is really important to look after the wellbeing of the ocean. This is where IORA comes in. My proposed solution is developing a networking system that will increase the Blue Economy, as well as

cultivate ocean technology. Although the development of the Blue Economy and ocean technology are big projects, IORA can certainly help in advancing. For example, IORA can help put limits on certain activities to help preserve the ocean. Restrictions can be put in place in certain areas of fishing. If there is overfishing, there can be a restriction to prevent fishing there for a while. Moreover, there can be an increase in innovative technology such as Bioprospecting, Seabed mining, Marine Life protection, or Coastal Renewable Energy.

Climate Change is a big global problem. However, it is not possible for IORA to control climate change. However, what it can do is control the effects caused by global warming and climate change, in turn limiting the harm caused to the Indian Ocean. As mentioned above, modern innovative solutions are one aspect that might help. Coastal Renewable Energy sources, for example, are great ones. Moreover, developing the Blue Economy includes protecting ocean wildlife such as sharks and coral reefs. Coral reefs occur in a lot of countries and territories and whilst they cover only 0.2% of the seafloor, they support at least 25% of marine species and underpin the safety, coastal protection, well being, food and economic security of hundreds of millions of people. Scientists estimate that some 50-80% of the oxygen production on Earth comes from the ocean. The majority of this production is from oceanic plankton; drifting plants, algae, and some bacteria that can photosynthesize.

The Blue Economy also provides a lot of opportunities. Shipping and Port facilities, for example. 80% of global trade by volume, and over 70% by value, is carried by sea and handled by ports worldwide. Fisheries. Fishes account for 15.7% of the annual protein consumed. Through following the model of Blue Economy, fishing optimally can benefit both in profit, as well as sustainability. Then, there is Aquaculture. Aquaculture is breeding, rearing, and harvesting fish and other sea organisms in various water environments. Next, we have tourism. Tourism is of key importance to many developing countries. For some countries and small islands, tourism can be their main source of income. Through the model of Blue Economy, there is increased international tourism. Moving on, there is energy. In 2009 offshore fields accounted for 32% of worldwide crude oil production and this is projected to rise to 34% in 2025. Furthermore, Biotechnology also comes with the Blue Economy. Biotechnology includes a vastly different amount of areas; from Bioprospecting to Ocean Engineering to Marine Technology. Bioprospecting refers to the finding and creation of medicinal drugs from plants and animals. Submarine Mining is another aspect, since the world is “gearing up for the exploration exploitation of mineral deposits on and beneath the sea floor.” Last but not least, the Blue Economy presents us with the opportunity of governance. Each sovereign country is responsible for its own resources and sustainable development. A key aspect that guarantees the success of these kinds of international collaborations for the Blue Economy is research. Since the Blue Economy is a relatively new concept, plenty of scientific research and technical advancement are being funded. This opens a new door, since a lot has yet to be explored.

Furthermore, another way IORA can help to save the environment is raising awareness. With its 23 member states, some of which are heavily populated, IORA can help promote action. Updating the member states with current news, as well as the statistics of the Indian Ocean is useful, in the sense that can raise people’s concern.

Another way of promotion is by using social media and technology. In today's world social media can be a powerful thing, considering the vast amount of users. According to a report, over 3.6 billion people in the world are connected in some form or other social network. Promoting campaigns and raising awareness through platforms such as Facebook, Instagram, Twitter, and Youtube, can also help meet the goal.

In conclusion, the Indian Ocean is one of the "organs" of our mother earth. Without the wellbeing of the Indian Ocean, millions, if not billions of people will suffer. Ocean protection is not only important, but vital to our survival. Throughout the essay, a lot of problems, such as ocean acidification, reduced Oxygen levels, excessive heat, and marine debris. To top it all off, there is the problem of Climate Change, which is one of the, if not the biggest threat to the environment in today's world. Next, a few possible solutions were discussed. Adaptation is a big one, followed by Mitigation, Protection, Strength Resilience, and Sustainable Fisheries. Then, a comprehensive plan of how IORA(Indian Ocean Rim Association) can help tackle these problems was discussed. The highlight was developing a more Blue Economy, as it comes with a lot of benefits, and opens up new opportunities. With twenty three, mostly high populated, member states, IORA can campaign and raise awareness to a ton of people. Social Media can also help in raising awareness, due to the large number of users. Raising awareness is an important task, since a lot of people are still under-educated about the Indian Ocean. This point is crucial, especially those sharing borders with the ocean. I would like to conclude by saying that we are faced with an early warning. It's not too late for action, however, if we don't act now, we suffer later. The choice… is ours to make!

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The impacts and mitigations of Marine plastics in the Indian Ocean region

Third Winner of the YWC, Mr. Eliya Peter, Tanzania

Abstract

The dramatic increase in human population and the unsustainable use of plastic products as well as lack of proper waste management have contributed to the accumulation of plastics in the marine environment. In 2014, The Indian Ocean was ranked second following the North Pacific Ocean with an estimated total count of 130.0 X 10^{10} pieces and weight of 591.3 X 10^{2} tons. The accumulation of marine debris in the Indian Ocean has become an urgent environmental issue as it poses a threat to the marine ecosystem and to people living across the Indian Ocean region. Some of the harmful impacts associated with marine plastics include; loss of biodiversity, alteration of water quality, socio-economic losses and public health concerns. In this paper, the proposed mitigations to overcome theon-going trend of plastic pollution in the Indian Ocean have been put forward addressing how Indian Ocean Rim Association (IORA) should work in collaboration with other respective bodies and agencies in ensuring the protection of the marine environment as well as reducing the impacts posed by plastic pollution. The following have been proposed, (1) raising the public awareness and education on the potential dangers of marine plastic pollution and the necessary actions to be taken; (2) creating policies that ensure systemic changes; (3) adopting waste bank management approach; (4) Ocean clean-up strategies; (5) reducing plastic wastes through recycling of wastes and lastly (6) converting unrecyclable wastes to produce energy.

***Keywords*:** Marine debris, Indian Ocean, Plastic pollution, Harmful effects, Mitigations

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Introduction

Marine debris refers to any synthetic material or object thrown, abandoned or disposed in the marine environment. It can be deliberately in a manner as dumping of waste materials in the ocean or fortuitous release of objects through the action of wind, water ways or natural disasters (Sheavly, 2007). Floating plastics are considered to be the most polluting items in the ocean that pose a threat to the marine life and ecosystem (Thevenon et al., 2014).

Plastics are synthetic or semi-synthetic organic polymers (made from fossil-fuel based chemicals and natural gas or petroleum) which are long and high molecular weight molecules constructed from units called monomers. The widespread use of plastics is as a result of the plasticity nature that makes plastics capable of being extruded, molded or pressed into different types of solid objects of different shapes with regard to various purposes (Thevenon, et al., 2014). Plastics have widely been used in construction, packaging, electronics and automotive sectors.

According to Worldometers, (2022), as of January 2022, the human population was 7.9 Billion. The tremendous and dramatic increase in human population has brought about the high demand for plastic production, of which has brought a widespread environmental problem due to their bulk presence as a

result of durability and very slow degradable property which makes them persist in the environment for centuries as waste (Barnes, et al., 2009).

Plastic pollution has become an urgent environmental issue affecting the world. In their study, Eriksen et al., (2014) postulated that the Indian Ocean ranks second following North Pacific Ocean in plastic loading with an estimated total count of 130.0 X 10^{10} pieces and weight of 591.3 X 10^{2} tons. Wang et al., (2018) categorized plastics on basis of their size in which >1m is mega-plastic, <1m is macro-plastic, <2.5cm is meso-plastic, <5mm is micro-plastic. The harmful effects of the plastic debris have well been reported by many researchers and their consequences to both human beings and the marine ecosystem pose a great threat.

Photo by Depois (2018) showing the accumulation of plastics in the marine environment <https://phys.org/news/2018-12-oceans-garbage-prompt-war-plastics.html>

Impacts of plastics in the marine environment

Loss of biodiversity which is attributed by the presence of plastic debris have proven fatal to the life of marine organisms as they can accidentally be ingested or trap marine species. Plastic pieces may mistakenly be taken as food and once ingested, can cause obstruction of the gastrointestinal tract leading to failure of digestion and consequently causing starvation which poses lethal impacts such as death to species (Murray, F and Cowie, P.R., 2011). Furthermore, different fishing gears such as nets, hooks and traps that are abandoned or left in the ocean may entangle and cause death to various marine species such as fish and turtles due to inability to breath, move or feed (Sheavly, 2007; Baulch S. and Perry C, 2014).

A photograph by Pitts, M (2017) showing marine species killed by abandoned fishing nets <https://www.breathemagazine.com/2017/11/21/20-things-need-know-plastic-oceans/ >

The chemical, physical and biological characteristics of water can be altered as a result of organic pollutants sorbed in plastic resin from surrounding water or coastal areas leading to habitat destruction (Rochman et al., 2012). Water quality alteration has facilitated loss of nursery and spawning sites for many marine species. In addition, plastics can cause habitat degradation through physical damage to sensitive marine ecosystem such as sea grass beds and coral reefs of which affects the marine species number (Sheavly, 2007; Diaz et al., 2019; Rogers and Aburto, 2020).

Beaumont et al., (2019), estimated an annual loss of about 500 – 2500 Billion U.S Dollars occurs on a global scale as a result of decline in benefits derived from marine ecosystem services. Plastic pollution in the marine environment has caused significant economic damages in various sectors and communities. Marine debris that accumulates along the beautiful beaches, waterways and shorelines reduces the aesthetic value and diminishes the use of such areas for recreational purposes of which discourages tourists to visit the places and therefore impairing the tourism sector. Furthermore, economic costs can be encountered as a result of discarded or abandoned plastics, fishing ropes and nets that stuck and wrap around marine equipments such as propellers, engines and operating machines causing disturbance and damage to the boats and ships (Charitha et al., 2021). Watkins and Brink, (2017) explained how loss of potential fish catches has affected the fishery sector as a result of accumulation of marine debris. Presence of plastic debris causes decline in the quality of captured fish and seafood by destructing the marine ecosystem, habitat and killing species.

Health of human beings becomes exposed to risk following consumption of contaminated marine products such as fish and seafood. Polymers are rich in additives such as biocides, flame retardants and plasticizers of which when accumulates in the marine environment undergoes sorption to concentrate persistent organic pollutants such as dichlorodiphenyltrichloroethane (DDT) and Polyclinic Aromatic Hydrocarbons

(Rios et al., 2007) and microbial pathogens (Kirstein et al., 2016). Teuten et al., (2009) reported that, once marine debris are accidentally ingested by the marine species, the organic pollutants tend to accumulate in the tissues and result into contamination of marine products which increases its concentration in the tissues of higher predators including human beings. Some of the plastic pollutants and toxins have developmental problems and hormonal abnormalities to human beings.

Solutions for the control of marine debris (plastics) in the Indian Ocean region

Public awareness and education: The goal is to increase the awareness and understanding of the public on the potential dangers posed by plastic pollution and the necessary actions or solutions to be undertaken. In today's world, technology has managed to hasten the rate at which information and ideas are shared among individuals. Social media has taken over, for example; as of September 2021, according to Johnson, (2021), he reported that approximately 951.11 million people use internet in Southern Asia, 495.95 million in Southeast Asia, 146.3 million in Eastern Africa, 29.42 million in Australia and Oceania, 182.58 million in Southern Europe. It is easy for one to convey a message and reach majority since social media provides a platform where both literate and illiterate people share narratives, stories and pictures.IORA should collaborate and work with public figures such as famous politicians, musicians, athletes andother people with massive influence in the social media and internet by providing endorsements to them so that they help in promoting public awareness through short educational video clips, inspiring photographs on environmental issues and music to help changing the perception of people on the dangers of plastic pollution as well as the available solutions.

Policies formulation: The Indian Ocean Rim Association (IORA) should collaborate with respective national governments of countries in the Indian Ocean region, non-governmental agencies as well as different stakeholders in creating policies that ensure systemic changes such as phasing out the single-use plastics that pollute the most by shutting off the plastic machines operating in the respective regions. This is because, we are putting the world in danger by agreeing to use materials engineered to last forever to produce items geared to be used once and thrown away. Plastic production has far outrun the world's ability to keep up and manage waste. The way out to plastic pollution is to stop plastic use. For example,Tanzania started an initiative by passing a regulation that prohibits all plastic carrier bags regardless of their thickness from being imported, exported, manufactured, sold and used (The Environmental Management Regulations, 2019). An audit carried out from 1st June 2019 to March 2021 following the prohibition in Tanzania revealed a decline in the use of plastic carrier bags in which, about a total of 253.7 tones were surrendered to collection point (National Audit Office, 2021). IORA and respective stakeholders should lead the way by promoting policies that encourage plastic-free services such that, the use of sustainable and biodegradable materials to supersede plastics in different areas such as restaurants, hotels, shops, beaches and workplaces.

Waste banks: IORA should adopt waste bank management approach in the respective regions as means to reduce plastic pollution. In this system, the waste deposited by community members in the collection points, will be weighed and valued with a sum of money that is offered to the person depositing the plastic waste. IORA can work to improve the waste collection systems in the respective countries and then sell the collected waste to recycling agents or factories. This method is suitable in giving positive results because it is true that people are always highly motivated to work when it is beneficial, such that when a reward likemoney is put forward. Wulandari et al., (2017) pointed out that the waste management model by using waste banks proved a good effort in managing waste problems in the areas of Indonesia. Waste banks not

only help in managing plastic pollution but also serve to empower members of the societies economically with regard to their efforts in collecting and depositing plastics (Pariatamby and Tanaka, 2014).

A picture showing a waste collection point where people exchange plastic wastes for money (waste bank) in Morogoro region, Tanzania

Ocean clean-up strategy: The already accumulated plastic waste in the Indian Ocean can be get rid off by trapping and collecting them by using floating barriers. The U-shaped floating barriers are installed on the surface of water in areas with massive accumulation of plastic to trap them into a retention zone at its far end and prevent escaping underneath (Slat and Peytavin, 2022). Rivers should also be intercepted so as to prevent plastics from entering the ocean. Natural forces such as wind sweep and push the plastics which become trapped in the barriers. The collected waste is then taken to recycling or down cycling agents and factories for energy conversion. IORA should offer technical arrangement support and work with stakeholders in respective regions of the Indian Ocean to ensure effective implementation of the strategy and create special teams for close monitoring of the systems for the aim of reducing plastic pollution in the Indian Ocean.

Recycling of plastic waste: Plastic debris found floating or in the surface of the Indian Ocean as well as the landfills can be reduced through the action of recycling. Even though recycling process is expensive but its benefits surpasses many waste management approaches as it reduces pollutant emissions, saves energy and resources, reduces the need for landfills and open air burning. IORA should work with respective countries in the Indian Ocean providing sufficient recycling bins and encouraging the recycling rate to help reduce plastic waste in the environment.

Converting plastic wastes to energy: The unrecyclable plastic wastes can be transformed to produce fuel, char, combustible gases and monomers. Various environmental friendly techniques can be used to convert waste to energy. For example pyrolysis is widely used in which plastic wastes are heated at a very high temperature to produce fuel, carbon gas, hydrogen chloride gas, char and monomers (Pahl, 2020). Another commonly used method is gasonification, in which under the absence of oxygen gas, plastic wastes are

melted at very high temperatures (525 to 625 degree of Celsius) resulting into production of synthetic gases used to fire turbines (Sharma et al., 2021). The methods work in an eco-friendly way as they capture and store carbon by using developed technologies to balance greenhouse gases emission.

Conclusion

The ongoing tremendous increase in human population coupled with mismanagement of non degradable plastic has facilitated the accumulation of marine debris which has posed threat to the ecosystem, human beings and marine life. With the ongoing trend, the world is expected to have a drastic increase in plasticwaste coming from the land to the Ocean if countries continue to produce plastics without keeping up with the proper strategies and methods to manage and combat waste materials. Taking into consideration the ramping up and the impacts as well as the fate of plastic pollution in the Indian Ocean, further action needs to be taken. There is a need for the governments in the respective countries of the Indian Ocean region, policy makers, stakeholders and other environmental agencies such as Non-governmental organizations and community based organizations to work in collaboration to provide appropriate interventions as well as ensuring appropriate and necessary actions are implemented to effectively address the threats posed by ineffective waste management so as to ensure success in terms of reduced plastic pollution and offer sustainable life to people living across the Indian Ocean region. Much focus should be on switching to alternatives (plastic-free services) because targeting the source before its production is far more effective than clean-up projects and dealing with the consequences of plastic pollution. Furthermore, more sponsorship to researchers should be offered in the area of finding solutions to plastic-free-alternatives so as the world could overcome the use and dependency to plastic services.

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WHAT IS MARINE DEBRIS?

By: Adel Jeanne, Mauritius

The world's oceans encompass three-quarters of the planet's surface, contain 97 percent of the planet's water, and account for 99 percent of the planet's living space by volume (UNESCO 2017). Nonetheless, the use of this vast resource offers a variety of threats to the coasts, oceans, and seas' long-term viability. For example, the Sustainable Development Goal 14 states that human activities have a significant impact on up to 40% of the world's oceans and seas, including pollution, reduced fisheries, and the loss of coastal habitats.

Every day, massive amounts of plastics, metals, rubber, paper, and textiles, as well as abandoned fishing gear, ships, and other lost or discarded goods, enter the marine environment. As a result, marine debris is one of the most common pollution issues plaguing the world's oceans and waterways.

The UN defines marine litter as “items that have been made or used by people and deliberately discarded into the sea or rivers or on beaches; brought indirectly to the sea with rivers, sewage, storm water or winds; or accidentally lost, including material lost at sea in bad weather.”

In recent decades, the scientific community has been fascinated to the large amount of marine waste washed ashore and the discovery of garbage patches in all three subtropical oceans.

More than nine 8.3 billion metric tons of plastic have been manufactured worldwide since its introduction in the mid-20th century, with roughly 8 million metric tons of it entering the oceans each year. In a business-as-usual scenario, the equivalent of a garbage truck of plastic is poured into the ocean every minute, a statistic that is expected to double by 2030 and quadruple by 2050.

COVID-induced behavioural change is worsening the problem of ocean pollution as the world

battles to deal with the ongoing COVID-19 epidemic. For example, we may fairly estimate that there are at least a billion facemasks in India now, the most majority of which are disposable. These abandoned masks and gloves, along with much else that humans trash,

wind up in the ocean in an alarming number of cases. In reality, multiple surveys from nations throughout the world have documented an increase in discarded single-use latex gloves and surgical masks washing up on beaches and coasts around the world.

MARINE DEBRIS IN THE INDIAN OCEAN

The Indian Ocean is the world's third biggest oceanic division, covering 70,560,000 km2 or 19.8% of the planet's surface. It is bordered on the north by Asia, on the west by Africa, and on the east by Australia. Unlike the Atlantic and Pacific Oceans, the Indian Ocean is surrounded on three sides by major landmasses and an archipelago and does not run from pole to pole. 80% of the Indian Ocean is open ocean and includes nine large marine ecosystems: the Agulhas Current, Somali Coastal Current, Red Sea, Arabian Sea, Bay of Bengal, Gulf of Thailand, West Central Australian Shelf, Northwest Australian Shelf, and Southwest Australian Shelf.

The Indian Ocean, however, has not been spared from the problem of marine garbage. The Indian Ocean has evolved into a busy thoroughfare that plays an important role in commerce exchanges between East and West. Cargo containers that have been lost are prevalent, and they are the source of a diverse range of garbage that ends up in the Indian Ocean.

Plastics make up between 61 and 87 percent of this litter. Because plastics have a low density, they float on the surface of the sea and can be carried for vast distances by winds and currents. Plastic is a long-lasting material that is made to last. This can be useful and vital for things like medical gadgets that keep a lot of people safe and healthy. However, one of the characteristics that makes plastic so harmful as marine trash is its durability.

The Indian Ocean receives up to 15 million tons of plastic per year, contaminating it with a trillion particles of plastic and making it the world's second most contaminated ocean after the North Pacific.

According to a 2015 survey conducted by three experts, plastic made up 96 % of marine debris gathered from various parts of the Indian Ocean. Except for the categories of ‘Glass bottles’, ‘Light bulbs’, ‘Light tubes’, and ‘Other’, all categories included plastic materials of various types: polyethylene terephthalate PET (common for beverage bottles and food packaging), polyethylene HDPE (used in detergents, bleach, and motor oil containers), polyvinyl chloride PVC (toys, furnishing), polypropylene PP (fishing ropes), polyurethane (beach sandals), and polystyrene PS. ‘Domestic goods’ made up 6% of the total items collected and were the most diverse, with 16 different types of artifacts. 'Fishing items' accounted for barely 2% of the overall amount of marine garbage.

In the western Indian Ocean region, plastic remains a serious contaminant, with less than 5% of it being recycled. The Indian Ocean generates more than US $22 billion in marine goods and services each year through fisheries, trade, and tourism, all of which are threatened by plastic waste. With the exception of South Africa, there is minimal data in the region in terms of study and information on the volumes, types, trends, sources, and sinks of marine litter. No country has undertaken economic effect evaluations on marine litter, despite the fact that existing policies and legislation should address it more comprehensively, taking into account the entire life cycle of plastic items. Recycling is still low, with South Africa, the Seychelles, and Mauritius having

the most successful official waste plastic recycling programs. If countries are to establish suitable on-the-ground policies and practices that can enable positive change, data and knowledge are essential. While the developed world has made significant progress in reducing their plastic footprint in the oceans through advances in waste management, treatment, and recycling, many African countries are still struggling, with plastic releases into coastal and marine waters dominated by improper solid waste disposal.

The Sundarbans, the world's biggest mangrove ecosystem, is found in India's mangrove cover (~4,975 sq. km). The principal coral reef ecosystems of India are the Gulf of Mannar, Gulf of Kachchh, Andaman and Nicobar Islands, and Lakshadweep Islands. Along the coast, there are also patchy and submerged reef systems (e.g., Grand Island and Angria Bank). As a result, the different coastal habitats along the Indian coast are potential plastic trapping locations.

Coastal inhabitants in the Indian Ocean, like everywhere, have traditionally been concentrated at river mouths and locations appropriate for the building of ports, and increasingly in tourist-oriented areas. Furthermore, industrial development has moved into such locations in order to take advantage of commerce, tourism, and other economic prospects.

The Indian Ocean connects Africa, Asia, America, and Europe via significant shipping routes. As a result, the Indian Ocean waters have been unwittingly exposed to overboard trash. For example, shipping has had a substantial impact on the ecological status of Somali marine life and coastal habitats. The fishing industry is another major contributor to marine litter in the Western Indian Ocean, with discarded fishing gear and waste serving as potential litter sources. Local and foreign fishing vessels operate both legally and illegally in Indian Ocean waters, with the potential for littering.

Marine debris tends to collect in areas called ocean gyres. A gyre is a circular ocean current formed by the Earth’s wind patterns and the forces created by the rotation of the planet. The area in the middle of a gyre is usually calm and stable. The gyre's circular rotation attracts garbage. The garbage eventually makes its way to the gyre's center, where it becomes stuck and accumulates. Trash build-ups in the middle of gyres are known as garbage patches. For example, the Indian Ocean garbage patch, discovered in 2010, is a marine garbage patch suspended in the upper water column of the central Indian Ocean, one of the five major oceanic gyres. The Indian Ocean's garbage patch covers a massive area: at least five million square kilometers.

Scientists discovered that the Cocos Keeling Islands, a remote island in the Indian Ocean, is polluted with 414 million plastic garbage objects weighing 238 tonnes.

According to the United Nations, every year, over eight million tonnes of plastic wind up in the oceans, accounting for up to 80% of all litter in the oceans. This is expected to climb by 2025, wreaking havoc on marine ecosystems and tourism, according to studies.

IMPACTS OF MARINE DEBRIS IN THE INDIAN OCEAN

The effects of marine debris on marine fauna have been well documented, and the implications are concerning. Plastic has now been found in a variety of water organisms, including those that live on the seafloor, sea birds, and mammals. Over half of sea turtles may have eaten plastic, and numerous images of these seemingly innocuous creatures found wrapped in plastic bags or trapped in fishing nets have upset the entire community. Large sea species, such as whales, have also been harmed by plastic garbage. Whales have washed up on the Indian coast, particularly in the Bay of Bengal, on multiple occasions.

Ghost-netting, rope, and monofilament fishing lines are either lured to or mistakenly ensnared in marine animals. Ingested plastic debris clogs the intestines, causing hunger and death, or

ulceration of delicate tissues caused by jagged fragments, as well as a decrease in quality of life and reproductive performance. The movement of fishing gear across shallow reefs can destroy the coral substrate, putting the reef's structure in jeopardy.

Marine debris can be mistaken for food by a variety of marine biota and consumed. Seabirds, marine animals, and sea turtles have all been observed eating marine trash. Sharp debris in their stomachs can cause illness, pain, and even death if they ingest it. The plastic polymer mass may irritate stomach tissue, create abdominal discomfort, and lead the animal to get satiated and stop eating. It is possible that many of the recent strandings are due to the animals ingesting marine litter, which could cause physical damage to their digestive systems and eventually cause them to feel full, reducing their desire to feed, resulting in malnutrition.

Plastics include a wide range of potentially harmful substances that may be released into the environment during manufacturing. Plastics take a long time to deteriorate. Surprisingly, some new biodegradable polymers may not degrade at all in oceans. Chemicals used in some plastics, such as phthalates and flame retardants, have been found to have toxicological impacts on fish, mammals, and mollusks, according to research. Microplastics (<1 mm) have a substantial surface area to volume ratio that facilitates adsorption of chemical pollutants to their surface, and so have a high ability to aid the movement of contaminants due to their small size.

According to a 2014 study, more than half of the loggerhead sea turtles (51.4 %) in the South-West Indian Ocean ingested marine trash (mainly plastics), resulting in sub- lethal effects or fatality. Furthermore, marine debris has financial ramifications in the tourism industry since it reduces the aesthetic value of beaches, resulting in low economic returns due to a reduction in the number of visitors.

Small plastic fragments floating on the ocean's surface can block the sun's rays from reaching plants and algae that rely on the sun to produce nutrients. The entire marine food system may be disrupted if these organisms are threatened.

Smothering, entanglement, and abrasion are just a few of the ways marine debris can destroy habitats. The size, number, content, and permanence of the debris determine the magnitude of the damage, as well as the susceptibility of the affected environment (i.e., habitat vulnerability and resilience).

Marine debris has detrimental effects not only for biodiversity, but also for the economies of many coastal countries and small island republics like the Seychelles, which rely largely on tourism and promote idyllic beach landscapes. Fish population declines can have an impact on human activity in the area. Fisheries are shrinking, putting a strain on the economy of the region. As a result of bioaccumulation, fish captured may have a high level of poisons or other marine detritus in their system.

ACTIONS TAKEN BY COUNTRIES IN THE INDIAN OCEAN

Cleaning up marine debris is more difficult than it appears. Because many pieces of debris are the same size as small sea critters, trash-collecting nets would also trap these organisms. Even if we could develop garbage-catching nets, the immensity of the oceans makes this a too time-consuming task to consider. Because of these challenges, most environmentalists are concentrating their efforts on preventing more rubbish from entering the oceans. Governments and international organizations have implemented rules prohibiting ocean dumping in an attempt to eliminate marine debris since the public became aware of the problem.

Plastic waste poses a risk to the country's shores and oceans, which has prompted some

action. South Africa, Kenya, and Rwanda, for example, have implemented policies to discourage the use of short-life plastic bags, earning them recognition as champion countries in combating the problem in a recent UNEP study. Other legislative initiatives, such as voluntary agreements, levies, charges, and taxes, exist to prohibit single-use plastic, albeit their success is dependent on country settings. Such techniques might be used to change the price of plastic bags to include all external expenses, so catalyzing a shift toward a more circular economy.

Kenya postponed a PET bottle ban in order to discuss with industry and other stakeholders the concept of extended producer responsibility through container deposit schemes, which are used in Asia, Europe, the United States, Canada, and Australia. In 1975, South Australia enacted container deposit legislation, which resulted in the return of more than 80% of plastic containers and has since been legislated. South Africa performed a "plastic material flows and end of life" study to analyze the current state of plastics manufacturing and management in order to guide recycling improvements.

ACTION PLAN THAT CAN BE TAKEN BY IORA

The Indian Ocean Rim Association was founded on March 7, 1997, as an intergovernmental organization. IORA is a dynamic intergovernmental organization with 23 Member States and 10 Dialogue Partners whose mission is to foster regional cooperation and sustainable development in the Indian Ocean region.

The problem of plastic pollution necessitates holistic methods, multi-stakeholder participation, and regional collaboration. Without a regional solution, companies facing strong plastic bans may be tempted to look into moving their operations to countries with less stringent regulatory limitations. This will hamper progress in countries attempting to address the problem of plastic pollution caused by the unlawful import of prohibited plastic items.

Action to address the global problem needs to be complemented by regional and local solutions tailored to different sources and pollution pathways.

This initiative helps to meet SDG targets, particularly target 14.1, which calls for the avoidance and reduction of all types of marine pollution, including marine debris.

The focus of solutions must shift away from waste management and toward product eco-design and lifecycle thinking. With a projected three-fold rise in annual production by 2050, the traditional plastic consumption and disposal paradigm is unsustainable and poses issues that are only going to grow in size.

To 'close the plastic tap', initiatives should focus on multi-stakeholder conversation processes to investigate how to change to a national circular economic model that considers the complete lifecycle of plastics.

Ultimately, the action plan can be developed with four objectives:

1. To provide guidance and enhance knowledge on the prevention and reduction of marine litter and microplastics including upstream interventions and their impact on marine ecosystems, public health and safety through coordinated regional actions.

2. To improve understanding and build a regional framework to deal with the marine litter problem and its impact in the region, monitor the quantity and distribution of marine litter and microplastics.

3. To act as a guide for the management of marine litter and microplastics in conformity with internationally recognized standards and techniques.

4. To advocate for the eradication of existing marine litter to the greatest degree practicable through clean-up campaigns.

All coastal States in the Indian Ocean Region, as well as all other Flag States, should be encouraged to ratify and adhere to existing international instruments, particularly Annex V of MARPOL (International Convention for the Prevention of Pollution from Ships), which deals with ship-generated garbage, and the London Convention, which deals with dumping at sea, in order to control marine-based sources of litter. Waste receiving facilities, including land-based treatment, recycling, and disposal services, are also required by ports. The International Maritime Organisation (IMO) is now evaluating Annex V of MARPOL, which pertains to port reception facilities, and the decision will have an impact on the strategy taken by signatory countries in the Indian Ocean region.

MARINE DEBRIS IS EVERYBODY'S BUSINESS

While governments, businesses, civil society, and others all have a role to play, consumer action may help to address the global problem by reducing the use of unneeded single-use plastics and putting an end to littering. Community cleanup operations raise awareness of the problem while also providing crucial data on trends and the traceability of recovered items back to their source.

Finally, marine litter is a worldwide concern, and promoting awareness among people, fishermen, and coastal communities is the essential to avoiding future dumping of plastic into the sea.

Everyone can contribute to the solution. The less garbage we generate, the less waste will end up in the environment. The most crucial rule is to avoid littering.

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PYROLYSIS THE SOLUTION TO MARINE POLLUTION

By Appiah Kenny

Nowadays the problem of plastic in our ocean is no more a fact and many countries around the world namely Kenya try to adopt a more ecological approach. Since 2017 the production, the use and the selling of plastic bags have been prohibited at risk to face 4 years of imprisonment or $ 38,000 of fine. Rwanda was the first plastic free nation since 2008. The reason why those countries take severe action against the use of plastic is that, when plastic stay for a long period of time in sea it breaks down to form what is called microplastics which are often mislead for food by fishes and also other marine animals which have for effect to destabilize the normal functioning of their gills, reduce their appetite and can prevent some species to breed.

WHAT IS PLASTIC?

Plastics are the group of materials, either synthetic or naturally occurring, that may be shaped when soft and then hardened to retain the given shape. Many products such as shopping bags, bottles, straws, takeaway coffee cups, takeaway food containers and bottles of shower gel are made of plastic. It was estimated that 367 million metric tons of plastic was produced in 2020 and that there is at least 363,762,732605 pounds of plastic pollution in the world's oceans. The Plymouth University had demonstrated that 1 in 3 fish caught for human consumption contains plastic which shows the propagation of plastic in seas. If nothing is done during those coming years there will be more plastics in seas than fishes in oceans. In an article of CBCNEWS, they have highlighted the point that if no action is done, plastics will outweigh fish in oceans by 2050. It can be difficult to tackle the problem of marine debris, mostly when there is no definitive solution to get rid of it and it is where pyrolysis can be the solution for a clean ocean.

WHAT IS PYROLYSIS?

Pyrolysis is a thermal process where raw materials/ wastes are heated at a high temperature between 300 to 500 degrees Celsius in absence of oxygen to decompose chemical organic into liquid and gas state. The fifty-nine years old Japanese inventor Akinori Ito created a pyrolysis machine which has the capacity to produce oil from plastic. The oil produce can be used in steel factory, cement factory, brick factory, glass factory and in heavy oil generator. Many countries such as Turkey, Poland, Nigeria, Ukraine, Romania, United Kingdom, Brazil and Malaysia have already get use to it. Ben Dixon the head of circular of Systemiq, a consulting and investment group say "Chemical recycling plastics is a niche solution but it is getting extraordinary attention from largest petrochemical companies and consumer brands". This demonstrates the value of pyrolysis to become the new way of producing fuel. The functioning is simple, first of all the reactor of the machine will consume diesel to heat the plastic until oil gas passed from a manifold where heavy gas will be liquefied to generate heavy oil, after that the light oil gas will continue its path in some tubes until finally the condensers liquefied it to oil fuel. With a minimum of 1 kg of plastic the machine can produce 750 ml of synthetic oil which can therefore be refined as diesel and reuse in the machine. Due to the strict filtering system, it provides a safe and eco-friendly way to release gas and its high level cooling system ensure a good dedust effect. The pyrolysis plant is capable

to create oil from different plastic product as from daily life rubbishes to large fishing nets and even if the plastic product was in the ocean for years. Often when collecting plastic from the sea to prevent more sea pollution, people burn the plastic which has for consequences to pollute the air by releasing toxic gases like:

- Dioxins and Furans that have for effect to change the hormone systems, it changes the normal development of fetus and suppressed the immune system.

- Mercury a persistent toxic polluant. It accumulates in water laid sediments where it converts into methylmercury and enters the food chain.

- Polychlorinated biohenyls (PCBs) which are more harmful than other gases. Its molecule is very stable thus making it very persistent in the environment. When polychlorinated biophenlys burns it generates dangerous by-products such as dioxins, it also evaporates and dissolves easily in water which can be unhealthy for human, vegetation and animal life.

In November 2019, due their constant burning of plastic in Indonesia some chicken eggs had been found with a high level of toxic dioxins, 70 times from the authorise level. Pyrolysis could be a better way to destroy plastic than burning it in the open air and putting at risk the environment and human life. It will also bring a valuable help to the typical recycling. The secret behind recycling, is that it can only be done one or two times and then the chemical composite of the plastic is so deteriorated that the only solution of preventing plastic pollution is to incinerate where pyrolysis plastic plant can be the substitute. The possibility of reducing landfills will be consequent and at the same time it will reduce one source of plastic pollution in seas. It is estimated that around 3% on the total of eight million metric tons of plastic which leaks annually in ocean comes from mismanagement of landfills.

The action of the IORA can help to decrease effect of microplastic in ocean, reduce air pollution and protect the fauna and flora of our sea by implanting a plastic pyrolysis plant in Yemen.

WHAT IS IORA?

IORA stand for Indian Ocean Rim Association, it is dynamic inter-governmental organisation that aims to enhance sustainable development within the Indian Ocean. It was established on 7 March 1997. It is now compose of 23 countries including Australia, Bangladesh, Comoros, French, India, Indonesia, Islamic, Kenya, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Oman, Seychelles, Singapore, Somalia, South Africa, Sri Lanka, Tanzania, Thailand, Yemen.

WHY YEMEN?

Yemen is one of the poorest and least developed country in the world which form part of IORA. During years, the Yemeni has faced a lot of difficulties such as non-potable water, food crisis resulting to malnutrition of child, low health care facilities, poor education conditions and joblessness. Yemen’s population stands at 24.5 million and about 54% of Yemenis live in a complete poverty earning less than 2 dollars per day. More than 40% of population find it difficult to buy the minimum of food due to an increase of price.

IT IS TIME TO HELP YEMEN BY RAISING UP ITS ECONOMY AND TO ACT MORE ECO-FRIENDLY.

Yemen's plastic waste estimation is about 887,497 tons and until there is companies which recycle waste found in rural areas. Plastic continue to accumulate and 60% of the waste generated went uncollected, and was generally dumped, buried or burned. In November 2016, Shayef al-Asri said in an interview that "At night I cover my mouth (from the smell), the smell of rot wakes me from my sleep" which show that since a long time the local population suffer not only from humanitarian crisis but also from a big trouble in the waste management.

THE FIGHT AGAINST PLASTIC WASTE STAYS HARD

The aquatic life of Yemen is extremely diversified due to its proximity to the Red Sea which greets about 1,200 species and 10% of it cannot be found anywhere else. One aim of IORA is to bring an equal position among each of its member and also to help its partners during financial difficulties to develop their economy by participating in large event. IORA can use its special fund which is reserve for accomplishment of their project to settle their pyrolysis plant in Yemen. This pyrolysis plant can be used to treat plastic waste of every member but mostly for Yemen which has a lot of plastic waste that can be use to make oil. 20 percent of Yemenis are unemployed and would be great to work for the cleaning of their country.

A formation can be done by specialist from the 23 countries which compose IORA to train the Yemen population on how to collect plastic in Red Sea in the safest way possible to avoid disturbing the aquatic resident and to avoid any tragical circumstances. The pyrolysis plant work automatically and do not need a lot of labour, but only for some verification during the process and also for the changing of tanks full of oil. The fuel collected can be sold and part of the money collected can go in the special fund of IORA for future project and the other part can be used to pay labour and help for the development of the filtration of water, which will benefit a lot the host people. An approximation on how much the project will cost before its realisation would be around Rs4 to 5 million including the cost of the pyrolysis plant and any extra cost related to material needed for the start of operation of the machine. The profit estimated in ten months of use is about Rs 22 million which clearly shows that the profit made in one year can completely cover the capital invested.

SUPPLIER OF PYROLYSIS

The pyrolysis plant can be provided by the company Beston located in china, a certified company which have exported its product over 20 different countries. Compare to other manufacturer of pyrolysis plant, Beston have innovate by upgrading its technology at the point where it reaches the European Union's environmental protection and emission standard and at the same time preserving the good quality of the oil extracted. Their pyrolysis plant profit from a high production, a 100% avoid burning technology and lower noise. Beston employees personally go to install their product, ensuring at the same time the training of the new pyrolysis users. The feeding system and discharging system are sealed to ensure the safety of employee and no loss of heat during the process.

POSSIBLE PARTNERS

As it is always hard to start a project alone, IORA can try to convince some eco-friendly organisation to join the project. The Fauna & Flora International (FFI) is a non-governmental organisation operating in more than 40 countries which fights for the conservation and protection of endemic plant and animal by not forgetting taking human need in the process. FFI had accomplished during those years to established Kruger National Park in South Africa, launched an operation to save the Arabian oryx and discover the Myanmar snub-nosed monkey. This NGO would be helpful for saving the endemic species that inhabit the Red Sea as for example: the masked butterfly fish, the Springer's Dottyback, the Picasso triggerfish ,the Red Sea Pipefish and the Red Sea Flasher Wrasse. All those fishes need to be conserved for future generation so they get the opportunity to admire their natural beauty. Moreover, The famous non profitable organisation known as The Nature conservancy that operate in more than 70 countries would be a greatest help to clean the Red Sea and to keep Yemen environment safe. This organisation aim is to protect natural resources that human need to live such as water and land. They have achieved till now to conserve 10 trillion acres of ocean, 1.6 billon acres of land and conserve more than 620,000 miles of rivers.

The conclusion of this article is does IORA must adopt pyrolysis has a method to eradicate plastic? The answer is yes. The pyrolysis plant will bring stability in the management of plastic waste. It will give enough revenue to restore the special fund of IORA bringing at the same time enough money for developing Yemen infrastructure. Respecting the objective of IORA to impose equality between countries and acting ecologically. If good negotiation is done an eventual partnership can be form with big non-governmental organisation for a saving not only ocean and marine life but also Yemenis. It will be a considerable error to not giving pyrolysis the chance to repair human mistakes.

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The issue/s of marine debris (plastics) and what IORA can do to address the issue/s

By: W. P. G. Mandira Perera, Sri Lanka

A wail in the deepest ocean, far away from human touch, the turtle caught up in a plastic bag,

screamed on top of his lungs, 'Life, there's life here too',

With the ebbing tide, 'the scream' seized to be a helpless murmur, for the man had made a blunder; the cry never reached the shore.

Inspired by the news of the recent death of the pilot whale in Thailand with 80 pieces of plastic rubbish in stomach

It is the 21st century and has already come to 2022. Plastics are the by-products that are extracted when refining petroleum. We were told back in 2010 that the world will witness flying cars by 2022 based on the rate at which the technology developed. However, technology is far behind in finding logical and sustainable solutions for issues that have already started to threaten the very existence of human beings and nature. That is to say, the world is still exploiting natural resources and continues to do so at a rate greater than nature could recover.

Production and heavy usage of plastic in countries despite the economic development which those countries possess; have become a great issue today. This is largely due to its attractive cheap prices. Even though plastics are not durable they shall serve the temporary service that is expected by the consumer and the producer, thus creating greater satisfaction. However, the terrible fact that most of us forget is that this utility is gained costing the future utility. This article may look into how the use of plastics shall be compromising the future utility and how Indian Ocean Rim Association (IORA) could provide solutions to help resolve the issue of marine debris.

What is Marine Debris?

Seba B. Sheavly states that ‘Debris is more than an unsightly inconvenience for beach-bound vacationers or pleasure boaters’, it is any manufactured or synthesized solid waste which makes way to the ocean environment (Coe & Rogers, 1997). Starting from, the cigar buds to disposal syringes, used test kits of medical waste of Covid-19, is the litany of litter that is piled up daily, every minute, and will be sent to the ocean at the end of the day.

The Impact of Marine Debris

Much marine wildlife has become the direct victims of marine debris. Marine debris has resulted in inflicting wounds, suffocation, ingestion and brought deadly effects on wildlife. Endangered species such as Hawaiian monk seals and Pacific loggerhead sea turtles are among nearly 700 species that get caught up in plastic litter daily.

Plastics being trapped in ice will create certain lethal germs and bacteria which will be released into the open air when glaciers meltdown as a side effect of global warming. Thus, it is not just nature that is hurt, it poses an immediate threat to human safety as well. Meaning, the issue that was habitual and relevant only for the marine life has surpassed and has inflicted the same threat or perhaps a greater threat upon the very creator of the menace right back at him.

Are there solutions for the issue of ‘Marine Debris’?

It is a long practice that many non-biodegradable items were disposed of, at the ocean bed. Plastics, one of the main components among the non-biodegradables disposed at the ocean are

becoming an emerging problem not just to a single country, perhaps to the entire world.

Even though the international arena is governed by Treaties and Bi-lateral, Polar-lateral agreements binding the member countries of a particular region to follow certain practices and take efforts dutifully to take part in protecting nature and the ocean, it is questionable the real impact such agreements have created thus far.

There are many governmental, non-governmental organizations that are actively engaging in the process of creating awareness and looking for viable solutions for this marine debris issue.

The ocean is very important as it gives birth to lives. Such natural treasures should not be polluted at ease by humans for their convenience causing future generations to suffer. It is not just awareness that is required, now it is high time to implement the suggestions and thinking that are discovered already by the experts in the field of marine biology and the related field of interests, with collective funding and efforts.

According to the IORA Action Plan (2017-2021), strategic and economic partnerships internationally and regionally could be created, as these areas have successfully arrested the focus of IORA already, where strengthening regional collaborations, expanding beyond frontiers, touching upon the concept of Indo-Pacific, building international partnerships, and deepening the dialogue partners and among others have already been the objectives of the Association, thus the approaches suggested in this article would be quite useful if taken into account.

Annually 0.64 million tons of mismanaged plastic are being released to the ocean by Sri Lanka, which is an island that is surrounded by the coast. Around 15 million tons of plastics make their way into the Indian Ocean yearly by the region. Southeast Asia is the home of one of the world’s top four marine polluters.

These statistics show how plastics have become a menace for most countries due to several reasons. Thus, it is crucial to identify the common reasons for such collection before reaching out to consider the possible remedies.

There are two ways to look at the issue of the collection of marine debris at sea. Firstly, finding solutions for the issue of the generation of plastic waste which is land-based and that makes way to the sea annually. Secondly, finding solutions to the issue of already collected piles of marine debris at the bottom of the ocean.

Collecting plastics near coasts is one of the most effective ways of reducing the release of land-based plastics into the ocean. This requires greater awareness and manpower to make it possible. IORA could find assistance connecting with other movements through collaboration to reach a greater audience and involve the youth.

"Creativity is seeing the same thing, but thinking differently" (APJ Abdul Kalam)

Conversion of plastics back to oil technology is another possibility that is being tested and has gained a patent license. These technologies are not affordable singularly by an individual country, however, as per the

United Nations structure, if IORA could create a fundraiser where each member country based on their GDP could share the cost and contribute yearly, purchasing of such technology and using it for the greater benefit of the entire region will provide a lucid solution. This could be in addition to the High-Level Task Force (HLTF) that was established by the Council of Ministers in the meeting held in Oman, April 2001, which supports and complements the funding projects and programs adopted by the IORA.

Professor Vlacho teaching Physics at the University of Delaware has found a cheap way to recycle plastics back into oil and other useful products such as gasoline or other types of plastic in a new study. Earlier this was deemed as a non-viable technique because recycling plastics back into oil may consume more fuel than what it would create in the process. However, this situation has been reversed under the new study, and the patent has been filed last year for the process.

He goes on to point out that successful commercialization could only be achieved within a duration of five to ten years. Here the writer suggests that, at a time where plastics pose a rising environmental threat, Global Organizations should purchase or create a global awareness for such research and related studies. IORA also could allow these researchers to partake in the programs to further the studies made to find energy- efficient ways to recapture the used carbon in plastics and put them to good use.

As an Intergovernmental Organization, IORA may have to disperse the interest and the responsibilities over to the member states, as they are the direct stakeholders of such processes. Furthermore, partnering with energy companies may give more value addition to the initiation. IORA as the center of such a complex process will be the coordinator and the regulator which have the potential to reach more and beyond.

The interesting part then would be the legal implications. In countries like Sri Lanka, an acute problem faced by the country is the use of indirect methods to implement International Treaties, the gist of the Treaties is often lost in the process. Thus, as a country, even though it may be among the pioneers of being a signatory to an International Treaty, but is far behind in properly implementing the Treaties with the command of the law.

As an organization, IORA may have a limited command of law than the Governments of the respective member states. However, in a world where the state's sovereignty is increasingly compromised in the realm of many players who are capable of transcending the territorial boundaries of the 'modern state', with proper regulations and terms, states will pledge to compromise and may join in to create a safer world to create a greater benefit to a greater majority.

International Treaties could be signed to entice the member countries to participate with great enthusiasm and engage actively. Few international legislations such as MARPOL 73/78 and the London Convention prohibits and controls pollution from vessels and sources of land-based pollution at sea respectively. However, it is difficult to locate the source of marine debris, this has caused people to be cautious and disciplined in the usage of plastic.

Already existing marine debris within the ocean is the next serious issue that this article tries to address. This has become a threat for two reasons. Firstly, the difficulty to exact the position of the deposited debris, and secondly, the problem of the hindrance of the ability to such plastics to incinerated due to the saltiness. However, if special facilities and equipment that are necessary to collect and remove from the seabed are found, achieving the end goal will not be that difficult.

Creating policies to regulate ships with travel routes falling within the rim to avoid dumping plastic materials into the ocean is another solution that could be placed. In the Atlantic rim, major reforms have been introduced to regulate the use of certain fuels and substances within the ships. In such a way the organization has managed to avoid air pollution that was created due to shipping. Similarly, policies could be used to regulate ships that dump pollutants into the ocean including debris.

Furthermore, the organization with the partnership with the state interventions of the respective member countries to regulate the hotel chains, and factories that have outlets to the ocean, to

use meshes in the drains to block the entry of plastics to the ocean, is also another feasible initiative. This could be done in three stages, to obstruct the flow of the big, medium, and microplastics using different netting.

For an instance, Geocycle addresses the issue of plastic waste through PlaNet Solutions. It provides a quick path to achieving plastic neutrality while supporting the creation of closed-loop waste management solutions. This provides plastic waste producers with the opportunity to invest in innovative recycling solutions to address plastic pollution in areas of high environmental impact. Geocycle is driving new collection and isolation solutions such as B. Geocycle bubble barrier for capturing plastic from rivers. PlaNet TogetherApp manages municipal post-consumption plastic or mobile sorting stations to divert plastic from landfills. PlaNet offers a full range of plastic waste management solutions, from strategic planning to collection, transportation, separation, and final treatment.

Micro-plastics is another serious issue that has created more concerns among environmentalists and interested parties as to the trends of production and consumer-use patterns all point towards more use of plastics rather than a reduction. Micro-plastics are ubiquitous plastics particles that are less than 5 mm in size. These microplastics have the potential to remain within the organisms and translocate between tissues (Hall et al, 2015), meaning there are inverse effects on the organisms who ingest them and thus have severe implications in the food chains. Furthermore, studies have confirmed that microplastics can end up in wastewater and ultimately in the drinking water.

For the issue of micro-plastics scientists have found a solution with the use of nano-technology. Scientists have designed reusable ‘nano coils’ that trigger microplastics to break down. They have further found that these broken-down pieces of microplastics could be used as carbon-based food for plant-based lifeforms, such as algae. Nevertheless, this study is in its basic stages since the scientists who conducted the use of ‘nano coils’ suspect that they may not work when cleansing wastewater as it is complicated and contains many organic materials.

This shows the importance of greater awareness and publicity such that people are motivated to find ways to reduce, recycle plastics and step out to invent technologies to further the already done studies as above, for the betterment of the entire global community. It is understandable that the issue of marine debris, even though it is an issue that is far away from the shore, the sources of the aforementioned issue have proximity to the land-based plastics, if one tries to realize the big picture on plastics, may require myriad solutions with the help and great awareness of all the stakeholders and global community at large. Therefore, as per the firm belief of the writer, the suggestions made in the article would be feasible upon proper planning and appraisal, despite the possible capital constraints.

“…But I’ll use my final breath,

To tell that I’m sorry, let us end this dance of death, To centuries of agony, that to your heart we sent,

Here and now with my amends, the senseless killing ends…”

(The Apology Song in the Book of Life by Diego Luna and Gustavo Santaolalla)

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Illegal, Unreported, and Unregulated fishing: Environmental disaster or economic necessity?

By: Jem Midgley, South Africa

Introduction

Commercial fishing is grueling labor, requiring dedication, physical strength, and a deep understanding of the ocean and its ecosystems. Fishing is an important source of food for humans, but fish must be obtained carefully and sustainably. Disrupting the process by avoiding regulations or using illegal means of fishing damages the fish supply and the ecosystems of the ocean in ways that cannot be ignored.

In this article, I am going to examine the dangers of Illegal, Unreported, and Unregulated (IUU) fishing. I will consider the factors that motivate unsustainable fishing practices; unless we understand the causes, our solutions will likely be inadequate. Lastly, I will propose actions which the Indian Ocean Rim Association (IORA) can take to prevent IUU fishing.

The problem with IUU fishing

IUU fishing stands for Illegal, Unreported and Unregulated Fishing. This includes fishing without proper permission, not reporting the right number of fish caught to national or regional authorities, fishing in a way that disregards the rules or regulations of the organization or state and fishing by boats with no nationality or flag. IUU fishing is most common in small operations but even extends to organized crime. Illegal fishing is not the only issue; misreporting fish is a huge problem as well.

The sad truth is that many people do IUU fishing, whether they believe they have no other way to get fish or just want to make some easy money. IUU fishing is common in poorer countries where the regulations are not strictly enforced. The people still need food, so they turn to IUU fishing. People who live near the shores may use gleaning (fishing with hands or primitive tools to catch overflow fish) as a way of getting food as well. Gleaning is necessary for many small communities around the Indian Ocean, but it means many fish are caught but never reported.

IUU Fishing is prevalent in countries with corrupt governments and poor citizens, in the Indian Ocean and off the coast of West Africa especially. According to World Ocean Review, “The situation off the coast of West Africa is particularly critical. Here, IUU fishing accounts for an estimated 40 percent of fish caught

– the highest level worldwide.” IUU Fishing is most common in those regions either because governments can’t afford to pay any extra money to enforce the regulations, or because the managers of the systems are corrupt and allow IUU fishing to take place, taking a portion of the income for themselves.

IUU Fishing being unpunished leads to many people doing it, which further leads to overfishing, damaging the marine environment. When so many people are involved in unregulated fishing, fish are killed faster than they can reproduce, and there is a steady decline in fish population. Some governments have well- managed regulations in place

to stop people from overfishing and damaging the fish population, but poorer nations are unable to stop the people from fishing as there is no motivation due to low salaries of enforcers.

Not only does overfishing influence fish populations, but it also damages other ocean ecosystems. The lack of fish can cause imbalance in the food chain, causing animals like seals and coastal birds to suffer from the drought of fish. Irresponsible fishing can also cause other marine animals to be harmed or killed in the process.

Overfishing and illegal fishing also have an effect on humans. Fishing employs tens of millions of people around the world, and when there aren’t enough fish left after overfishing, these people lose their jobs and income.

IUU Fishing is bad for the fish, the economy and the nearby ecosystems. The more illegal and unregulated fishing happens, the more overfishing happens. These coastal nations rely heavily on the fish for their economy, and when the seas are emptier due to overfishing, that part of the economy is weakened.

Economic factors driving IUU fishing

Now that I have considered the dangers of IUU fishing, I will examine the reasons why people engage in IUU fishing. Most often, people who do IUU fishing are desperate. People from all over the world can illegally fish, and IUU fishermen exist in all coastal countries. However, the number of practitioners can change drastically. In first world countries there is a much lower rate of IUU fishing, compared to that of third world countries. Even so, illegal fishing is a large industry even in powerful nations like the USA. IUU fishing is not limited to poor people, although the poorer countries are more likely to do it.

IUU fishing is especially prominent in developing countries because the lack of economic stability can lead to a distinct lack of capacity and ability to handle a problem as big as the illegal fishing industry. Nations with a weaker economy prioritize other issues above the IUU fishing problem. This leads to much slacker regulations and much less enforcement of punishments toward practitioners of IUU fishing in and around those countries. The people of these nations are desperate for food and for money, so when they see how weakly the government controls the IUU fishing issue, they eagerly hop on board. In richer, more powerful countries, the authorities can spare effort and finances towards the prevention of illegal fishing. However, in the more economically weak countries there is no such prevention. People fish as they please, with very little risk.

The kind of people buying illegal fish is not limited to poor people. IUU fish creep into the seafood market all over the world, and once they're in circulation anyone can buy them and eat them. Often those consuming the fish have no idea that the fish wasn't legally obtained, because the regulation of seafood products is so poor.

Governments in some nations can't properly regulate fish and therefore IUU fish can very easily slip through into the marketplace. This is an issue because unregulated fish can contain poison or diseases that make them unhealthy for humans to eat. It is very important that the authorities report fish as they are being fished, so that the unhealthy fish can be filtered out and will not reach the market. People all over the world are

susceptible to buying and eating IUU fish.

The fishing industry is a massive and widespread industry, which makes it extremely hard for governments to control and regulate all of it, especially in undeveloped or economically weak countries, where the government already has trouble in other areas. Regulating the entire fishing industry is an expensive and time-consuming task, and many poor nations cannot afford to do it effectively. In first world countries like the USA, the control over IUU fishing is much better and stricter. But in third world countries such as Madagascar, the government has little to no power over the illegal fishing trade. IUU fishing is a bigger problem in these poorer countries, and work should be done to change that. However, change like this would take many years, and billions of dollars. It is going to be a long fight. But I have hope that in the future even the economically weak nations will have a tighter hold on the IUU fishing industry.

There are alternatives to IUU fishing. Legal fishing is common; hundreds of thousands of people around the Indian Ocean make their living with legal, government-authorized fishing businesses. However, by avoiding paying regulations and taxes, illegal fishing can be easier and cheaper than legal fishing. In some countries IUU fishing makes up a significant percentage of the total seafood industry, because it is easier and simpler for the people to fish illegally than to register and report all the fish they catch. Many people, especially more financially desperate people, prefer to catch fish illegally. In countries where there is little to no authority over the fishing industry, it makes a lot of sense for the people to turn to IUU fishing rather than legal methods.

Many people doing IUU fishing are poor or desperate, and they have no other choice than to join in and make the problem worse. An interesting thing to note is that many people who fish illegally have no bad intentions, and some don't even know that what they're doing is wrong in any way. These people see it only as a way to get more food and money, and they have no idea of the environmental impact of what they're doing.

Although the problem itself is hurting the environment, the root cause is economic. Poor, under- developed countries have a much harder time preventing illegal fishing. As a consequence, IUU fishing affects countries with a weak economy more than it affects countries with a strong one. The difficulty of preventing IUU fishing is due to several reasons, including lack of finances, lack of knowledge, and lack of prioritizing the issue. Economic strength relates directly to decreased IUU fishing.

What the IORA can do to prevent IUU fishing

Due to the economic factors involved, severe punishment seems a cruel way to deal with the problem of IUU fishing. Furthermore, since it is a crime largely born of necessity, severe penalties are unlikely to deter the individuals who take part in committing the crime. A man will break the law if it’s the only way he knows how to stay alive. And there we find the problem: fishing illegally is the only way they know. Education is the most productive countermeasure. Those who practice IUU fishing must be shown the right way before they can choose to take it. So how can the IORA help with a problem of this size? The key lies within close ties with local governments. Education on this scale can only be undertaken by the governments of the fishermen.

The first component of an effective IUU response plan is communication. The IORA can

certainly make strides in this area. Raising public awareness with the help of local governments is the simplest way to reduce IUU fishing. Once people know what they're doing wrong, and how to do it right, they're far more likely to choose the legal route to continue their practice.

The second component is enforcement. This is more difficult, but not impossible. Once the people are aware of the dangerous of IUU fishing, the government should be willing to ensure that it is being discouraged. In Australia, for example, this simply means keeping an eye on things through "monitoring, control and surveillance (MCS)".

The third component is strategic engagement. Though the name sounds important, strategic engagement simply means communication and cooperation within the nation's government. The aim is to come up with relevant and practical strategies for specific issues in different regions and for different problems. While the IORA may not be able to solve these problems on their own, they can work with the governments as professional consultation on the various issues that will inevitably arise.

The fourth component in the model is capability development and supplementation. This means improving and expanding on the second component. For a growing industry, there must be growing oversight. Governments must not assume that the taskforce they establish to keep watch for illegal fishing will always be enough. It must be encouraged to grow and meet demand.

The final component is a targeted threat program. This means identifying specific areas that are at a high risk of IUU fishing and preventing illegal practice before it takes place. The IORA may not be able to oversee every component of a plan like this, but they can present it to governments and help them implement it in their specific contexts.

People and governments may not even be aware of what practices can replace the current fishing methods. The IORA has the responsibility to promote responsible and sustainable fishing practices and aquaculture throughout its member states and to other nations engaged in making use of the oceans. Education, strategic engagement, and ongoing development and threat prevention can make a difference to IUU fishing and the health of our ocean ecosystems.

Conclusion

IUU fishing is a large-scale problem requiring large-scale solutions. In this essay, I have discussed the dangers of IUU fishing. I have also looked at causes of IUU fishing to determine how best to combat the problem. Finally, I presented five components which the IORA can use to create a strategy for combatting and preventing IUU fishing.

IUU fishing presents a problem, but it is also an opportunity. We all share this Earth's oceans. When it comes to the ocean, what affects one of us affects us all. IUU fishing is an open door for the IORA to foster global connectedness and international cooperation, not only to combat IUU fishing, but to promote a positive and sustainable relationship with the resources of the Earth.

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MARINE DEBRIS (Plastics)

By: Amiirah Hosanie, Mauritius

Introduction

Over the past few decades, oceans and marine life has been interrupted. 'Life below water' has its own world and is rich in itself with different and numerous aqua creatures. Yet, man's greediness leads them to be involved in activities which keep on innovating and rising that lead to the depletion of our marine life. Nature provides us with almost everything for us to survive on earth but in return we remain ungrateful. The successful management of this issue requires a comprehensive understanding of human behavior and marine debris. This can be outreach through education, programs, law and policies that can be reinforced by the government and private organisations. In this paper, the topic on 'marine debris' will be discussed in the following paragraph and also the measures that IORA can take to tackle the problem.

'Marine debris'

Defining 'Marine debris'

Marine litter is one of the most prevalent and solvable environmental pollution issues plaguing the world's oceans. It involves several items such as cigarettes,nets, food wrappers, bottles, rope, baby diapers and other materials that have serious consequences on marine creatures. Marine debris has changed dramatically since ocean dumping has been practiced. Most of our waste is made with synthetic elements such as plastic beverage bottles, synthetic fishing lines and also packing straps.

Plastic in marine environment

Floating marine litter such as plastics can drift away over long distances by prevailing winds and currents. Sources of plastic in marine environments are wide, but majority are considered to be land-based which come through to the sea by the flow of river. It has been predicted that by 2050 there will be more plastic in the oceans than fish. However, plastic arises through marine activities mainly ships and fishing vessels. These ships generate huge amounts of plastic waste in the marine environment. Fishing vessels also polluted the ocean by discharging large amounts of fishing nets, fishing gear and line in the water. According to a report, it is estimated that up to 639,000 plastic containers are discharged into the ocean every day. Another research reveals that fishing vessels discharged more than 52 million pounds (equivalent to 26,000 tonnes) of plastic packaging material and this is increasing day by day as the world progresses. For example, the population of Mauritius is 1.3 million and the waste it generates daily is quite huge.

According to the U.S. Marine Mammal Commission, "136 marine species have been reported in entanglement incidents, including six species of sea turtles, 51 species of seabirds, and 32 species of marine mammals". This shows us how our human activities are putting the life of these innocent species at risk.We have one amongst the major problems that is ingestion of debris by animals. Our waste such as plastic or shopping bags may look edible, for example plastic bags may appear as jellyfish to a hungry sea turtle. Many sea species are confused between debris and food, so once they swallow

it, it lodged in their throats and stomach. The physical effects that are blockage of internal organs can lead to starvation.

Sustainable Development Goals (SDGs) and Marine debris

Across the world we have initiatives being taken at different levels: globally, regionally and nationally. It includes programmes,guidelines, action plans, agreement, regulations and strategies. Generally, marine debris is increasing alarmingly due to high production and consumption. We have some international conventions such as the London Conventions (1972), International Maritime Organization (IMO) and others but in this paper we will focus on SDGs.

Sustainable Development Goals (SDGs) is relevant to marine litter as it is related to the environment, economics and to our society. We have several SDGs but we will discuss only on SDG 14 namely, 'life below water' and the rest will be mentioned partly throughout the discussion. Marine debris has threatened the marine life environment and also the wellbeing of human health. SDG 14 seeks for conservation and sustainable use of oceans, marine resources and seas. In order to achieve SDG 14, collective and coordinated action should be taken on national, regional and global grounds by reinforcing integration of stakeholders. Moreover, the rise in global plastics pollution is firmly related to SDG 15 "Life on land" as the majority of debris comes from the land. For example, researchers have estimated that 2.4 and 4 million tons per year of river litter are input to the ocean.

Life Below Water (Goal 14) that directly or indirectly prevent, reduce and encourage management of marine debris.The main objectives of these SDGs are prevention and reduction of pollution in order to protect human health and environment (United Nations, 2015). Therefore, these SDGs are very important as the marine debris poses threat to the wellbeing of human health, marine life and environment. Nowadays, the microplastics in the environment are also being considered as marine pollution. If this is not tackled properly, microplastics will result in negative impacts on marine biota and the environment, and this may delay the efficient implementation of sustainable development goals.

According to the United Nations Environment Programme (UNEP, 2015), plastic marine debris will rise by a factor of ten in the subsequent decade since future plastics production is anticipated to double by 2035 and almost quadruple by 2050. Plastics can be found even in the deepest world's ocean trench. Our daily plastic use is produced massively in an amount of 330 billion pieces per year and often used for just a few hours before being thrown into the environment. Research indicates that plastics can take hundreds of years to break down or may never truly degrade.

Impact of plastic marine debris

Injury to or death of marine organisms

The potential risks associated with plastics for marine life has been a subject for research for many years. As we have mentioned above, the first victims of marine debris are aquatic animals which get entangled in fishing nets, and other plastics debris. The entanglement results in restricted movement, having difficulty in seeking food that is why they are confused between their prey and plastics. Furthermore, a research by

Dr. Kathy Townsend states that colorful plastic debris can easily attract marine animals. The injested plastics may cause physical and physiological effects on aquatic organisms. Physical effects such as gut blockages that lead to starvation. For the physiological impacts, such as endocrine which come from the chemicals and additives. This also affects megafauna aquatic animals such as whales, dolphins and sharks. Another

threat is to abandon entangled marine organisms in fishing gear. Marine debris can degrade delicate coral reefs and other benthic species which lead to high mortality of these creatures.

Effects on human lives

Humans are exposed to microplastics through the consumption of seafood. Substances used to produce plastic bags are dangerous for animals and also for human beings. Many studies prove that through the food chain process, marine plastics impact human health as it is related to cancer, reproductive problems, immune dysfunction and imbalanced development in children. The exposure level was recorded in Italy, Canada and China as high concentrations of microplastics have been observed in their market sample. The prospective effects that are related to our health are in our hands as we must be conscious of how our daily activities can have a ripple effect on our life.

On the other side of the coin, marine plastics represent a threat for socio-economic affairs, as it also affects our coastal activities by avoiding fishing in the affected areas. The livelihood of fishermen living near the coastline are threatened. So to compensate this government needs to invest by providing them an amount of money for their living. Yet, some governments allocate huge amounts of resources in projects such as cleaning up of coastal areas. Moreover, landscape degradation due to accumulation of debris is an eyesore and unpleasant, this leads to a decrease in the number of tourists specially for destinations which rely on the tourism sector for example, Mauritius. Many people who work in hotels and other related jobs linked to the tourism industry will lose their job and this will increase the poverty rate. We must have a glance at people who survive by the ocean, as they gain their livelihood through it. Therefore, by using recycled items such as biodegradable bags, this will help us to protect marine life and also the livelihood of the coastal inhabitants.

International law on prevention of marine plastic

Marine debris is a global issue, so we have regulations which have been imposed by international organisations. The United Nations Convention on the Law of the Sea (UNCLOS, 1982), the laws that they have set was to prevent marine dumping and conserve aquatic species. Some direct regulations set by UNCLOS was that coastal states had the rights to protect marine environments by prohibiting dumping of waste and any discharge from industries. In order to achieve this, countries must work together to make it a success.

Moreover, we have the London Convention that controls the pollution sources that can have a negative impact on aqua environment, marine life, affect human health and living resources. This Convention comes up with a list of prohibited wastes such as plastics and synthetic materials. The 1978 Annex V protocol (MARPOL 73/ 78) the agreement

aims to prevent marine pollution derived from board ships such as pollution by oil and toxic substances. For example, about 1,000 tonnes of fuel oil from the Japanese-owned MV Wakashio leaked into the ocean in July 2020, causing Mauritius' worst ecological disaster.

National law on prevention of marine plastic

Mauritius is known to be a paradise island in the Indian ocean. It is an island surrounded by the ocean with no natural resources such as gold, petrol or minerals but a huge maritime zone of 2.3 million square kilometers which offers great perspectives. Mauritius depends on the resources which the ocean offers. The three ‘s’ of the island that are sea, sun and sand have helped to boost the economy of Mauritius as it attracts overseas visitors. In order to keep the island’s beauty, Mauritius has authorized several conventions to address the issue of marine pollution. The Convention on Marine Pollution by Dumping of wastes, the MARPOL Convention to prevent pollution from ships, Basel Convention on the Control of Transboundary Movement of Hazardous wastes, the Nairobi Convention on healthy oceans, coasts and rivers in the Western Indian Ocean Region and the Convention on the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region all these has been integrated to protect the sea of the island.

Furthermore, under the Environment Protection Agency (EPA) 2002 which is an agency of the United States federal government, the regulation of banning of plastic bags has been introduced in 2015. It involves the banning of importation, manufacture, sale, supply of plastic bags. All the importers and manufacturers of plastic bags had to be lawfully registered and crack down operations will take place several times to seize up illegal plastic bags. Since 2016, it has been noted that around 179 million biodegradable bags have been imported and manufactured.

What can IORA do to address the issues?

The Indian Ocean Rim Association (IORA) as an intergovernmental organisation can help to tackle this problem through many ways. As the world keeps on changing, human life keeps on innovating such as there are new platforms and approaches through which an individual sees a situation. First and foremost, new methods of campaigning should be implemented in the meantime keeping the previous methods. For example, raising awareness in a mall about using recycled bags instead of plastic one. But nowadays, the ‘new normal’ has pushed people to adopt new ways of living and campaigning only in malls or face to face may not be enough. People are well versed with technology, so IORA can use social media platforms to raise awareness and to educate people about the effects of plastic bags in our ocean. IORA can share short educational videos, create question polls on Instagram and Facebook stories to collect information about how much people are aware about what is happening in our ocean.

Secondly, IORA can encourage and provide traineeship to youngsters such as fresh graduates and school leavers as this will help them to get involved in projects such as working as a team on a research related to marine life. This will help them to gain an attachment with the ocean and its creatures and the teamworking will benefit IORA as there will be sharing of ideas and will have a glance on how our youngsters, our future generations are concerned about this issue. Our young people are more comfortable

with social media platforms where they can spread the words of the ocean and encourage their followers to be more conscious and aware of marine debris. For example, the influencers on Instagram and Facebook have many followers. These people can help to promote ‘Go Green’ biodegradable products such as takeaways, straws, cups, bottles and bowls.

Moreover, IORA can sponsor small local organisations which want to combat plastics marine debris such as help them to print their brochures, and other materials in order for them to access huge audiences. They can even train them at the beginning as it will boost their motivation and willingness in their project such as cleaning up programs at public beaches with the aim of ‘marine environmental awareness’. IORA can also send these small local organisations to regional schools located nearby them to educate the adolescents, the children at an early age to contribute for the well being of the ocean. Creative tools and activities can be organized by these organizations such as interactive powerpoint presentations which will make them attracted to the subject. The environmental club in school can help students to participate in activities such as cleaning up classes, avoid usage of plastic bottles and presentations from these local organisations can help the young people to have a better view on what is going on in our oceans. A workshop can be organised by IORA where all these small organisations can meet up and also bring out new members along with them.

IORA can implement a circular economy that gives value to waste, promotes reduction in waste generation owing to the application of 3R (reuse, recycle, recover), thereby bringing about sustainable production and consumption patterns. Despite the efforts taken to overcome the issue of marine debris, marine debris is still accumulating in the environment every day. This increase, along with their persistent nature, the negative impacts of marine debris, especially of microplastics, are going to be even more harmful to human health.

Conclusion

As a whole, marine debris can be a major part in the possible collapse of the ocean's well-being, together with other modifications, such as global warming, rising sea levels and changes in the ocean chemistry. Indirectly, marine litter is a global stress that compromises the equilibrium of the ecosystems, which could cost a tremendous amount of money in the long run through control efforts, cleanups and negative economic impacts To tackle this issue, there are numerous initiatives that have been taken in response to persistence and universal abundance of marine debris, such as international conventions, global and regional partnerships, sustainable development goals and national regulations. However, it is in our hands, as we need to be responsible first by making a choice between the use of toxic substances, plastic products or biodegradable ones.

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Plastic debris in the Indian Ocean: a threat to the coastal population and ecosystem of IORA countries

By: Istiak Ahmed

Introduction:

Marine debris includes any processed or manufactured solid materials which are abandoned or disposed into the ocean or coastal area **(Gall and Thompson, 2015)**. Debris in the ocean contains a wide range of materials lost by people or unintentionally discarded into the sea, such as wood, plastic, rubber, metal, clothing, paper etc. **(Gall and Thompson, 2015)**.Nowadays plastic has been found almost everywhere, from the remotest of a beach to the stomach of a sea bird. Since 1950, the worldwide production of plastic accounts for 8.3 billion metric tons and it is recognized as the most noticeable pollutant responsible for ocean pollution **(J. Jambeck et al. 2017)**.Since the utilization of plastic, oceans have become the major dumping station for plastic debris. Although there are policies and conventions related to marine litter, those legislations arewidely ignored and tons of wastes are dumped into the ocean **(Duhec, 2015)**. In 2010, a total of 275 million metric tons of plastic waste was produced by 192 coastal countries and 4.8-12.7 million of those plastic waste accumulated in the ocean **(J. Jambeck et al. 2015)**.

However, the Indian Ocean is one of the most polluted oceans. In fact, it is the second-highest container of floating plastic waste, with 96400 tons of plastic debris floating on its surface **(Eriksen, 2014)**. Some of the most plastic polluted river empty in the Indian Ocean. Thus it receives a huge amount of plastic every year **(Pattiaratchi et al, 2022)**. Some of the Indian Ocean rim countries have the highest population density **(Pattiaratchi et al, 2022)** and nearly one-third of the global population is hosted by the Indian Ocean Rim countries. The lives of these tremendous amounts of the population as well as their livelihood is intertwined with the Indian Ocean **(Nimit, 2021)**. Thus any impact on the IO corresponds to the people and ecosystem of the nearby area. Therefore, IORA should take a collaborative approach to mitigate the issue of plasticdebris by emphasizing on the management of plastic waste and implementing existing legislation on marine litter.

Plastic debris as a concern for coastal population:

Almost all of the member countries of the IORA are from Asia and Africa, except for Australia and France which are from Oceania and Europe respectively. Every member country of IORA have coastal areas and some of the countries are island surrounded by Indian Ocean from every direction, such as the Comoros, Madagascar, Maldives, Mauritius and Seychelles. Table: 1 illustrates the enormous numbers of population living within 100km of coastline. It is very clear from the table that in most of the countries nearly 50% people residing near ocean. It is not surprising that for some countries the percentage is 100 as those countries are small and situated far from mainland or adjacent to the sea, such as Singapore, Sri Lanka, Seychelles etc.

Since there are a tremendous amounts of people living near coastal areas and their life is depended on the Indian Ocean and maritime resources **(Nimit, 2021),** the safety of ocean is a precondition for the survival of the population living nearby. As plastic debris are harmful for people and the whole environment, it is a matter of concern for these people as well as the corresponding countries. Every year millions of tons of plastic debris are dumped into the Indian Ocean through rivers **(Pattiaratchi et al, 2022)** and many other sources. As a result the coastal areas are polluted by those debris which inevitably affect the life of people and other living animals. One of the sources of income for coastal people is tourism business. People all over the world come to the coast of these countries to spend their holidays, mostly because of the natural beauty intertwined with

the ecosystem and overall environment of the coastal area and sea. The pollution of ocean and nearby

Region	Country	Total 2000 Population(000 people)	Population within 100 km from coast (%)
Oceania	Australia	18838	89.8
Europe	France	59061	39.6
Africa	Kenya	30340	7.6
	Madagascar	17395	55.1
	Mozambique	19556	59
	Somalia	11530	54.8
	South Africa	46257	38.9
	Tanzania	33687	21.1
Asia	Bangladesh	128310	54.8
	India	1006770	26.3
	Indonesia	212565	95.9
	Malaysia	22299	98
	Singapore	3587	100
	Sri Lanka	18821	100
	Thailand	60495	38.7
	Iran	76429	23.9
	Oman	2717	88.5
	United Arab Emirates	2444	84.9
	Yemen	18118	63.5

Table: 1 (Source: Maul & Duedall, *Demography of Coastal Populations* 2005)

areas reducing the beauty and attractiveness which in turn cause economic downfall for the indigenous people. Plastic debris also affect the sea creatures and animals such as Invertebrates, fish, seabirds, marine mammals. Plastic is also the cause of their death **(Rochman et al.2016)**, which is a matter of great concern.

Overall, the marine debris particularly plastics is the reason for economic and environmental damage for the coastal region of most of the IORA member countries. The issue needs to be addressed as early as possible to restraint it from being worse than the present condition. The coastal areas are already in a threat of drowning because of the rise of water level as a result of climate change and global warming, plastic debris is nothing but worsening the overall situation.

Responsibilities of IORA to address the issue:

The members of Indian Ocean Rim Association countries are not same regarding economy, population, size etc. However, to the point of being affected by plastic debris, all countries are same though the rate of impact varies. Some of the countries of IORA are technologically and economically advanced, such as India, France, UAE, Singapore, South-Africa etc. rather than the others. So, it will need a collaborative approach to solve

the issue. The advanced country should share their technology and invest on addressing the problem while the other should take part by joining their man force.

The following steps should be taken by the Indian Ocean Rim Association to address the growing concern of plastic debris in the coastal region:

- First of all, IORA should introduce a limited production of plastic. Less production of plastic means that less debris will be dumped. At the same time, alternative of plastic should be introduced. The member countries should raise a fund to invest on finding the alternative of plastic. This will be asustainable solution if a reasonable and convenient alternative is found.
- One of the major sources of plastic debris are the rivers those are opening into ocean. Rivers are working as a media to bring plastic debris into the ocean. If river pollution can be reduced, eventually it will lessen the ocean pollution. A commission can be established by the IORA to maintain the security of the rivers which are opening into the ocean.
- Educating the coastal population is a must need. Many Asian and African countries are holding uneducated people living near coast line. This people lack the necessary awareness because of their inadequate or no education. Educated people are needed to reduce marine pollution. Long term plan should be taken for educating the coastal people.
- IORA members could work as a lobby in the United Nations to raise special attention to this region in terms of plastic pollution. The member states should raise their voice unitedly, IORA could work as platform of group diplomacy. It could help the relatively poor countries to gain their objectives also.
- Reuse and recycle policy should be taken by the IORA members. They could also regulate the shape of plastic bottles and other things so that these could be used many times. Recycle technology should be made easier and the entrepreneur of recycling project should be encouraged by financing them.
- Often tourists are the major carrier of plastic debris into the ocean. It is causing the pollution, at the same time destroying the beauty and attractiveness of the spot. As a result tourism industry suffers. To protect the tourism industry while maintaining the environment, special awareness program should be introduced in the relevant areas, so that people become aware of the harmful effect of the plastic debris.
- IORA members could ask collaboratively for fund to the giant producer of plastic so that they could use the money to restore and reduce pollution in coastal region.
- IORA should take initiative to make all the coastal region as protective areas to save them from further pollution.
- Transfer of technology should be encouraged among the IORA countries to obtain sufficient capability for addressing the marine pollution problem especially plastic debris.
- The Indian Ocean region should be declared as a restricted zone and no ship should be allowed to dump waste into the ocean.

Conclusion:

Indian Ocean Rim Association members are the most vulnerable to marine pollution because of their geographical position. Plastic is a rising concern for polluting the maritime area and coastal region. It is also accountable for destroying coastal ecosystem. As a result, the people of the concerning areas are affecting

very badly. As the matter is not personal for any country and the nature of the issue requires a collaborative approach, it makes sense to maintain a platform like IORA. This platform should act as a media to discuss the plastic debris problem and the way to solve. The member countries should be proactive for their own betterment. The varying diversity of the countries in IORA should be an advantage of solving plastic problems.

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Issues of the Illegal, Unreported, and Unregulated Fishing

By: Pamudi Samaraweera

Illegal, unreported and unregulated (IUU) fishing is a major issue that negatively affects social, environmental, economic and regulatory systems in all ocean basins. According to the Food and Agriculture Organization, IUU fishing activities cause a loss of 11–26 million tons of fish each year in oceans. Fishing activities which violate international laws and national laws, activities that doesn't fulfil responsibilities to conserve and manage the marine living resources of seas and activities which doesn't comply to management measures of a Regional Fishery Management Organizations are coming under IUU fishing. Generally, it includes fishing where no formal management measures exist.

Illegal Fishing - Source: iStock

It is a fact that IUU fishing is happening all around the world but when considering Indian Ocean, it has become threat to economy and to the living marine fauna species. This crime in fisheries is driven by the need to meet basic human needs with the increasing population growth. Also, the legitimate commercial fishers deliberately set out to conduct IUU fishing seeking to increase profits by maximizing the returns and minimizing their costs. Most fishers conduct IUU activities in small scale by artisanal vessels in their own waters or in waters of other states. With that a great deal of international heed is paid to high seas fisheries in Indian ocean. However, FAO's recent assessment depicts that 30% of the Indian Ocean's stocks are not fished within biologically sustainable levels. With the increasing demand for fish products continues worldwide, significant challenges are faced by seafood importing nations to ensure IUU products are not entering their markets. In addition, these illicit trades put seafood value chain at risk including the coastal communities in less developed countries who rely on the ocean for their livelihoods. A 2015 study of selected species representing Indian Ocean portraits that 16% to 34% of catches were either illegal or unreported. Generally, the unregulated aspect of IUU fishing

is often overlooked while international attention directs heavily on illegal and unreported fishing in the Indian Ocean. Also, IUU fishing cause impacts to both economies and marine ecosystems, yet they are under-estimated. Besides, IUU fishing has a significant disadvantage to authorized fishers. Endlessly it contributes to resource decline and overfishing. It has been estimated at >8% of fisheries catch within the South Asia and South East Asia region while more than 50% of IUU catch by foreign vessels put developing countries most at risk as high amounts of seafood are taken out of impacting the food supply system, food security and livelihoods of millions. Also, a huge amount of seafood stocks is traded illicitly by directly shipped overseas without unloading in host countries, reducing the local economies of income, jobs and revenue. Furthermore, if the animal protein that enter illicit trade are not accounted it will lead to extensive depletion of marine resources. As reported by studies, a larger part of waters in Asia falls under Exclusive Economic Zones (EEZ). In there, domestic IUU fishing use illegal gear and unregistered vessels whereas transboundary IUU results from fishing in other countries waters without a license along with trans-shipping of fish out of one EEZ to land elsewhere. Apart from those largescale vessels fishing in reserved zones, high seas drift netting also practiced in Western Central Pacific closer to Indian ocean.

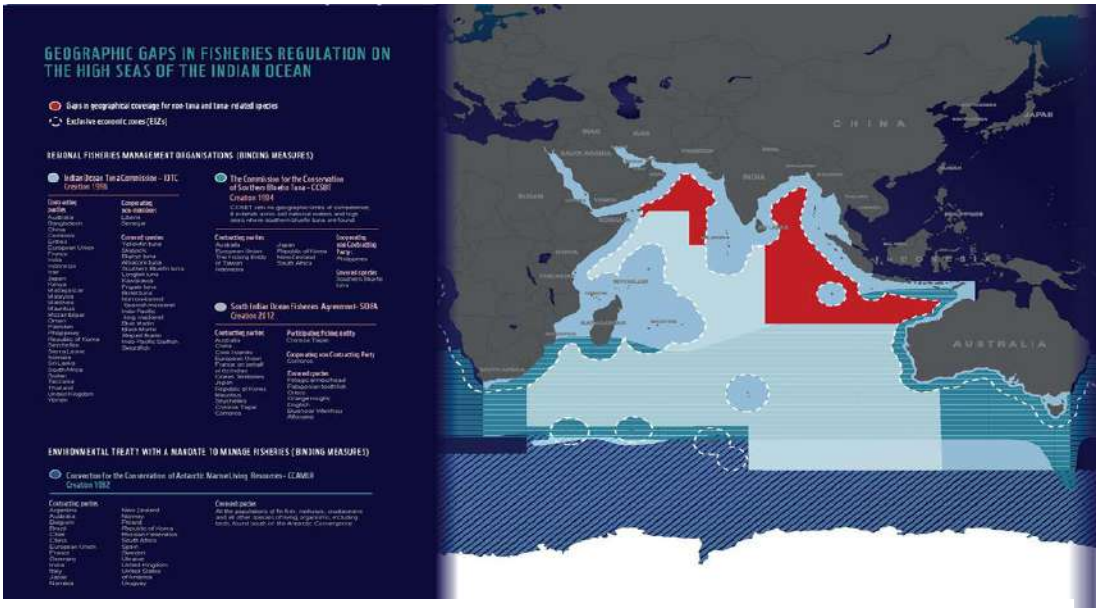
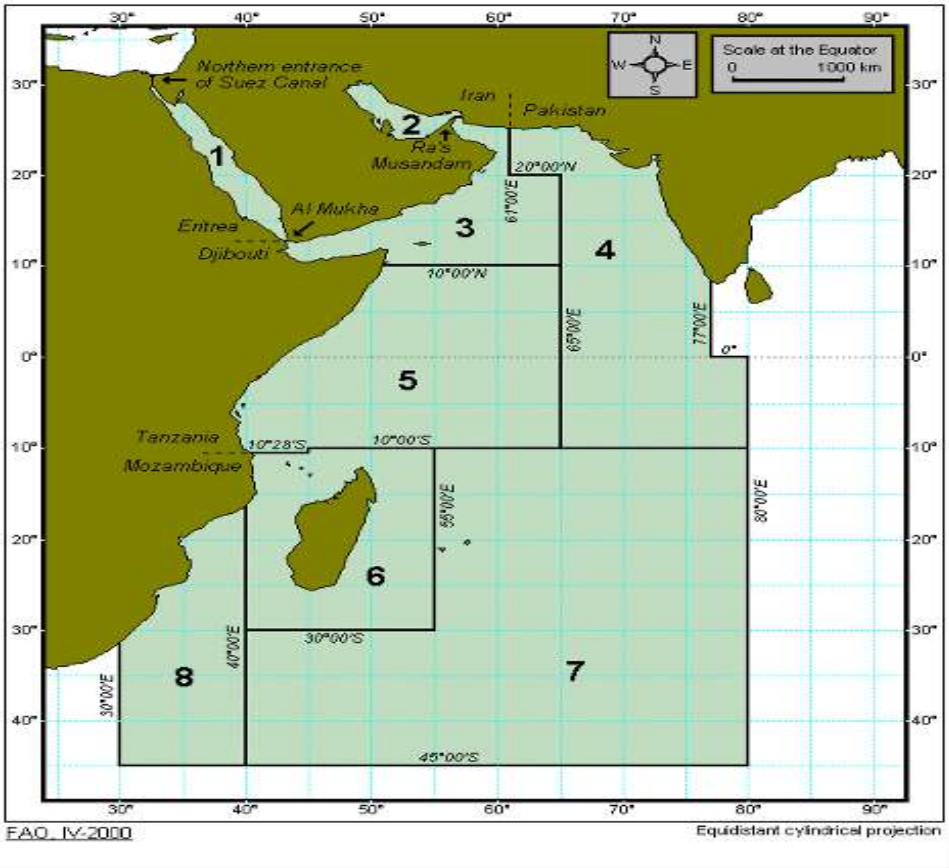


Image by

https://wwfeu.awsassets.panda.org/downloads/wwftmt_unregulated_fishing_on_the_high_seas_of_the_indian_ocean_2020.pdf

Most IUU catch in Asia is domestic or between neighbor countries. Poaching by foreign vessels is a fact and Tuna is a significant target in some places whereas demersal resources somewhere else. All most every country have a clear objective to practice more in offshore seas fishing and they target tuna and other offshore resources. In order to achieve that, what they do is upgrading their ports to handle higher value fish for export. On top of that the Western Indian Ocean region is blessed with high biodiversity, tropical weather, coral reefs

which provide habitats to a vast fishery resource. While the fisheries sector contributes for a massive part of the GDP of the Western Indian Ocean region but at the same time it has become full of Illegal, Unreported and Unregulated (IUU) fishing. The prevalence has resulted in exploitation of the fishery resources, depleting the marine flora and fauna, reducing regional economy and destroying the ecological balance. Eventually it has affected the overall economy, food security, and the fishing of the Western Indian Ocean region compared to other regions.



The Western Indian Ocean region

Image by: https://rsrr.in/wp-content/uploads/2021/09/Picture-1.png

Without a doubt IUU fishing has been identified as one of the major challenges affecting the 'right to life' and 'right to livelihood' of people living within 100 km of the coast in the region. Once Dirk Zeller, professor and director of the Sea Around Us said, "Only through full accountability and public transparency can we ensure that fish resources are not only sustainably and legally caught and traded, but that the benefits of this economic activity accrue to the people and governments of each country where fisheries occur". Therefore, as responsible nations we should care about the IUU fishing because it creates many issues. In this case damaging the economic well-being, societal development, food security and its impact on the whole ocean ecosystem by

removing key species can be stated. Also, these impacts are mainly based on using of destructive, forbidden practices. Generally, IUU fishing often targets threatened species such as sea turtles, sharks and seabirds. Without stopping in there it also does physical damage to coral reefs and sensitive marine ecosystems. Furthermore, illegal fishers do not report the catching amount. Therefore, it affects the accuracy of estimating official fish and stock. Also, as the amount of catch is unknown it is really problematic to manage fisheries sector where illegal fishing is taking place. Another major issue linked to IUU fishing is many illegal fishers engage in other illicit activity. As United Nations Office on Drugs and Crime states many illegal fishing operations include human right abuses, some use a crew bonded labor with few rights and minimum reward. In addition, common crimes include tax evasion, money laundering, trafficking of drugs, arms and even people etc.

In fact, there are critical gaps to be addressed in order to put a stop to IUU fishing. They are the lack of policy implementation, not having an internationally recognized identification numbers on fishing vessels, the lack of a system for tracking vessels, and low sharing of information among agencies related to the suspected illegal fishing activity. Therefore, it is important to introduce an International Maritime Organization (IMO) number as the vessel's unique vessel identification number along with increasing the sharing of information among coastal countries, improving law enforcement, adopting and implementing of Port State Measures Agreement to cut off the port access to illegal fishers, practicing controls in major markets to keep IUU fishing stocks in off store shelves etc. At last, but not least need to ensure that IUU fishing to be recognized as a criminal activity so that the law can be enforced against people those who are engaging in it. Though several measures have been already made to combat illegal, unregulated and unreported (IUU) fishing activities at present, there are still illegal cases documented and reported by Regional Fishery Management Organizations and countries who have coast. When attempts are taken to find the causes behind this haunting IUU problem, it is found that ineffective policy, insufficient supervision, lack of regulatory measures and control are the main hindrances to get rid of the on-going illegal, unregulated and unreported (IUU) fishing problem. Due to these hindrances “The overall economic impact related to the diversion of fish from the legitimate trade system is costing us $26 billion to 50 billion globally," said Rashid Sumaila, lead author and professor in the Institute for the Oceans and Fisheries and the School of Public Policy and Global Affairs.

There are different measures we can take as member states of IORA to prevent IUU fishing. Firstly, following the In Port State Measures International agreement which is aimed to block cash flows to IUU fishers reducing their engagement in IUU fishing. Also, the port state measures try to prevent IUU fish from being imported or traded as well. In order to achieve that prohibiting the port access can be done. Secondly, to combat IUU fishing Coastal State Responsibilities play a major role. They can collaborate to improve data collections to gain accurate information, assess the status of fisheries, develop national plans of action to reduce overfishing,

eliminate IUU fishing activity etc. Furthermore, sharing the collected information and providing support for traditional, small-scale fisheries management are some important responsibilities. Thirdly, there are Market Measures which is closely related to the implementation of Port State measures. Another significant provision that can be applied is the global cooperation and harmonization. There, a global vessel list should be introduced to replace the various IUU vessel lists of different RFMOs. Moreover, need of having a better tracking of how products of IUU fishing enter markets, ensuring the various parties such as importers, transhippers, buyers, consumers, etc about the impact of IUU fishing is really important. Finally, raising the awareness among people about the negative aspect of getting linked to other forms of crime suppression like the money trail and not do business that promotes IUU fishing, can be taken as measures that would combat IUU fishing.

When discussing IUU fishing Regional Fishery Management Organizations (RFMO) cannot be missed as it is a type of international organization that is dedicated to the sustainable management of fishery resources in a particular region of international waters to halt IUU fishing by paying their focus on high seas, which may also include Exclusive Economic Zones waters of riparian countries as well. RFMOs establish management and conservation measures such as catch certification, trade documentation, vessel registration, licensing, boarding and inspection, vessel listing (IUU, Authorized Vessels) monitoring trans-shipment and conducting observer program etc. Also, they share information among member countries which is an important measure to slow down the IUU catch. It should be noted that Indian Ocean Rim Association (IORA) as a RFMO which is an inter-governmental organization focused on strengthening Indian Ocean Regional cooperation and sustainable development of fisheries. Though fisheries sector of Indian Ocean Regions plays a major role in job creation, poverty reduction, food security providing food to millions of people, it faces many challenges due to overfishing, IUU fishing, marine pollution, habitat destruction etc. Therefore, IORA give high importance to fisheries sector. Not only that fishery is one of the main focuses in IORA's Blue Economy Agenda. According to the world bank, blue economy is the sustainable use of ocean resources. Moreover, it contributes for improved livelihoods, economic growth while conserving the health of ocean. At the 14th IORA Ministerial Meeting in Perth, Australia, on 9 October 2014, Blue economy captured the attention of all IORA member states due to its contribution toward sustainable development. Since, Indian ocean is full of resources IORA member states established a common vision to drive towards a balanced economic development with the blue economy concept in the Indian Ocean Rim region. Since 2014, with the initiation of new programs, wide range of areas have been covered such as seafood processing, handling and storage, seaport and shipping, ocean forecasting etc. With the recent increase rate of IUU fishing blue economy sector is facing challenges. Therefore, IORA which acts as the first line of defense to many traditional and non-traditional safety and security challenges in Indian Ocean also address crimes in fishery sector where IUU fishing includes into.

Though IORA is already in action to prevent IUU fishing they can study novel solutions introduced by different researchers, professionals etc to strengthen their present action plan to gain more results in future. To illuminate the above measure some of the solutions proposed by researchers to prevent IUU fishing include the increasing transparency, enforcing of various existing international agreements, addressing fish 'laundering', granting fishing access permission only to vessels that are insured, being diligence, and stepping up of collaborative activities across all water between countries etc can be mentioned. In addition, there are tools available to combat Illegal, Unreported, and Unregulated Fishing such as coastal state responsibilities, international instruments, flag state controls, port state measures & market measures, vessel registers, catch documentation schemes, regulation of trans-shipment etc. which can be used by IORA in their action plans. Indeed, now a days with the development of technology, use of Automatic Identification System (AIS) data to examine the risks of unregulated fishing to ocean health is also being carried out. Furthermore, AIS data can be used to address the challenges faced by regional management sector and decision makers to tackle unregulated fishing on the high seas of the Indian Ocean. Since, using AIS data will be an effective strategy to face the current challenges related to IUU fishing if Indian Ocean Rim Association pays their focus on using Automatic Identification Systems to gather data. In the opinion of some authors, fishery authorities in China have stronger determination to impose strict supervision and control on marine resources in their waters to prevent IUU catch. At the same time, not only China, IORA also can-do strict supervision in Indian Ocean and give more concern to fishery sector by offering training courses to fisherman and raising their awareness on law compliance related to IUU fishing. Focus on such means would assist the Indian Ocean Rim Association to address the issues of IUU fishing, to promote sustainable and healthy development of fisheries in Indian Ocean regions and to become the responsible organization as it aims to be.

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Bettering the priority areas of the Indian Ocean Rim Association, emphasising Marine Debris in achieving a sustainable and healthy Indian Ocean region.

By: Nosipho Dube, South Africa

Introduction

The following piece will look at the Indian Ocean Rim Association and outline suggestions, spanning public engagement, avenues of reform and Marine Development Awareness on how IORA can mitigate the issue of marine debris.

The most pertinent global environmental problem is marine debris, particularly plastic and microfibres generated from plastic and clothing. Studies dating from 2018 have already painted a grim picture of an annual amount of 8 metric tons of plastic in the ocean. Furthermore, once plastic breaks down, it becomes “microplastics”, eaten by fish and later humans (Whiting, 2018). Poignantly, the severity of plastics on wildlife was evident in the 2018 case of a dead whale found off the coast of southern Thailand with 80 plastic bags found in its stomach (Whiting, 2018). Marine debris comprises “any form of anthropogenic manufactured or processed materials discarded, disposed of, or abandoned in the marine environment, deliberately or unintentionally, and may be transported to the ocean by rivers, drainage, sewage systems, or wind” (Sheavly, 2007). Plastics have low density, so they float on the sea surface over long distances by winds and currents (Corbin & Singh, 1993). The travel patterns resulting in plastic debris prevalence strongly suggest these plastics originated primarily from land-based sources. The accumulated debris enters the sea due to inadequate waste management and negatively impacts even remote environments. Persistent waste generation only increases proportionally with the dramatic growth of the world’s population and industrial production. Moreover, this is made dramatically worse by weak legislative measures/penalties put upon corporations or people. Developing nations often prioritise economic liberalisation over a policy that promotes healthy oceans and sustainable development, which means that large corporations can operate without significant ramifications and threats to their business operations.

On 17 November 2021, Bangladesh assumed the role of the IORA Chair, with the Democratic Socialist Republic of Sri Lanka and the United Arab Emirates taking the position of vice-chair (Sukheja, 2021). The theme for the 2021 – 2023 period, “Harnessing the opportunities of the Indian Ocean sustainably for inclusive development”, was adopted during the 21st IORA COM Meeting and aimed for “an open, free, peaceful and inclusive Indian Ocean” and prompting a move away from “any unilateral dominance in the region” (Sukheja, 2021). Bangladesh’s appointment and theme of inclusive, sustainable development are crucial in achieving sustainable development and addressing the demonstrable environmental concerns prevalent within the Indian ocean and the broader blue economy.

Plastic, plastic everywhere!- Contextualising the plastic dilemma at hand

In concert with limited public awareness, a lack of early, efficient, and consistent waste management plans have led to profound pollution levels by marine debris. Since the widespread utilisation of plastic in contemporary times, oceans have become a dumping ground for human waste. A concerning 90% of waste originating from rivers within proximity to the Indian Ocean ends up in the ocean; added to this are five Asian nations, namely: China, Indonesia, Thailand, Vietnam and the Philippines, accounting for over half of the planet's sea-dumped plastic waste (Daghar, 2019). Moreover, the increase in megacities and subsequent population growth has resulted in large industries cost-cutting and not conforming to proper plastic waste disposal methods.

In alignment with most developing countries in Southeast Asia, an example of this is Malaysia; with over 1,300 plastic manufacturers, Malaysia has become one of the largest plastic production industries globally (Chen, Nath, Chong, Foo, Gibbins, and Lechner, A.M., 2021: 2). As a result, the country's waste management systems are inadequate for dealing with the amount of plastic waste produced. With the county's exponential population growth, the country already produced more than 0.94 million tonnes of mismanaged plastic waste annually by 2018 (Chen et al. 2021: 3). Adding on to this dilemma, the primary source of ocean contamination, brought about by coastal populations' direct disposal, is a concern in Malaysia. Because the country is estimated to be the eighth largest producer of mismanaged plastic waste globally, with 140–370 million kilograms of plastic wastes entering the ocean annually and; an area of concern is that within Malaysia, very little is known about microplastic pollution levels in the environment (Chen et al. 2021: 5).

Countries such as China, Indonesia, Thailand, Vietnam and the Philippines - whose industries comprise complex plastic manufacturing – are directly affected by plastic pollution and lack adequate legislation to prevent or mitigate the problem (Daghar, 2019). As such, there is an urgent need to enforce punitive measures on pollution emanating from nations whose industries comprise plastic-heavy production and border the Indian Ocean (Daghar, 2019). Against the backdrop of environmental risks, the marine debris crisis has seen a run-off effect of harmful fishing nets, untreated sewage and industrial wastes entering coastal waters in the Indian Ocean, causing eutrophication and hypoxia (Davis and Balls, 2019: 16). As a result of billions of litres of sewage and industrial waste entering the region's coastal waters, certain parts of the Indian Ocean are experiencing declining oxygen levels. The aftereffect is called 'dead zones, as there is not enough oxygen to sustain marine life, including coral reefs that are fundamental in protecting marine life (Davis and Balls, 2019: 17). It is essential to understand the movement of waste in the oceans and where it ends up to gauge the ramifications, this will have for both ocean life and the blue economy as a whole. Floating plastics move along ocean currents, waves, and wind resulting in what is referred to as subtropical "garbage patches" in the oceans. The garbage patches accumulate in mass amounts before being spread across the ocean, affecting the state of the entire Indian ocean.

A prime example of this is the Indian Ocean garbage patch discovered in 2010, measuring 5 million square kilometres. This vortex of plastic garbage moved from Australia to Africa and back to Australia and is a sad reflection of what has transpired in the Indian Ocean marine environment (Schottli, 2018: xiii). The 2010 Indian Ocean garbage patch is misunderstood; however, it is described as a zone featuring circulating floating plastic. Continuing this circulating pattern over some years until it reaches its destination of a centre point within a Gyre, where it believed it would reside indefinitely. This patch's origins are the upper water column of the Indian Ocean Gyre(Davis & Balls, 2019: 17). The discovery of this patch by Australian authorities resulted from a search for the Malaysian Airlines flight MH370, believed to have been lost in the Indian Ocean. What was initially thought to be aircraft debris was later discovered as plastic waste (Davis & Balls, 2019: 19). [1]

Moreover, evidence suggests that the trash does not condense into an island-like state, and instead, it is spread out like a thin plastic soup across the ocean (Bongiorno, 2010). Scientists concerned with the movements of garbage in the patch suggest that the best solution would be to "collect debris that washes up on beaches, which act as natural nets before it washes back into the ocean, reducing health risks for fish, seabirds, and other marine animals" (Bongiorno, 2010). What is required is significant legislative frameworks to ensure the effective clean-up of beaches and educational programmes to educate the public on responsible waste disposal.

Over the last few years, Indonesia has been one of the second-largest producers of marine plastic debris after China (Jambeck et al., 2015; Lebreton et al., 2017). Indonesia produces approximately 200,000 tons of garbage annually, of which 36% ends in the ocean (Cordova and Nurhati, 2019). Some of the garbage not adequately disposed of from Jakarta and its surrounding cities flow to Jakarta Bay and accumulate in the open ocean. If it is already in the open ocean, it is not easy to manage and can affect the survival of the marine environment. In a year, particles repeatedly released in Jakarta Bay have an average transit time of 66 days, but overall, particles' movement is not always straightforward toward the Sunda Strait. Moreover, the particles take detours before crossing the Sunda Strait and require a longer transit time (Iskandar, Surinati, Cordova, & Siong 2021: 4). Taking Into account those mentioned above, one can argue that in the event of garbage flow passing Indonesia's Exclusive Economic Zone (EEZ) – a zone covering 200 nautical miles off the coast of a nation, it is no longer the country's responsibility.

[1] Much about the Indian Ocean garbage patch is still a mystery, hence very little to no response from the IORA. Although, like others of its kind, it is very fluid, and changes seasonally, making it difficult to pinpoint. However, both gyre experts and scientists concur that the "garbage patch resembles plastic soup or confetti.

Within Asia, a contributing factor to marine debris is the considerable number of flip-flops and foam sheets used in flip-flop production that washed onto the Alphonse beaches. Approximately 70% of Southeast Asia's human population lives in coastal areas, with China being the number one manufacturer of flip-flops globally. The widespread use of flip-flops as a simple warm-climate beach or outdoor wear has spread through much of the world, and they are the most common form of footwear in many developing countries. Supposedly, most flip-flop foam sheets originated from manufacturers' illegal dumping. Beach sandals likely originate from public littering exacerbated by inefficient waste disposal systems or landfills damaged by flooding or other natural events. In 2010, China, Indonesia, and the Philippines were the top three countries having an enormous mass of mismanaged plastic waste due to economic growth, large coastal populations, and lack of management infrastructure (Duhec, Jeanne, Maximenko and Hafner, 2015: 84). Nations such as Sri Lanka also have an additional responsibility to assess their marine debris pollution level due to its high position on the list of countries delivering mismanaged plastic waste to the ocean (Jang, Ranatunga, Mok, Kim, Hong, Choi and Gunasekara, 2018: 130). Considering the aforementioned, IORA can assist in fixing this by letting the governments of the top 5 Asian nations, China, Indonesia, Thailand, Vietnam and the Philippines (Daghar, 2019), enforce punitive measures on plastic industries, following their respective jurisdictions. Moreover, IORA member states and their dialogue partners can also ensure that their priority areas and future projects are aligned with the 2019 guidelines on the 'monitoring and assessment of the scale of plastic litter in the ocean'. These guidelines were made by the Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) and published by the UN Environmental Programme.

Part of aligning with the guidelines is designing monitoring and assessment programmes to understand better pollution levels in providing objective information in mitigation measures and effective and adaptive management. These should be ongoing, long-term and the creation of monitoring programmes should also be cognizant of policy concerns such as: "the abundance of marine litter in seas under national jurisdiction, the type and origin of marine litter, Setting targets for reduction measures as well as Impacts on biodiversity and animal welfare, human health issues and injuries, seafood safety, food security, tourism and recreation and maritime safety (Kershaw, Turra and Galgani, 2019: 13). These can be adapted accordingly to the context of IORA and member states. IORA can also ensure that monitoring and assessments are apt to each member state's local or sub-national contexts. Whilst also creating awareness on prescribing to the UNEP environmental indicators of monitoring projects:" Scientifically valid, simple to understand by the public and policymakers, sensitive and responsive to change, cost-effective and policy-relevant" (Kershaw, Turra and Galgani, 2019: 15). Additionally; because there is "Currently no international data governance on marine litter" (Kershaw, Turra and Galgani, 2019: 17); this also calls for an opportunity for IORA, perhaps working closely with the Indian Ocean Rim Academic Group, IORAG, to pilot one for member states. This can include field data sheets, digital information, and metadata (Kershaw, Turra and Galgani,

2019: 17). Data sharing should allow access by different member states and dialogue partners.

Moreover, IORA and all international organisations and individual nations in their capacity; should always work on enhancing the importance and role of citizens or, as mentioned in the guidelines, 'The role of Citizen science' (Kershaw, Turra and Galgani, 2019: 21). Especially as; "There is a growing recognition that members of the public represent a vital resource for finding out more about the environment and that it empowers citizens in exploring, measuring and experimenting with the world around them can in addressing the challenges to a sustainable future (Kershaw, Turra and Galgani, 2019: 21). Especially as there is already a "long tradition of volunteers in marine litter research, most of which have been conducted on sandy beaches given their accessibility and interest to the general public (Kershaw, Turra and Galgani, 2019: 21). Undoubtedly, through means of active recruitment, be it on social media, projects geared towards the involvement of citizens play a paramount role in "public engagement in the scientific and policy-making process. In terms of a monitoring programme, the objectives may be related to a policy-relevant goal and thus increase the stimulus to citizens" (Kershaw, Turra and Galgani, 2019: 23). These are all possible avenues that IORA can explore.

The compounding marine debris effect brought about by the Covid-19 Pandemic: Covid Waste and Mask Litter

Discarded masks are becoming a growing concern, brought upon by the scourge of the Covid-19 pandemic. "Covid waste" refers to the vast quantities of plastic arising from the pandemic that has piled up on streets, beaches, landfills, and choking waterways and oceans (Bega, 2020). Covid-19 inaugurated a "new normal" in the way that people interact and has brought about waste and a new form of pollution by the single-use of personal protective equipment (PPE); and presents several impacts on the environment that curtails recycling, increasing the use of plastic worldwide (Edmond, 2020). Poignantly, this results in the unfortunate sightings of "waterlogged masks, gloves, [and] bottles from hand sanitisers, [that] are found on the world's seabed and washed up on our beaches" (Edmond, 2020). It is worrying considering the advent of "Covid-19 waste" coupled with some 8 million tonnes of plastics that enter the world's oceans annually, adding to the estimated 150 million tonnes already circulating in marine environments (Edmond, 2020). Compounding to the plastic issue brought about by the Covid-19 pandemic is the increasing use of disposable masks, PPE and gloves. Added to this is the new norm of social distancing that has increased at-home deliveries and takeout by courier services and the amounts of plastic used in the packaging (Bega, 2020).

Pre-dating the pandemic, plastic pollution was amongst the most prominent environmental threats. Now the pandemic events have only exacerbated the daily usage of plastic products to curb the spread of the virus, with estimations that 75% of used masks and other related covid waste may find itself in landfills or floating in oceans (Bega, 2020). The events brought about by the pandemic have brought some financial incentives within the

plastic industry in pushing production, especially within online purchasing in the food and retail industry. However, what is overlooked is that, for businesses in distress due to the pandemic, the economic value of reusables in packaging is safe on the condition of being thoroughly cleaned (Bega, 2020). The importance of reusable and recyclable avenues should be exploited more than ever in reducing the mountain of plastic usage brought about by the pandemic. However, as with addressing many societal challenges, plastic usage also comes down to efforts in behaviour change, be it individually or collectively in a household and the larger world. Nevertheless, the pandemic has highlighted that plastics are essential to our modern lifestyle. Nearly every sector relies on plastics to make life easier, safer, and more convenient; however, an additional viable option in addressing covid plastic waste is through the disinfection of PPE using autoclave and microwave technologies (Bega, 2020).

The growing role and challenges of IORA member states

IORA has institutional features and distinct shared aims emphasised in their priority areas. The first-ever meeting of the heads of government in Jakarta, Indonesia, in March 2017 under the theme ‘Strengthening Maritime Cooperation for a Peaceful, Stable and Prosperous Indian Ocean’ detailed the significance of the security realm cooperation (Onyango Ogutu, 2021: 81). Additionally, the aftermath of this meeting resulted in the IORA Concord and Action Plan 2017–21, setting out a road map for maritime safety and security initiatives, including exploring a regional surveillance network. However, IORA and its member states face challenges that hamper effective regional engagement. As very few members states can commit substantial resources to the organisation, the secretariat is small and underfunded, and there is little follow-up on decisions.

IORA challenges

Issues around decision-making in the IORA are premised on a consensus model, meaning all members have to approve of any decision taken. It is worth noting that hegemonic states may use this as leverage to sway votes in their decision-making favour in advancing their nations own interests. The Charter further states that bilateral and other issues likely to generate controversy and impede regional cooperation’ are excluded from deliberations. They allow for easy governance of uncontroversial issues successfully, making it almost impossible for the institution to set the agenda. This inability to discuss complex issues means that individual states remain important actors in making the international governance of the Indian Ocean. For the rest of the Indian Ocean member states and nations, the main problem is the capacity to develop laws and policies, resources for implementation, and the political will to ensure enforcement. Undoubtedly, it shall remain a challenge as marine resources and the environment in the ocean are already under pressure from marine pollution (Balfas, 2021: 2898). Moreover, the complexity of IORA and the Indian Ocean as a whole reflects the different constellations of domestic interest in a country and respective spatial-based regulatory

regionalism challenges. Especially in a context of a regional network in a bureaucratic institution, community, academia, and the NGO sector compete to provide more formal and state-centred information to develop these regions (Balfas, 2021: 2900). Fellow countries in the Indian Ocean need a collective guideline to share maritime data, access information about transnational security challenges and promote an integrated national maritime domain awareness system in the Indian Ocean for better synergies to achieve environmentally sustainable goals (Balfas, 2021: 2903).

One of the structures created during the establishment of the IORA is the Indian Ocean Rim Academic Group (IORAG). IORAG acknowledges the importance of academia in regional organisations between participating member countries by providing coordinated and rigorous research results and outputs and serving as a vehicle for the development and dissemination of the research (du Plessis et al., 2018: 230). In 2017, South Africa proposed the institutional reform of the IORAG to provide a more active role in the functioning of IORA. As yet, there are still no Terms of Reference guiding the work of the IORAG. One of the challenges identified within the IORAG is that not all IORA Member States have a dedicated focal point person/institution for IORAG activities. Working on addressing these issues at hand could facilitate better engagement and outputs in mitigation strategies on marine debris. Especially as public servants in foreign affairs or foreign diplomats already in the host countries may not be able to maximally represent their countries' academic aspirations of actively participating and benefiting from the IORAG and other IORA meetings and workshops (du Plessis et al., 2018: 232).

Overall, what the IORA, its member states, dialogue partners and the larger international community should strive for in debris mitigation is effective monitoring to assess potential sources of debris. Effective monitoring in conjunction with public education and the creation of solid waste management plans for each country and their contexts presents the possibility of creating goals and steps leading to the reduction and eventual abatement of such pollution of the oceans (Duhec, Jeanne, Maximenko & Hafner, 2015: 77). The aforementioned is important as location sourcing of debris is critical in preventing littering, especially as most marine debris sources are land-based or ocean-based, depending on how the debris entered the water (Duhec, Jeanne, Maximenko, & Hafner, 2015: 83). A potential avenue for realising this is incorporating these efforts as part of the Association's Maritime Domain Awareness (MDA) efforts.[AP5] This is especially true in the context of some existing Ocean Clean-up [AP6] initiatives, capturing trash from oceans and water bodies, serving the potential towards collaborative efforts in incorporating NPO's and other important non-state actors. Maritime domain awareness (MDA) involves the practical "understanding of anything associated with the maritime domain that could affect security, safety, the economy or the environment" (Brewster, 2019: 31). There are growing calls for more practical use of Marine Development Awareness as an essential enabler for various government agencies in maritime security (Brewster, 2019: 31).

Achieving MDA involves developing systems for collecting information and data, aggregation, interpretation, and distributing results to decision-makers such as governments, shareholders and policymakers. The gains in MDA are achievable from collating information that may already be available to government agencies (both military and civil) and commercial sources in a way that all agencies can use with responsibility in advancing maritime security and sustainability (Brewster, 2019: 31). Further to MDA, the Blue Economy's importance is also an essential tool for regional engagement, and it has particular salience among many Indian Ocean states. Regional groupings such as IORA have already adopted it as a critical focus area. Countries such as India and Indonesia emphasise it as a critical element of cooperation in the maritime realm. In advancing debris mitigation, it is also essential to establish a linkage between the Blue Economy and ocean governance and the role that IORA can play in ensuring good governance of the Indian Ocean Region.

Building maritime domain awareness capabilities

Although marine debris is a global issue, it serves vast potential to solve debris issues locally through source reduction. Standardised monitoring protocols and global partnerships are necessary for optimal marine debris management. Regional cooperation on MDA should not be confined to information sharing, as much involvement is needed to realise the more effective use of already available information.

The ultimate source of marine debris is the product of land-based pollution. Developing effective waste management plans, educating the human population throughout the region, and reducing waste generation is essential in minimising pollution domestically and within the rim. In order to prevent the contamination of remote environments, international agreements must be fully implemented and obeyed by all parties and stakeholders. Additionally, efforts are needed worldwide to control pollution derived from plastic products and other pollutants released into the environment. Waste disposal and landfills need to be better managed and refuse needs to be recycled and reduced to minimise the amount of debris generated by humankind (Duhec, Jeanne, Maximenko & Hafner, 2015: 85). One of the biggest challenges in achieving MDA is integrating data sourced from various military, law enforcement, and civil government agencies. Commercial entities are also a key source of shipping information. Each entity will have its agenda, motivations and concerns about confidentiality or secrecy and might not always be persuaded to share information. The COP also needs to be used for various military, law enforcement and civil purposes. The most effective MDA systems should simultaneously serve multiple users with different priorities and time imperatives (Brewster, 2019: 31). Overall, respective nations, IORA member states, and dialogue partners should be cognizant of the guidelines for scientists and governments in response to Sustainable Development Goal 14:1 to prevent and reduce land-based activities that produce plastic litter (Daghar, 2019). Irrespective of the vast contexts that make up IORA member states - as with all international and inter-governmental organisations - it is imperative to maintain inclusive platforms. These better allow for strategic partnerships

and improvements on mitigating illegal, unreported and unregulated dumping of plastic waste in the Indian Ocean.

Conclusion

In conclusion, this piece aims to outline methods and action steps spanning public education and marine development awareness, to name a few, that the intergovernmental organisation IORA can take to strive towards a sustainable and environmentally friendly Indian Ocean committed to mitigating marine plastic. Be it at a local level, governmental or international level, everyone can play a role in living in a close to plastic-free world.

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The Ocean

By: Alison Jessica Lee You Voon, Mauritius

Let me take you on a tour – or in a time machine rather. We are paying a little visit to a milestone in the history of our species: its first days on Earth. 300,000 years ago, Homo sapiens started off. Our survival depended upon the resources available: Mother Nature's offerings. She was the one determining our survival. Now, fast forward to 2022, the simple Homo sapiens are today at the forefront of every field – from agriculture and textile to science and economy. Blinded by our "superior" brains, we have fast become massive consumers – much to the detriment of that very Nature which allowed us to be. We are now the ones determining the survival of our Mother Nature.

With such power comes deep responsibilities. Indeed, we ought to craft a balance where Nature and humans will be in symbiosis; each one thriving while catering for the other's needs. This is where the IORA plays a pivotal role. Founded in 1997 and inspired by Nelson Mandela's wise words, the Indian Ocean Rim Association (IORA) has worked for nearly 25 years towards uniting its member states and sharpening their economic, scientific and social aspects.

Each of the IORA member states is valuable, comprising of its own unique mix of resources. Amid challenging times that humanity is today facing, more than ever, wise tapping into those resources could prove transformational. In fact, the theme chosen for the 2021 - 2023 chairmanship period frames this well: "Harnessing the opportunities of the Indian Ocean sustainably for inclusive development". Governing IORA's every decision, the theme's essence can be found in multiple of the 6 Priority and Focus Areas' strategic goals.

Bounded by the rich and postcard-like Indian Ocean, many of the IORA member states have nothing to envy to other countries' coastlines. Indeed, many of the member states' beaches are known as worldwide quality choices for tourists and photographers – and even films shootings. Mauritius, Australia and Maldives, just to name a few, are such instances. We can be most proud of our smooth sand and clear blue lagoons. Yet, often far from aesthetic social media pictures and professional shoots, is the part we all wish away: marine debris. True, marine debris – persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment – is a major marine issue.

A recent study has shown that 8.3 million tons of plastic trash enter the sea every year; the equivalent of 5 bags of trash for every foot of coastline. The Indian Ocean alone accounts for 20% of that total. Worse, this already alarming figure is predicted to double by 2030 and quadruple by 2050.

Plastic litter has serious negative impacts on the marine biodiversity. As is now well known, plastic debris is the number one enemy of aquatic animals and coastal wildlife. Even if this concept is now so widely publicised that it has become cliché, it is still a crude reality. By mistaking plastic trash for food, marine animals ingest it, filling up their stomach of something that they cannot even digest. As a result, real essential food cannot enter and the animal starves

to death. Alongside, discarded or abandoned fishing nets often transform into marine animals' traps which again lead to their death. More than 1 million sea birds and 100,000 marine animals die every year from plastic pollution. Those unnatural deaths are constant disruptions in the ecosystem's food chains. On the long term, biodiversity loss is incurred, impacting Nature's ability to regenerate in case of unprecedented destruction. Biodiversity loss can also have economic ripples by undermining fisheries, causing economic instability and food insecurity. In fact, marine debris can even be defined as a man-made disaster. Resolving it should certainly be a priority. Doing so would accurately satisfy the "Disaster Risk Management (DRM)" strategic goal by reducing marine plastic's "existing disaster risks" as per the Sendai Framework for disaster risk reduction. In this context, a partnership with the Intergovernmental Oceanographic Commission of UNESCO (IOC- UNESCO) could even be considered.

Not only must we fear for sea animals' security but for ours too. Indeed, plastic manufacture process has been confirmed to involve health hazardous chemicals. BPA which allows for transparency of bottles has been shown to interfere with our hormonal system. Similarly, DEHP which gives to plastic its flexibility is Cancer-inducing. Thus, when our beverage bottles, sweet wrappings and straws enter the waters, those dangerous chemicals go along. Eventually, when we consume ocean-borne foods, those chemicals enter our bodies. They are not completely excreted and remain within us causing unseen-on-the-short-term damages like developmental, neurological and immune disorders. More alarming still, this accumulation can start as from quite early. 8 out of 10 babies have been shown to have significant amounts of phthalates (a plastic additive) while scientists claim that most – if not all – adults have it too. Alongside, marine debris also interfere with boats' navigation, impairing navigation security. So, be it for navigation or health, marine plastic have dire consequences on maritime security. Tackling this issue would thus be crucial in meeting the "Maritime Safety and Security (MSS)" strategic goal. After all, ensuring safety and security of our 68.56 million square kilometers of maritime zone is key in establishing bases for socio- economic development of the IORA member states.

Plastic, which had once been described as "the material of thousand uses" with immense economic potential, is today hampering economic growth and welfare. A recent World Economic Forum has estimated plastic after-use externalities coupled with plastic production greenhouse gas emissions at $40 billion per year, exceeding the profits of the plastic packaging industry. Also, the Indian Ocean provides its rim countries with about $22 billion income through marine goods and services including trade, tourism and fisheries. Yet, this income is being threatened by the aquatic plastic debris. While revenue decreases, costs rise. The latter are not only incurred owing to damage to marine equipment by collision with large marine fragments, but also and mainly through tourism decline. As such, many plastic debris drift onto beach shores, becoming eyesores and major discouraging factors for tourists. Plastic debris also affect corals – major fish habitats – thus indirectly putting fisheries in financial difficulty. As revenue generated from the economy decreases, poverty will rise and so will social evils like thefts. Social stability will hence deteriorate, causing

the foreign direct investment to drop as confidence of investors fall. With less financial resources to support the economy, the government's plan for progress will be impeded, dragging the country into a vicious poverty circle. Consequently, the country's Net Economic Welfare (NEW) would decline. This is a concrete disastrous chain that could result from the sole problem of marine debris.

It has been estimated that the Indian Ocean contains the second largest ocean plastic loading worldwide. With millions of plastic items accumulating in this area, it is a major "microplastics production site". Microplastics – plastic fragments smaller than 5 mm – result from plastic items being photo-degraded through exposure to the Sun's UV radiation. The macro pieces break down into smaller and smaller pieces: microplastics. Weathering of plastic increases its surface area. As such, the plastic becomes more prone to reacting with toxic pollutants like Polycyclic Aromatic Hydrocarbons (PAHs). A recent study by the Gwangju Institute of Science and Technology has even suggested that microplastics can act as microorganisms' vector – including the Covid-19 virus. Today, more than 51 trillion microplastics are drifting in the ocean. Some have even been found stuck in polar ice. The contaminated microplastics get accidentally eaten by marine mammals and crustaceans from where they travel up the food chains ending on our plates. Microplastics have been detected in a range of commonly consumed foods like honey, beer and sea salt. While the precise health threats of microplastics ingestion are still being thoroughly researched, all scientists have agreed: their findings will certainly not be positive ones.

As we have seen, marine debris have profound negative impacts spanning several spheres. Yet, it is still on the fast lane to our waters. Simply put, there will be more plastic than fish in our ocean by 2050. This can be frightening when we consider that 2050 is not that far away. About 75% of us will still be there – either satisfied with the good progress of our efforts or incurring the banes of improper marine debris management. The choice is ours.

If we want to end the flow of plastic into the ocean, we first have to know where all the plastic is coming from. 80% of plastic waste finds its way into oceans directly from land-based sources like hotels, restaurants and factories while the remaining 20% are from ocean-based sources like the commercial and recreational shipping. Thus, an action plan tackling marine debris would direct attention to both of those sources.

Conscious of these key targets, IORA has already started taking bold moves towards the phasing out of the marine debris issue. A series of workshop has been carried out through a partnership between Working Group on Blue Economy (WGBE) Indonesia and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Acting as a discussion and think-tank platform, this workshop series has successfully put in place the "IORA Framework in Combating Marine Debris". The latter is action-based and thus leads the way to concrete tackling of marine debris.

Fisheries being prime "victims" of the marine debris pollution, the IORA Core Group on Fisheries Management (CGFM) has highlighted in its Work Plan, the

emphasis that it places on the issue of marine debris and how CGFM plans to combat it. As such, a webinar on the theme “Developing Awareness Program and Mitigation against Marine Debris Impacts towards Sustainable Fisheries in IORA” was conducted in November 2021, inviting relevant stakeholders to meet and share ideas and strategies concerning the impending aquatic plastic challenge. One of the most pertinent features of this webinar is its promotion of public-private exchanges. Indeed, cooperation is one of the strongest asset we possess as member states of the IORA.

Marine debris being, first and foremost, a scientific issue, brings in light a particularly relevant IORA Priority and Focus Area: “Academic, Science and Technology Cooperation” (ASTC). Bringing a myriad of academic and “Science&Tech” minds to think and work together is a powerful tool. The Covid-19 pandemic taking only 2 years to transition from a panic outbreak to WHO’s declaration of a “tentative slowing down of the pandemic” proves it. As such, IORA has established the Indian Ocean Rim Academic Group (IORAG), Expert Group Meeting on Academic, Science and Technology Cooperation (EGMASTC) and Working Group on Science, Technology, and Innovation (WGSTI). Today, all three are golden platforms where scientists, academics and technologists can share and brainstorm best practices against those water-bound plastic bits we are fighting. These groups are gateways to achieving the “Academic, Science and Technology Cooperation (ASTC)” strategic goals.

To go further, another initiative was brought up, namely the establishment of the IORA Regional Centre for Science and Technology Transfer (IORA-RCSTT). It supports research and creation of new technologies as well as facilitates the transfer of expertise and technologies among member states and other countries to create a rich pool of Academic, Science and Technology resources from which all contributors can benefit. Alongside, the 23rd Committee of Senior Officials (CSO) meeting has discussed the prospect of a Research Support Unit (RSU). The latter will certainly be highly resorted to in this combat against marine plastic pollution.

IORA is undoubtedly on the right path to addressing the issue of marine debris and its multiple harmful repercussions. So doing, IORA has also opened up the way to even larger-scale solutions and valuable partnerships. We shall remember that a big 80% of marine debris first started off as land-bound plastic waste. To stop marine plastic pollution, we thus have to mainly focus on reducing the production and trashing of plastic on land first. In other words, “closing the plastic tap” before mopping off plastic already at sea.

As much as marine debris is an issue of global scope, a major portion of the solution still lies in the hands of each and every human being. After all, with nearly 2.7 billion people in the IORA member states, if everyone does their part, the result ought to be significant. Let’s start with clean-up campaigns. These are often done for special occasions – be it for an international cleaning day, for an environmental club’s yearly activity and the like. Why don’t we transform community clean-up initiatives from occasional occurrences to monthly or even weekly ones? Indeed, Japan did it and the effect on the citizens is remarkable: they have all developed a sense of respect for the environment which is now second nature. Following this example, IORA could build a political multi-

stakeholder network whose aim would be to facilitate and coordinate those region-wide or even nation-wide clean-up days coupled with informal awareness campaigns. The latter could especially target the children and youth, not only because they are the adults of tomorrow but because, being often free of prevailing ideological constraints, they can more easily encode the litter-free culture. Also, children are often efficient catalysts in changing habits at home, thus rippling the plastic-free mindset to families at large. Through such measures, IORA would be taking a collectivity-based approach to marine debris phase out.

“What are the 3Rs?” We can all be quite sure that posing this question to school kids will yield many eager hands up. Indeed, almost 100% of us know the mantra: Reduce, Re-use, Recycle. Yet, less than 35% of us actually implement the 3Rs fully. This might be because of the lack of proper incentives. Thus, IORA member states could implement the bottle collection points system, whereby individuals get a cash back when they return their empty plastic bottles after consuming the contents. The collected bottles are then channeled to recycling companies like “B.E.M Recycling” or “JCL Plastic Enterprises (Pty) Ltd”. In this way, we will gradually get rid of the current linear path of plastics (Produce, Use, Dispose) and install a new circular and sustainable one. One where plastic can be recovered and fed back into the economy as a valuable material. For the Reduce and Re-use aspect of the 3Rs, IORA could promote simple – yet effective – tactics like the French “bring-your-box-to-collect-your-ham” idea to reduce plastic packaging or second-hand-use initiatives like the Mauritian “Good Shop.” A partnership with UNITAR would also be welcomed to strengthen the “Be Green and Responsible” motto. Each time an “R” is applied, less plastic gets dumped in landfills and beaches, meaning less plastic ending in our oceans.

In this “war” against plastic marine debris, legislation can be a potent “weapon”. The simplest way being to restrict plastic products use – or even ban plastic use all together. Having already enforced measures to deter the use of short-life plastic, South Africa and Rwanda are fitting examples of how to pave our way to the “Zero Plastic Policy”. In the long-term, IORA could consider implementing such a bold and efficient policy on all its member states. Until then, taxes and levies can be strategically applied on plastic products in phases. Also, plastic pollution permits can be introduced for industries producing plastic waste. The permit would allow them a maximum quota of legal plastic discharge. The companies could even be allowed some flexibility by allowing for trading of pollution permits among companies, such that a company producing less plastic pollution than its maximum quota could trade the “surplus” part of its permit against money. This would then incentivize industries to plummet their plastic waste production all while allowing the total amount of plastic discharge to be closely monitored. Alongside, relevant stakeholders could be made to work with public and private businesses, helping them understand their “plastic footprint” and henceforth how to mitigate it. For instance, cosmetics companies could find, through consensus, ways to reduce or remove the microbeads in their products, that very component contributing

to microplastics amounts in oceans. Since fisheries' resources, and thus food security, are highly impacted by marine debris, the IORA's Fisheries Support Unit (FSU) partnered with the "Food and Agriculture Organisation" (FAO) could – aligned with the "Fisheries Management (FM)" strategic goal – collaborate with policy-makers to sanction companies and individuals contributing to marine plastic pollution. Finally, laws will be paramount in the regional cooperation. The Indian Ocean Rim Business Forum could enable pro-plastic-reduction companies to extend their operations to neighbouring countries and wider networks. Subsequently, it will bring IORA closer to fulfilling the "Trade and Investment Facilitation (TIF)" first strategic goal of "enhancing intra-IORA flow of goods, services and investment […]". Expansion of low-plastic-producing companies will also promote plastic reduction among business and prevent a black market of illegal plastic commodities from emerging. As such, it is by judicious legislations and by working together that IORA member states will be able to achieve the UN SDG Goal 14.1: "By 2025, prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris […]"

The 363,762,732,605 pounds of plastic in our oceans are in constant movement. If we want to achieve efficient and sustainable elimination of plastics from oceans, we first have to know where the plastic bits are and where they are going. "Think, plan, then act" is the wise way forward. Yet, another challenge arises here. When we sample plastic density in one area, we have the data for only that area and for that specific point in time. Hours later, that data would have changed. Then how do we do it? The answer lies in one of IORA's Priority and Focus Areas: "Academic, Science and Technology Cooperation". The IORAG and WGSTI could bring relevant universities like those of the Association of Southeast Asian Nations (ASEAN), scientists and technologists together to work out a way to set up a "Marine plastic movement database". Following the proceedings of the already existing "Air Quality Index" database, each IORA member states would establish a team or control center responsible for sampling plastic- related data from their assigned water territories. On a regular basis, they would upload same on the shared database. As such, a powerful, information-packed overview of the marine debris movements in the Indian Ocean would gradually be built up. The plastic pollution hotspots will be quick to identify. This will allow IORAG, WGSTI and stakeholders to find timely and effective solutions. This project could be taken further by specifying not only how many plastics there are in one place but also what types of plastics there are. This further detail will then allow for tailoring of actions and boost the research for plastics alternatives. With solid data, scientists and technologists' cooperation would then shift into action, designing eco-friendly technologies (powered by renewable ocean energy) for cleaning up strategic points. For example, algorithm-based ocean currents and winds predictions could be one of their processing mechanisms. This project is also particularly interesting given that it promotes the Ocean Science field – the Science field with the most women being currently empowered (10% more than in overall Science). The "Marine Plastic Movement Database" could thus prove a powerful catalyst in reaching the "Women's Economic Empowerment (WEE)" strategic goals. By coordinating all member states' efforts and AST research sharing as per ASTC second strategic goal, IORA will have made a decisive step towards marine

debris reduction – if not elimination.

In most developed countries, financial resources abound. The opposite happens in Least Developed Countries (LDCs). Yet, both suffer from marine debris pollution. It is from that realization that came the idea of “Plastic Banks”. Presently operating in South America’s marginalized communities, they are based on the concept of “plastic is money” – literally. Basically, poor people can “buy” basic commodities with plastic collected from their locality. Considering that LDCs are lacking money and overflowing with plastic pollution, the “Plastic Banks” concept is a win-win one. With IORA having always strived to close the economic development gap between Developed and Least Developed Countries, application of plastic as fund is worth considering. The IORA Sustainable Development Program (ISDP) could act as the link through which developing and developed member states, as well as dialogue partners and appropriate stakeholders, would channel expertise and resources to support the plastic fight in LDCs. The collected plastic items could then be sorted before funnelling them into recycling companies. So doing, a circular economy would emerge.

The latter will shift the mindset from seeing plastic as annoying trash to a precious component of the sustainable plastic lifecycle. Even better, as the LDCs gradually develop, IORA could partner with the World Bank to provide grants to support LDCs’ eco-friendly SMEs and their engagement in aquaculture – the future of the fishing industry. As such, both “Trade and Investment Facilitation (TIF)” strategic goals will be reached. In parallel, the Working Group on Trade and Investment (WGTI) could partner with the African Union (AU) to devise economic investment in plastic pollution research (including marine biotechnology), infrastructure and equipment. Investing will create employment, inducing brain gain and ultimately economic growth of all IORA member states. The “Blue Economy (BE)” strategic goal will hence be fulfilled. Common tourism attractions like Mauritian Dolphin watching shall prosper better when our oceans will be free from plastic pollution. In this way, the IORA “Tourism and Cultural Exchanges (TCE)” strategic goals will be attained. Such sustainable coastal tourism would also allow for subsistence fishing, be pro-environment and take concrete steps towards sustainable economic development.

In 2020, the Covid-19 surge took us aback. Yet, putting our heads, hearts and hands together, we worked through it. Profound research coupled with extensive sharing has been pivotal: the virus genome was sequenced and vaccines rolled out in record time. Covid-19 is not the first – and certainly not the last – challenge that we will face. We will encounter issues in a myriad of sectors. The Indian Ocean maritime one is no exception. Today, marine debris is like a monster having extended its tentacles in every corner of our ocean – from surface to seabed, from animal guts to our plates.

Starting this paper, we embarked on a time machine. While in real life we, unfortunately, cannot press the reverse button, we can seize the reins of the present and unite the forces of all IORA member states in an interdisciplinary approach to solve the marine debris issue. With the IORA Strategic Goals clearly set out and the appropriate institutions and stakeholders mobilised, the

23 IORA member states shall strive together towards – as the year's theme inspires – an ever more sustainable and inclusive Indian Ocean.

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Illegal, Unreported and Unregulated Fishing

By: Nishat Ferdous Anika, Bangladesh

Introduction:

The International Plan of Action to Prevent, Deter, and Eliminate IUU Fishing defines the phrase "illegal, unreported, and unregulated fishing" as "a wide spectrum of fishing contraventions." Following Agnew et al., we use the term 'IUU fishing' to refer to all illegal and often unreported activities within Exclusive Economic Zones (EEZs), as well as all illegal and unreported activities on the high seas that are under the jurisdiction of regional fisheries management organizations (RFMOs, 2008). This study did not include discards or fatalities from licensed fisheries.

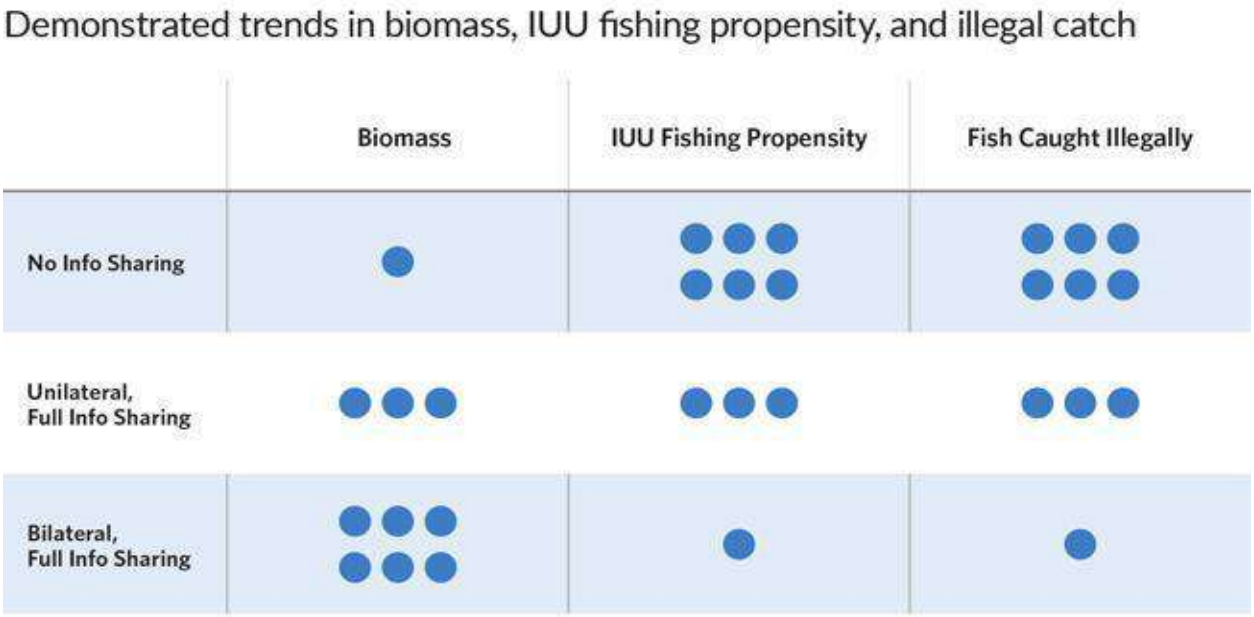

Fig 1: Demonstrated trends in biomass, IUU fishing propensity, and illegal catch

Causes of IUU Fishing

IUU fishing is mostly a commercial endeavor. The general economics of crime and punishment can be utilized to model this issue because the motivations to engage in IUU fishing activities are similarly economic in

character. A crucial result of this theory is that a risk-averse person will commit an offense if and only if his private projected reward exceeds the expected consequence for doing so.

In the case of IUU fishing, this means that as long as the projected benefit from IUU fishing is positive, incentives to engage in IUU fishing activities will exist.

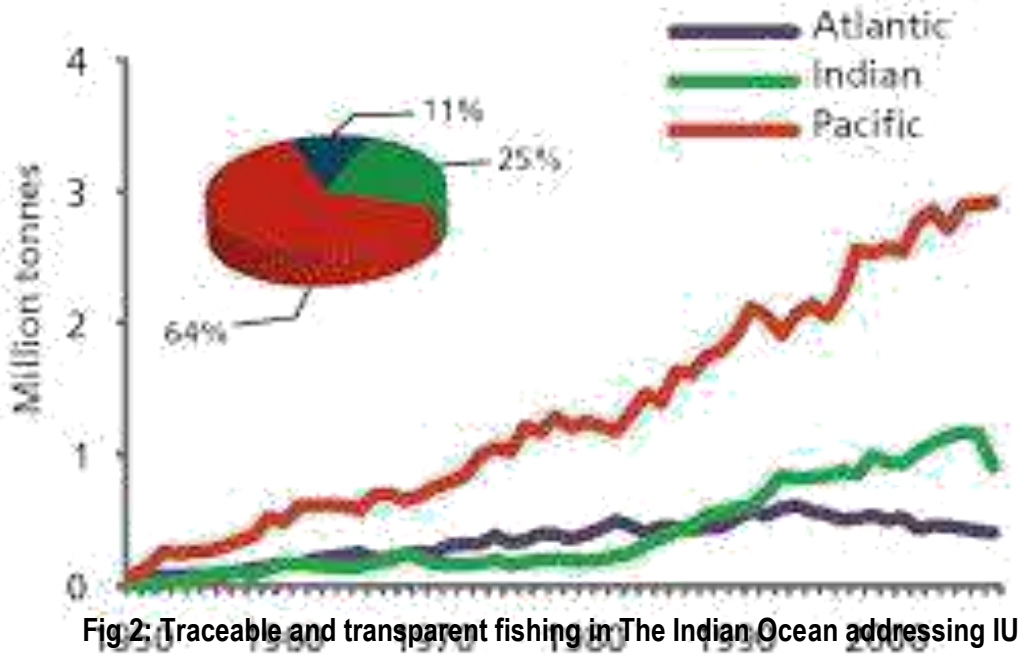

Fig 2: Traceable and transparent fishing in The Indian Ocean addressing IUU

1. **Economic causes of IUU fishing:**

   Three key economic drivers of IUU fishing have been identified: overcapacity, inefficient management, and subsidies. Overcapacity in the domestic fleet can be generated by a general imbalance between fishing capacities and fishing possibilities, or by an improper allocation of fishing rights, both of which are the outcome of ineffective management regimes. The research reveals that there are incentives to engage in IUU fishing as long as the expected return from employing extra capacity is higher than the usual best alternative, which is a loss. In a similar vein, IUU fishing may occur at the level of Regional Fisheries Management Organizations (RFMOs) since some RFMO members are not given adequate fishing opportunities in relation to their developing fishing capacities. This could be owing to the closed character of some RFMOs or the lack of fishing

experience of some members, limiting their claims to a larger part of the Total Allowable Catches (TAC).

Subsidies for the maintenance, development, or transfer of fishing capacity are likely to artificially lower the cost of IUU fishing capacity both locally and internationally. Individual fishermen's income is heavily influenced by the design of home management regimes and the effectiveness with which

they are implemented. In theory, the smaller the motivation for domestic fishermen to engage in IUU operations, the higher the income generated by those fisheries. As a result, countries with weak and poorly enforced management regimes could be a source of IUU vessels. Imposing capacity constraints in national fleets is critical, albeit prudence is essential in managing the transition to more economically viable fleet structures to ensure that capacity does not migrate to IUU operations. (Gallic and Cox, 2006)

2. Institutional Factors:

Some fishing activities are in practice beyond the reach of national and international legislation due to gaps in the current international legal framework for the sea (particularly as established by the UNCLOS). Unregulated fishing activities are those carried out by vessels with no nationality or flying the flags of countries that are not members of relevant fisheries organizations and hence do not consider themselves obligated by their laws. Those IUU operations carried out by citizens of a given State who register and flag their vessels in a foreign State with the intentional goal of circumventing domestic and international restrictions are of particular interest. Flag of Convenience or, as the OECD research puts it, Flag of Non Compliance (FONC) States are the terms used to describe these foreign countries. IUU vessels are not prohibited from fishing on the high seas, whether or not they are under the authority of an RFMO. Other institutional issues can compound the IUU situation, with direct implications for IUU operators' financial returns. First, both domestically and in RFMOs, it is widely acknowledged that there is an insufficient level of Monitoring, Control, and Surveillance (MCS). This minimizes the projected cost of IUU fishing by lowering the likelihood of getting captured (even within national EEZs). Second, there is frequently an insufficient degree of sanction.

The existence of tax havens is a third element that can amplify the lower risk and estimated expenses encountered by IUU operators. Vessel operators can use the confidentiality or secrecy of banking

institutions established in such locations to conceal their true identities and avoid paying fines if their vessel is discovered (Gallic and Cox, 2006)

3. **Social Factors:**

Some of the variables that contribute to IUU fishing are social in character. Because of the prevalence of low economic conditions and prospects in several developing nations, IUU vessels have access to a ready and inexpensive labor pool. Due to the near-zero opportunity cost of labor in most developing nations, an excess supply of labor drives pays to extremely low levels, regardless of the conditions and hazards . Poaching of Trochus in Australian seas in the early 1990s, for

example, was primarily motivated by the great poverty of Indonesian fishermen, who engaged in the practice despite the threat of severe penalties and imprisonment. (Gallic and Cox, 2006)

4. **Organized IUU fishing operations:**

By lowering the monetary and transaction costs of engaging in IUU fishing, the creation of organized IUU fishing operations has aided and expedited the development of IUU fishing. This aspect is significant because it goes beyond the standard premise that an individual's compliance decision should not be influenced by the actions of others. Coordination, on the other hand, can play a crucial role in deciding whether or not to engage in illegal operations, and the recent involvement of organized IUU fleets of vessels with shared ownership is cause for concern. The emergence of increasingly complicated firm ownership structures has a number of implications for these vessels' economic balance sheets. To begin with, combining IUU and legally caught fish will allow the price of IUU fish to be higher than it would otherwise be. Second, when a firm operates a fleet of IUU vessels, examining the economics of a single vessel is insufficient since single vessels can readily be sacrificed for the overall profit of the fishery. Third, a huge corporation will be able to conceal fleet movements by fast re-flagging, name changes, vessel modifications, and early warning systems. (Gallic and Cox, 2006)

Possible actions against IUU fishing activities

Under the current circumstances, IUU fishing is clearly profitable. The OECD analysis concluded that identifying measures that make such activities unprofitable is the first important step in combatting them.

This can be accomplished by taking steps to reduce IUU fishing revenues, increase IUU activity running costs, increase IUU vessel capital costs, and increase the cost of risk associated with participation in IUU activities. While some of the strategies below can alter specific issues, others have a more "cross-cutting" nature and are likely to affect multiple aspects at once.

There are steps that can be taken to limit the chances of captures being transformed into revenue. Such actions are of a trading character, as they attempt to keep IUU catches out of conventional markets. They can take the shape of an embargo or other forms of import restriction for fishery products.

Because tax evasion is frequently cited as an incentive to engage in IUU fishing activities, promoting the elimination of tax havens, as well as addressing any other tax distortions that may sustain IUU fishing activities, would be a direct way of modifying the incentive structure.

To increase the price of IUU vessels, trade measures could be introduced to prohibit the provision of certain goods and services to them. Preventing IUU vessels from landing their catch in a certain port, for example, is likely to raise the cost of steaming. Other limits on fishing input commodities (such as ice; navigation, detection, or communication devices) or services may be imposed. (Gallic and Cox, 2006)

Crew cost is an area where high incentives to engage in IUU fishing exist due to its relative importance in the total cost of most fishing operations. There are three categories of activities that can be considered.

Increasing the likelihood of fines will have a direct impact on decisions to engage in illicit and unreported fishing within national EEZs or on the high seas. However, under the current international framework, this will have no impact on unregulated high-seas activities carried out by IUU vessels. The likelihood of being apprehended and the severity of the sanction are both positively related to the level of projected sanctions. The Lacey Act, which was passed in the United States to prohibit interstate traffic in birds and other animals killed illegally in their home state, can be applied to acts such as landing, importing, exporting, transporting, selling, receiving, acquiring, possessing, or purchasing any fish taken, possessed, transported, or sold in violation of another state's law. A further and more direct means of broadening the scope of possible sanctions in any country would be to make any commerce in IUU fish illegal. (Gallic and Cox, 2006)

Avoidance costs, such as steaming time, steaming fuel costs, or "research" operations (e.g. costs associated with the detection of MCS vessels, including electronic equipment costs); moral or reputation costs, which are often considered insufficient due to a general lack of recognition of the seriousness of this activity; and fraud costs are all costs that fishing operators face when engaging in IUU fishing activities.

The enhancement of public MCS capacities could increase avoidance costs mechanically. Private activities, in addition to public actions, may help to increase the cost of avoiding IUU vessels

IUU fishing is a global issue that affects both domestic and international waters, as well as all types of fishing vessels, regardless of size or gear. IUU fishing is damaging to existing world fish stocks and impairs the effectiveness of national, regional, and international efforts aimed at securing and rebuilding future fish

stocks. As a result, IUU fishing not only has negative economic and societal consequences, but it also diminishes incentives to follow the rules.

Different approaches and a large range of parties are involved in combating various sorts of IUU fishing activity. This research demonstrates that there are numerous options for addressing the problem's multiple sources, as long as effective steps are taken. However, it is also acknowledged that each action has a cost, and that more research is needed in general to define each advantage.

Recognizing the limited success of "conventional" control and surveillance-like measures in supplementary initiatives such as the employment of non-discriminatory trade measures and the extraterritorial application of domestic sanctions, It also argues that new forms of high-seas governance should be developed in general to improve the effectiveness of the current legal framework.

The impacts of IUU fishing

IUU fishing has serious economic and social consequences, especially in underdeveloped countries, as it depletes and in some cases decimates fish stocks (Organization for Economic Co-operation and Development 2005; United Nations Office on Drugs and Crime 2010). The loss of the value of the catch is the most significant economic impact of illicit fishing in territorial seas. In addition to the loss of GDP, there is also a revenue loss because legitimate operators who are displaced by IUU fishermen do not pay levies, landing fees, or taxes. The loss of jobs in the fishing and fish processing industries, as well as a burden on national budgets, are further macroeconomic consequences. The downstream implications of IUU fishing are numerous, and include marketing, packaging, transportation, and fish processing. Because the majority of IUU catches are not landed inside the country whose waters the fish were taken from, there are significant losses in terms of bunkering, port dues, vessel upkeep, and transshipment fees. Due to the expenses of monitoring and enforcement, "multiplier effects" have a detrimental impact on investment and employment, putting pressure on national budgets. Other secondary economic effects include lower catch value for local fishing fleets and health and safety issues when artisanal and industrial vessels collide. Employment conditions in low-wage countries,

where fish industry workers are frequently subjected to an abusive and dangerous work environment, add to the human costs. . (Liddick. D, 2014)

IUU fishing has substantial societal consequences as well. Illicit fishing leads to hunger and poverty, especially in areas where fish is a key source of protein, as it is in Senegal, Sierra Leone, Angola, Somalia,

Kenya, and Guinea Bissau. In Liberia, as well as Africa's shrimp fisheries and the inland fisheries of Senegal and Mauritania, conflicts between foreign vessels and local operators are widespread. In Somalia and Mozambique's territorial waters, armed opposition to fishing surveillance and enforcement activities may be on the rise, raising the risk of injury and death. Reduced fish stocks in local waterways restrict employment options, which leads to lower household incomes, exacerbating the poverty that already exists (Environmental Justice 2005; Marine Resources Assessment Group 2005).

IUU fishing has serious economic and societal consequences, as well as harming target species and ecosystems, resulting in a decrease in biodiversity and ecosystem resilience (United Nations Office on Drugs and Crime 2010). The natural rebuilding of local fish stocks is hampered by damage to delicate mangrove regions and prawns. IUU fishing depletes less lucrative fisheries that are nonetheless vital food sources for human populations and marine ecosystems, in addition to lowering lucrative target species like sharks and tuna (Marine Resources Assessment Group 2008).

IUU fishing has a harmful influence on a wide range of marine life, particularly tuna and other large pelagic fish, which are sought after for their high market value. (Illegal tuna catches account for over 10% of all fish caught in the Indian Ocean, or around 130,000 tons per year.) Redfish in the North Atlantic, orange roughy around New Zealand and Australia, squid in the Southwest Atlantic, and toothfish in the Southern Atlantic and Antarctic are among the high seas species commonly caught by IUU fishing (Marine Resources Assessment Group 2008; United Nations Office on Drugs and Crime 2010). The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) estimated that 16.5 percent of all Patagonian toothfish caught in 2003/04 was illegal, while the International Commission for the Conservation of Atlantic Tuna (ICCAT) found that IUU fishing was responsible for 25,000 tons of tuna caught in 2001/02. According to the North East Atlantic Fisheries Commission (NEFC), IUU ships landed 27 percent of redfish captured in 2002 (Marine Resources Assessment Group 2008).

Because of their limited fecundity and slow rate of growth, sharks are particularly vulnerable to IUU fishing. Currently, more than 20% of the 591 shark species studied worldwide are listed on the International Union for Conservation of Nature's (IUCN) Red List of Critically Endangered, Endangered, or Vulnerable Species (Lack

and Sant 2008, 2009). Shark fin retention is linked to illegal shark fishing (although shark fins contribute for only 7% of the shark trade's volume, they account for 40% of its value). Increased long-line tuna fishing has resulted in increased shark bycatch, and by most accounts, discards and unreported catch indicate that shark population harm is likely larger than recorded (Lack and Sant 2008, 2009).

Some fishing techniques are particularly harmful to the environment. Non-target species such as sea birds, turtles, sea mammals, sharks, and killer whales can be harmed by the by-catch of long line vessels (legal and illegal trawlers that use nets up to twenty-five miles long) (Organization for Economic Cooperation and Development 2005; Marine Resources Assessment Group 2008). Illegal driftnet fishing in the Mediterranean Sea has wreaked havoc on the region's biodiversity, killing tens of thousands of cetaceans each year (Environmental Justice Foundation, n.d.). Illegal fishing kills an estimated 100,000 seabirds in the southern waters each year, including thousands of endangered albatrosses (Marine Resources Assessment Group 2008).

Illegal fishing gear, such as gillnets, is another environmentally destructive fishing approach, and some IUU vessels even employ explosives to keep whales away from fishing lines (Marine Resources Assessment Group 2008). The use of sodium cyanide to paralyze fish before capture is popular in the Philippines, driven by a demand for live fish to serve up-scale restaurants and aquariums, and causes widespread damage to coral reefs (Barber and Pratt 1998; Pratt 1996). Local fisherman in Tanzania employ dynamite and hand grenades to catch vast quantities of reef fish. Because maerl, coral seagrass beds, and inshore shallow seas are settlement and nursery areas for young fish and other marine animals (Organization for Economic Cooperation and Development 2005; Marine Resources Assessment Group 2005; McManus et al. 1997), this willful destruction of marine habitat can have far-reaching consequences.

After describing the different negative consequences of IUU fishing, it is vital to point out that the overall problem is almost certainly worse than is known. Unreported harvests are likely to vary from 25% to 100% of declared captures. The total loss from IUU fishing during the research period was $372 million, or 23% of the stated value of the catch, according to a case study of ten countries (Marine Resources Assessment Group 2005). . (Liddick. D, 2014)

Role of IORA in IUU fishing:

Coastal states in the Indian Ocean have a strong interest in the management and conservation of the region's essential resources, with fisheries being a crucial component. Overfishing and climate change

have accelerated the loss of key fish stocks in the Indian Ocean region, making fisheries and allied businesses crucial to food security.

As evidenced in the IORA Action Plan 2017-2021, which was adopted at the IORA Leaders' Summit in March 2017 in Indonesia, IORA places a high value on strengthening collaboration in both the Fisheries Management Sector and the Blue Economy. This Action Plan serves as a road map for implementing concrete measures over the short, medium, and long term, as well as charting the IORA's future development and boosting cooperation in each key sector and emphasis area. The IORA Member States have been addressing a variety of issues, including seafood product safety and quality, seafood handling, post-harvest processing and storage of fisheries and aquaculture products, banking and artisanal fisheries, sustainable management and development of fisheries resources, and fish trade, among others, in order to sustain and sustainably manage this growing industry.

Furthermore, the Sultanate of Oman hosts the IORA Fisheries Support Unit (FSU), which administers and spearheads IORA efforts to identify and debate critical fisheries-related issues specified in the action plan. It also helps Member States study proposals and supports research in areas that are useful to them. The FSU serves as a regional hub for information exchange, capacity building, and strategic problem solving in the fisheries and aquaculture industries.

Conclusion:

IUU fishing is a serious multinational crime that has serious economic, social, and environmental consequences. There are a variety of explanations, including a variety of economic drives, enforcement challenges, and legal, economic, political, and cultural imbalances integrally tied to globalization processes.

Clearly, the conservation of living marine resources and the execution of legislation aimed at preventing IUU fishing provide a conundrum. While certainly important, the flurry of restrictions enacted in recent years to improve the conservation of some fish species have also contributed to, and maybe aggravated, legal, supply–demand, and cost–price imbalances that provide sufficient opportunity for IUU fishermen. As a result, a leveling off of regulatory asymmetries, or a reduction in observed regulatory asymmetries, is critical to successfully eliminating IUU fishing. A global, normative framework for the enforcement of

commercial fishing activities should be more completely created and implemented. Obviously, a high-seas governance structure is essential. A larger number of RFMOs with more species-specific conventions would be ideal. Any significant, palliative attempt will require international collaboration and consistent execution of regulations, while enormous reform of the FOC system must be a fundamental component of any meaningful, palliative endeavor (Vukas and Vidas 2001; Marine Resources Assessment Group 2005).

At the most fundamental level, the challenging and contentious challenge of reconciling human interests and requirements with fish species and stock conservation must be intelligently handled. Furthermore, it must be recognized that IUU fishing is not only a manifestation of profit-driven, transnational crime perpetrated by corporate interests and organized criminals, but also a phenomenon—like transnational organized crime in general—that is linked to, if not derivative of, weak, incompetent, and corrupt governance.

As a result, preventing IUU fishing will be contingent on the promotion and continuation of sustainable and responsible commercial fishing, as well as political will to develop transparent governments and regulatory organizations. In the end, global progress will almost certainly necessitate a change in some consumption patterns, a tough behavioral shift that is crucial not only for people and their nutritional interests, but also for stressed and endangered fish populations.

Finally, it's crucial to note that the current research has several limitations. Inherent flaws in secondary data analysis are difficult to overcome, and researchers' biases, perhaps subconscious, may color conclusions.

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The impacts of Marine Debris, its consequences and the role of IORA in minimizing its effects

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Abstract: The essay enlightens us about marine debris, its sources and pathways into the environment, types of debris and long-term and short-term consequences of marine debris. This essay also includes a brief knowledge about IORA and its member states. Sequentially it depicts the situation of IORA member states in marine debris pollution and the possible role of IORA in making a progress to mitigate the effects of marine debris pollution. Although the emphasis is mainly on biology, the suggestions concern all the spectrum of life and the marine environment.

Keywords: Debris, IORA, Ecosystem, Coastal, Microplastic, Garbage patch, Ghost net.

1. Introduction

Marine debris is defined as any persistent solid substance that is made or processed and then disposed of or abandoned into the marine environment or the Great Lakes, whether purposefully or unintentionally. Marine debris, often known as marine litter, is human-made waste that has been thrown into a sea or ocean, either intentionally or accidentally. Floating oceanic debris is known as beach litter or tidewrack when it accumulates in the middle of gyres and along coastlines, usually washing ashore. Ocean dumping is the deliberate discharge of garbage at sea. Driftwood and drift seeds are examples of naturally formed detritus.

Because many forms of (petrochemical) plastics do not biodegrade as quickly as natural or organic materials, human influence has become an issue as the use of plastic has increased.

Discarded and lost fishing nets are the most common source of plastic pollution (10%) and the majority of big plastic in the oceans [1].

Waterborne plastic endangers fish, seabirds, marine reptiles, and marine mammals, as well as boats and coastlines [2]. Dumping, spilled containers, litter poured into storm drains and rivers, and landfill debris blown by the wind all add to the problem. Increased water pollution has had major negative consequences, including the capture of animals by ghost nets, the accumulation of plastic litter in large marine garbage patches, and higher levels of toxins in the food chain [3].

In case of marine debris, pictures speak louder than words. Following are the pictures of marine debris.

Fig 1.1 (Left) Debris on beach (Loranchet, 2005), (Right) Debris collected from beaches (Duncan Wright, 2006)

International regulations and policies have been enacted in an effort to avoid and mitigate marine debris and pollutants, with the UN mentioning reduced marine pollution in Sustainable Development Goal 14 "Life Below Water." Some governments have implemented more specific protection strategies based on the importance of the issues and varying levels of involvement. Furthermore, certain non-profits, non-governmental organizations, and government agencies are working on projects to collect and eliminate plastic from the ocean. However, the United Nations predicted in 2017 that by 2050, there will be more plastic in the oceans than fish if significant actions really aren't done [4].

Researchers divide debris into two categories: land-based and ocean-based. The United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution estimated in 1991 that up to 80% of pollution was land-based, with the remaining 20% coming from catastrophic events or maritime sources. Recent investigations have discovered that more than half of the plastic garbage observed on Korean beaches comes from the sea [5].

Plastic bags, balloons, buoys, rope, medical waste, glass and plastic bottles, cigarette stubs, cigarette lighters, beverage cans, polystyrene, lost fishing line and nets, and different wastes from cruise ships and oil rigs are among the items regularly discovered washed ashore. Six pack rings, in particular, are thought to be representative of the issue [6].

Plastic makes up 80% of marine debris. Plastics build up because they don't biodegrade as quickly as other materials. They photodegrade when exposed to sunshine, but only in dry conditions, as photolysis is inhibited by water. Scientists from the organization 5 Gyres estimated 5.25 trillion pieces of plastic weighing 269,000 tons were scattered in oceans in equivalent amounts in the Northern and Southern Hemispheres in the research conducted in 2014 using computer models [7].

Sources, Geographical Origin, Pathways and Transport Mechanisms: In this study, we use the term ‘source’ to refer to the economic sector or human activity that produces trash, but we use the term means of ‘release’ to refer to the process or method by which a specific item exits its intended cycle and/or

enters the natural or urban environment, becoming a problem. The ‘geographic origin’ can thus be determined from the source's location and the location of the discharge. Rivers and ocean currents are also referred to as sources. These are, however, ‘transport processes’ that carry garbage from various land- and sea-based sources into and within the marine ecosystem. The physical and/or technical means by which litter enters the marine environment is referred to as a ‘pathway’ [8].

Classification: The distinction between sea-based and land-based input is one of the most popular broad categorizations of the origin of ML elements. Trash with a sea-based origin is litter that is directly (inadvertently or intentionally) thrown into the sea by maritime activities such as shipping, fishing, offshore facilities, or refuse dumping at sea. Litter formed in more distant regions, such as towns and industrial sites, then blown or carried into the sea is referred to as "land-based origin.”

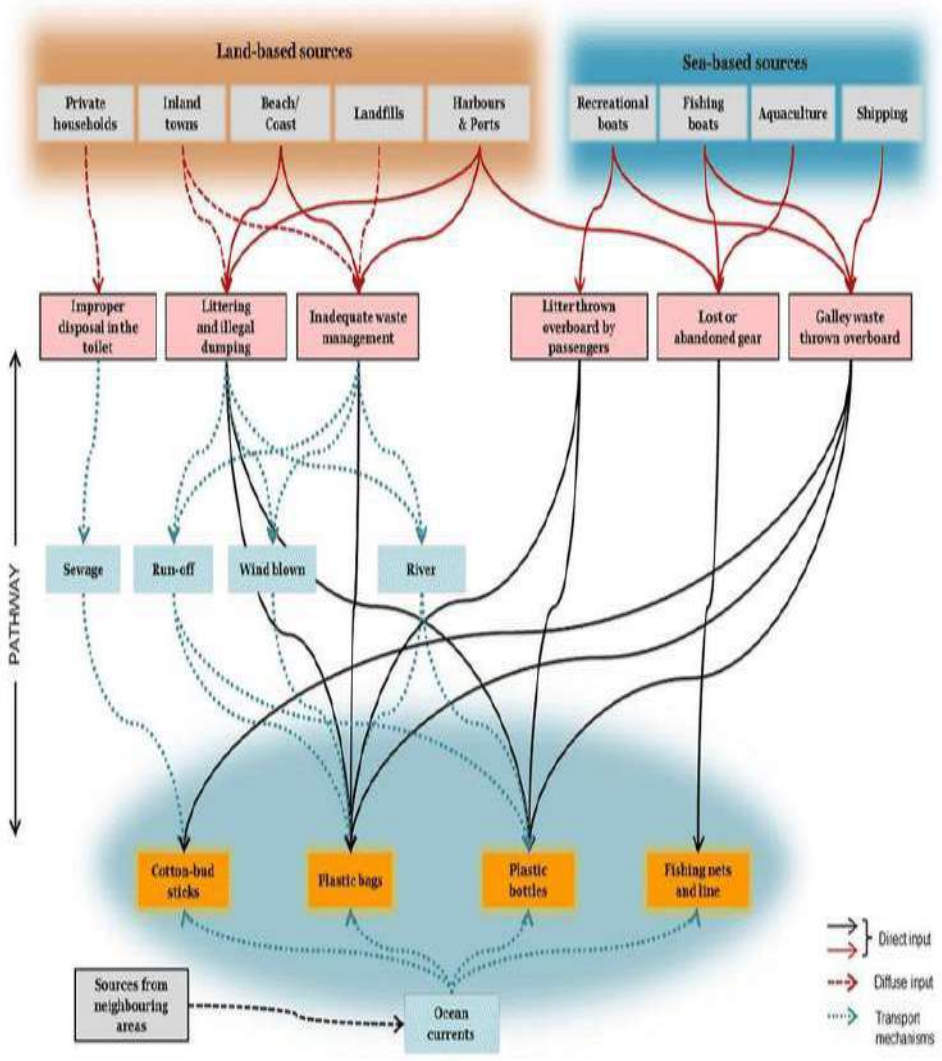

Fig 1.2: Multiple sea- and land-based sources (grey boxes) of 4 common items of marine litter and their potential pathways of entrance (blue boxes) into the marine environment. (Note: the size of the boxes does not reflect their relative importance) (Joana

Mira Veiga,2016)

Plastics and Micro-plastics: Marine debris, particularly plastic waste in the oceans, has been a major problem for environmentalists in recent years. The world appears to have only recently been aware of the hazards of plastic garbage, which is growing in quantity on a daily basis as a result of human activities that cannot be separated from the use of plastic in every necessity. When plastic, a petroleum product, is burned, carbon dioxide is released into the atmosphere, increasing carbon emissions. Plastic garbage will linger in the oceans for a long time and take hundreds of years to degrade in the oceans, which are the largest natural carbon sink for greenhouse emissions. [9].

Microplastics are fragments of any type of plastic less than 5 mm (0.20 in) in length, according to the U.S. National Oceanic and Atmospheric Administration (NOAA) and the European Chemicals Agency. They pollute natural environments by entering through a variety of channels, including cosmetics, clothing, and industrial activities. Microplastics are currently classified into two groups. Any plastic pieces or particles that are already 5.0 mm in size or smaller before entering the environment are considered primary microplastics.

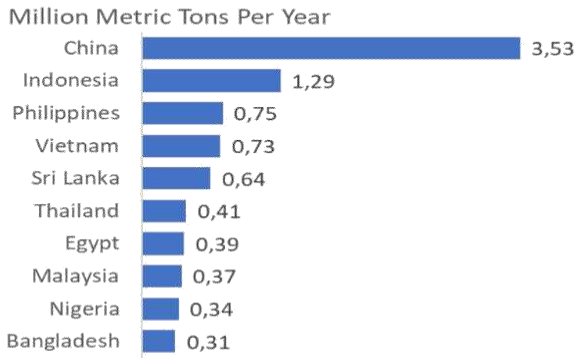

Figure 1. Countries with number of plastic debris entering world oceans [2]

Clothing microfibers, microbeads, and plastic pellets are examples (also known as nurdles). Secondary microplastics are formed when bigger plastic goods degrade (break down) in the environment due to natural weathering processes. Water and drink bottles, fishing nets, plastic bags, microwave containers, tea bags, and tire wear are all sources of secondary microplastics. Textiles/clothing account for 35% of all ocean microplastics, mostly owing to the erosion of polyester, acrylic, or nylon-based clothes, which occurs frequently during the washing process. Microplastics, on the other hand, accumulate in the air and in terrestrial ecosystems. Microplastics are distinguished from bigger plastic trash, such as plastic bottles, by the term macro-plastics [10].

Effects (chronic and acute) of marine debris on the environment (specially the biodiversity)

Marine debris is a global issue that has an impact on all of the world's major bodies of water, both above and below the ocean's surface. Individuals, wildlife, the ecosystem, and the economic health of coastal areas could all be harmed by this material. Beachgoers may be injured by broken glass, medical waste, fishing line, and discarded needles, while swimmers, divers, and snorkelers may become entangled in submerged or floating litter. These elements suggest that bacterial contamination, such as E. coli and other dangerous bacteria and viruses, may exist in these waters. Consuming or coming into touch with water contaminated with these contaminants and organisms can result in infectious hepatitis, diarrhea, bacillary dysentery, skin rashes, and even typhoid and cholera. Beaches become ugly and sometimes dangerous as a result of debris, prompting municipalities and governments to spend money on beach care. Because many coastal communities rely on money from seaside businesses, a cluttered beach can have serious effects. Marine trash makes it unsafe to go fishing, boating, swimming, or visit coastal areas [11]. Nets, fishing line, ropes, and other debris can entangle wildlife, especially those who live near or on the water. A seabird, sea turtle, dolphin, or other marine species that becomes entangled is at risk of being strangled or drowned [12]. By limiting an animal's mobility, preventing it from eating, inflicting cuts and wounds, or causing asphyxia or drowning, debris can smother or drown it. Monofilament line, fishing nets and ropes, balloon ribbons, six-pack rings, and packaging strapping bands are only a few of the deadliest sources of entanglement [13].

Fig 1.3: Marine debris and degradation of marine life (Coastal Wiki)

Plastic pellets and plastic shopping bags can resemble fish eggs and jellyfish to a hungry sea turtle. Many animals confuse waste for food and are unable to regurgitate it after eating it, causing it to become stuck in their throats and digestive tracts. The appearance of cessation is caused by debris that refuses to pass through the stomach, leading some animals to stop eating and starve to death. Marine life has been found to be harmed by fishing gear that has been abandoned for years. In a practice known as ghost fishing, an abandoned fishing net will continue to catch and destroy aquatic organisms. The global ghost fishing problem is becoming more well-known, as is the damage it is having on already overburdened fisheries. The seashore, living coral reefs, and other important habitats can all be harmed by debris. Ropes, nets, and tarps move with the tides and currents, abrading, scouring, breaking, suffocating, and destroying sensitive aquatic habitats. [14].

In recreational boats, plastic bags are a major cause of clogged and blocked water intakes, resulting in burned-out water pumps. [15].

2. The Current condition of the Indian Ocean

The Indian Ocean is surrounded on all sides by 34 countries with average population densities of roughly 100 persons per km2, with Australia being the least inhabited and India being the most populated. In 2010, the total amount of plastic garbage produced by all countries along the Indian Ocean rim was roughly 41 106 tons. In 2010, the combined amount of plastic trash produced by the United States and China was predicted to be 38 and 59 106 t, respectively. According to Kaza et al. (2018), the overall amount of plastic garbage produced by Indian Ocean rim countries in 2016 was roughly 24106 t, compared to 34106 t for the United States and 39106 t for China. Despite the fact that plastic trash output around the Indian Ocean rim

is relatively low, most Asian and African countries have poor garbage management, and a considerable percentage of it winds up in the environment. Around 73 percent of plastic garbage around the Indian Ocean coast is not properly managed and is dumped into the environment. The major coastal and riverine plastic sources in the Indian Ocean, according to current estimates, are in the Northern Hemisphere surrounding the Bay of Bengal and on the eastern side of the Arabian Sea. Plastic trash inflow from rivers is largely determined by river discharge, which varies seasonally. In the northern Indian Ocean, the biggest river discharges occur during the wet season, during the boreal summer. Plastic garbage inflow from rivers in the IO peaks in August, according to Lebreton et al. (2017). Indonesia is the greatest coastal and riverine source of Indian Ocean plastic trash in the Southern Hemisphere.

Ocean-based sources such as the fishing industry, commercial and recreational shipping, and offshore installations can all contribute to plastic garbage entering the ocean. The fishing industry's abandoned, lost, or discarded fishing gear (ALDFG), such as monofilament lines and nets predominantly composed of synthetic material, can produce huge amounts of plastic trash. Since 2000, the IO region has accounted for roughly 13% of global marine fish catch (Pauly and Zeller, 2016). In the IO, ALDFG is a major source of plastic waste. There are currently no estimates of plastic garbage entering the water from fishing vessels (e.g. ghost nets) or offshore platforms. Finally, the Indonesian Throughflow is capable of transporting plastic trash from Southeast Asia to the Indian Ocean.

Fig 2.1: Local beach heavily polluted by Plastic in Chandigarh, India (Fairplanet,2021)

Indian Ocean Garbage Patch:

The Indian Ocean garbage patch is a gyre of marine litter suspended in the upper water column of the central Indian Ocean, notably the Indian Ocean Gyre, one of the five major oceanic gyres. It was identified in 2010. There does not appear to be a continuous debris field in the patch. Plastics in this patch, like those in other patches in each of the five marine gyres, break down into smaller and smaller particles and constituent polymers. The field, like the other patches, contains a high concentration of pelagic plastics, chemical muck, and other trash, mostly unseen to the naked eye. The particle debris concentration has

been calculated to be around 10,000 particles per square kilometer. Researchers and scientists are having trouble locating the position of plastic articles of neutral and positive buoyancy as they pile up in this iconic rubbish area due to dangerous currents. Plastic pollution is transported across the Indian Ocean by garbage gathered from Asia on both the western Indian Ocean islands and the eastern African coast via the South Equatorial Current. Despite the fact that the Indian Ocean Waste Patch generates mounds of plastic that destroy marine life, researchers and scientists have uncovered two more garbage patches: the South Pacific Ocean Garbage Patch and the North Atlantic Garbage Patch. Unfortunately, plastic makes up around 90% of the waste gathered in these rubbish patches, posing a serious health risk to marine life. [16] Plastic trash accumulates and washes ashore, posing a health risk to living species. Plastic trash washes ashore in numerous regions due to strong currents, reducing environmental prosperity and damaging living organisms.

3. IORA and the role it can play

IORA's initial focus was mainly on economic and commercial cooperation, but it has since broadened its scope to encompass broader maritime security objectives, most notably a focus on non-traditional security concerns, which are becoming increasingly important in the maritime sector.

IORA's contributions include: -

IORA sees itself as the "first line of defense" in the region, bolstering existing marine security measures. IORA contains a "maritime safety" project that is concerned with training, transportation, equipment-related issues, and help in distress situations. Maritime security is widely considered to cover a wide range of challenges, spanning from the marine environment to human security.

-In recognition of the Indian Ocean Region's importance in global trade, the IORA has prioritized trade liberalization and the free flow of goods, services, investment, and technology; its "Action Plan 2017-2021" outlined seven trade targets for the region, ranging from lowering trade barriers in the short term to making business travel easier in the long run.

-While fisheries management is covered within the "Maritime Safety and Security" priority area, it has proven to be a particularly pressing concern for IORA member nations, earning it the organization's third highest priority.

-Natural and man-made disasters, such as cyclones, droughts, earthquakes, tsunamis, floods, and tidal surges; and oil spills, fires, dangerous substance leakage, and illegal dumping, are all common in the Indian Ocean Region.

-IORA promotes tourism and cultural exchanges by promoting policy proposals for cooperation among member states and dialogue partners in order to promote regional economic growth, encourage sustainable eco-tourism development, and promote cultural heritage and "harnessing the economic potential of this heritage."

-An IORA "Focus Area," the Blue Economy attracted the attention of all IORA member states at the 14th IORA Ministerial Meeting in 2014 because of its potential to promote employment, food security, and poverty alleviation while promoting business models and economies of both large and small member states. The formation of a Blue Economy policy for member states has been relatively well-organized, led by Australia and India, two member states with well-defined plans for engaging in the Blue Economy: platforms for cooperation on eco-tourism; the creation of the Indian Ocean Tuna Commission, which

regulates fishing in the Indian Ocean; research and development of marine and bio-resources for medicinal purposes; and economic investment are some examples of the successful imposition.

Works that IORA can do to solve the marine debris problem:

2. Deciding Goals- First step to solve any problem is to set the goals. IORA has worked on many issues related to marine life. It can work on setting goals to reduce marine debris.

3. Strategies- To set up the goals, they have to propose some strategies to the member countries. Strategies that can be used to solve this problem is given below-

Educating People: Everyone, from schoolchildren to people who eat fast food, recreational boaters and commercial fishermen, beach visitors and marina operators, waste management workers, and workers in all industries that transport or manufacture resin pellets, must take responsibility for their actions and keep their trash out of the marine environment. Every bit of waste and litter discovered in our rivers once belonged to someone who made a poor decision. Every bit of detritus, in a sense, bears the imprints of human beings. Consumers must be well-informed in order to make informed decisions about how to use and dispose of garbage. Various government agencies and school systems offer a variety of marine debris and litter prevention activities and lesson plans. Manufacturers of plastic objects have been involved in and supported the design and diffusion of these items in numerous cases.

Develop and apply high-quality studies to deal with the problem of marine debris: There haven't been too many studies on the marine debris of Indian Oceans. Increasing studies and scientific researches on debris is the first and foremost way to solve it. To do more research IORA can approach the member countries to increase funding in the universities related waste management research. The more funding and scholarships will be on the subject, the newer solves of these problems will appear.

Approaching Local Governments and Companies: The local governments are always in charge of controlling the local companies and people. They can take the most effective actions. Food, beverages, tobacco products, and other consumer goods are responsible for much of the garbage seen around the world. Transportation, fishing, and industry are three other major sources of maritime garbage. The industries that produce and provide these goods and services must commit to playing a responsible role in debris management and removal. Only with their participation and cooperation will we be able to come up with meaningful solutions to the debris problem. So, if IORA approaches the local governments and the industries to take steps that might be very effective.

Training Programs: IORA can propose some training programs to the member countries. Training for waste management and recycling is very much important to remove waste. It not only increases the trainees' skills but also spreads awareness.

Volunteering Events: IORA can arrange some volunteering programs. It can be a beach cleaning day every month, awareness spreading campaigns. These events will attract peoples' attention and also create awareness. Surf Rider Foundation, Oceana, The BLU, Five Gyres, take 3 are some volunteering organizations that are cleaning the beaches restlessly.

Approaching Funds: All the Indian Ocean Rim countries can raise a fund to make sure of these strategies to work. IORA can play a vital role there. The funds can be governmental or also open

for public donation. Scholarships, research programs, trainings, seminars will be much easier when there will be enough budget to spend on it.

4. **Enforcing Laws and Fines:** Anti-litter laws, bans on mass balloon releases, and regulations to limit rubbish discharge from dump trucks and dumpsters are all in place in many states and national governments. Litter and debris are regulated on both land and marine by a number of laws and international agreements. The 1972 London Dumping Convention (LCD) and the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), which provide a comprehensive approach to dealing with ocean dumping by creating international guidelines to prevent ship pollution, are two current laws relevant to the marine debris issue. MARPOL regulates the disposal of other rubbish at sea and forbids the discharge of plastic items at sea. MARPOL also mandates that ports and terminals provide rubbish collection services for ships and boats. Also, there are regional commitments to regulate marine debris, such as the Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, which was signed in 1987. This lawful environmental pact for the wider Caribbean compels governments to take steps to prevent, limit, and control pollution from ships, dumping, seabed activities, land-based activities, and airborne pollution. Like these laws above, the laws around the Indian Ocean Rim can be enforced and maintained. IORA can ensure all the related countries cooperate and enforce effective laws. There can be fines for throwing out debris. Though this does not solve the problem permanently, still it will help to create awareness.

5. **Correction of Existing Database:** Most of the data related to marine debris was collected at least 4-5 years ago. There have been many changes throughout these years. To take action on any problem correct data is always needed. So there has to be efforts on renewing the data frequently. A good amount of funding and cooperation of the research centers will be needed for that. IORA can approach that.

6. **Creating Awareness:** Last but not least, awareness is the solution to any global problem. Waste management can be very much easy with public awareness. As we can see, a huge portion of marine debris comes from land-based sources, land-based awareness is very much needed. Awareness campaigns, seminars, webinars can be done frequently for this purpose.

7. **Using alternative eco-friendly products:** Bamboo, paper, stainless steel are some echo-friendly products that can be used instead of plastics. Plastic reduction is something needed for marine and land environments. The use of jute-made products can reduce the use of plastics to a very large extent. Bangladesh, India produces a lot of jute and jute made products that are decomposable and also really cheap. IORA can propose these kinds of replaceable products for the member countries to use widely.

4. Conclusions

The ocean is our biggest resource. The main focus should be to preserve it rather than laying dangerous wastes in it. IORA can unite people overcoming this very difficult situation by adopting the suggestions

stated above and implying many more. After all, we all want a healthy and beautiful ocean, which we can only achieve by working together, hand in hand.

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Strengthening Mangrove Ecosystem by Mangrove Monitoring through Capacity Building Programs

By: Muhammad Yunus Zulkifli

ABSTRACT

Mangroves have a very important role in terms of biological, ecological, and economic aspects. The Coral Reef Rehabilitation and Management Program-Coral Triangle Initiative (COREMAP-CTI) is one of the national programs for the sustainable rehabilitation, conservation and management of coral reef ecosystems and related ecosystems in coastal areas carried out and aligned with national and regional programs for the management and conservation of coral reefs in the world's coral reef triangle area. The Indonesian Institute of Sciences (LIPI) was the national focal point of the Intergovernmental Oceanographic Commission (IOC) through LIPI's Deputy for Earth Sciences, in which LIPI's Research Centre for Oceanography (RCO-LIPI) managed the Regional Training and Research Centre on Marine Biodiversity and Ecosystem Health (RTRC MarBEST) for marine capacity building programs both nationally and internationally, particularly in the western pacific region. From 2020 to 2021, RCO-LIPI through RTRC MarBEST under the auspices of COREMAP-CTI project organized some capacity building programs in mangrove ecosystem to disseminate the platform at national and regional levels with a series of specific subjects of expertise. The programs targeted students, young researchers and lecturers. In this regard, those from IOC member states in the Indo-West Pacific, Archipelagic and Island States (AIS) and ASEAN countries were targeted for international programs. The participants were provided with specific subjects: an introduction to mangrove community monitoring activities, occupational health and safety, preparation for the implementation of mangrove community monitoring, data collection for mangrove community monitoring and its processing, data analysis and interpretation of the monitoring results, and report preparation of mangrove community monitoring.

Keywords : Capacity building, COREMAP-CTI, ecosystem, mangrove, monitoring, RCO-LIPI

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INTRODUCTION

In general, relatively protected tropical coastal areas, including those in Indonesia, have complete coastal ecosystems consisting of mangrove forests, coral reefs, and seagrass beds. The mangrove forest ecosystem usually has many linkages in fulfilling the needs of various marine biota, including the people around the mangrove forest. Mangroves have a very important role in terms of biological, ecological, and economic aspects. Based on the magnitude of this role, mangroves have the ability to support and create a balance in the surrounding aquatic ecosystem. With this very unique and complex environmental condition, the mangrove ecosystem has been considered as the place for spawning and rearing marine biota. In addition, the mangrove area has also been used as a provider of raw materials for medicines, food,

buildings, as well as a protected area from the dangers of tsunami natural disasters, and an environment suitable for the life of various marine biota.

The Coral Reef Rehabilitation and Management Program (COREMAP) is one of the national programs for the sustainable rehabilitation, conservation and management of coral reef ecosystems and related ecosystems in coastal areas. The COREMAP in phase III launched from 2014 to 2019 in its development was carried out and aligned with national and regional programs for the management and conservation of coral reefs in the world's coral reef triangle area, known as the Coral Triangle Initiative (CTI), so hereinafter referred to as COREMAP-CTI. The Indonesia Climate Change Trust Fund (ICCTF) has mentioned that the COREMAP-CTI is a program financed by the World Bank that aims to rehabilitate the condition of Indonesia's coral reefs, and to develop an implementable and sustainable national coral reef ecosystem management format. The COREMAP-CTI projects are implemented through collaboration between the National Development Planning Agency (Bappenas) and the Indonesian Institute of Sciences (LIPI) until March 2022. The COREMAP-CTI encourages the strengthening of decentralized and integrated institutions for the management of coral reef resources, related ecosystems in coastal areas. In relation to the above, the COREMAP CTI activities have been developed to collect data and information on mangroves and seagrass beds. Monitoring or assessment of the health of coastal ecosystems, which include coral reefs, seagrass beds and mangroves, as well as the associated biota in them.

The COREMAP-CTI is carried out in a fairly large marine conservation area. Therefore, the implementation of the assessment and the monitoring of the health condition of coral reefs and related ecosystems, mangrove as an example, must be supported by the availability of trained personnel or human resources. Related to this, it is necessary to conduct capacity building programs in the forms of training courses in preparing human resources as skilled and qualified personnel to carry out the both tasks. Mangrove monitoring as well as mangrove health index training courses were organized by the Indonesian Institute of Sciences (LIPI), next consolidated into the National Research and Innovation Agency (BRIN), from 2020 to 2021.

OBJECTIVES

This paper brings up mangrove ecosystem by mangrove monitoring through capacity building programs applied by the Indonesian Institute of Sciences (LIPI), next called the National Research and Innovation Agency (BRIN), under the Coral Reef Rehabilitation and Management Program-Coral Triangle Initiative (COREMAP-CTI).

RESEARCH METHODOLOGY

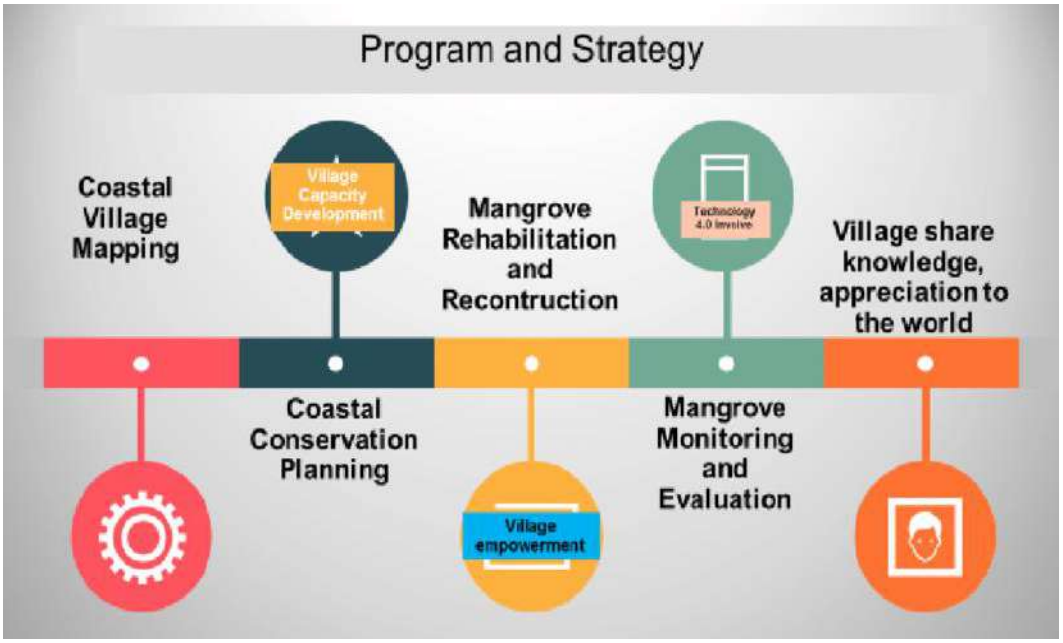
This paper uses a literature review to explore mangrove ecosystem by mangrove monitoring in accordance with capacity building programs applied by the Indonesian Institute of Sciences (LIPI), next called the National Research and Innovation Agency (BRIN), under the Coral Reef Rehabilitation and Management Program-Coral Triangle Initiative (COREMAP-CTI) from 2020 to 2021.

FINDINGS AND DISCUSSION

Indonesia would like to share experiences and knowledge to improve the capability and capacity of young students, researchers and lecturers in the area of ecosystems health, especially on mangrove ecosystem, with the focus of mangrove health index (MHI). This is in line with the endorsement of UNESCO/IOC Regional Training and Research Centre on Marine Biodiversity and Ecosystem Health (RTRC MarBEST) through Western Pacific (WESTPAC) Advisory Group meeting in Yogyakarta, Indonesia on 13-15 January 2016. The Indonesian Institute of Sciences (LIPI) was the national focal point of the Intergovernmental Oceanographic Commission (IOC) through LIPI's Deputy for Earth Sciences. LIPI's Research Centre for Oceanography (RCO-LIPI) managed the Regional Training and Research Centre on Marine Biodiversity and Ecosystem Health (RTRC MarBEST) for marine capacity building programs both nationally and internationally, particularly in the western pacific region. The targeted participants were Indonesian students, young researchers and lecturers for national programs. Whereas, those from IOC member states in the Indo-West Pacific, Archipelagic and Island States (AIS) and ASEAN countries were targeted for international programs.

During 2019, RCO-LIPI through COREMAP-CTI project had finished some scientific activities such as experts' meetings; field surveys and scientific conference attendees to promote the urgency of mangrove health index (MHI) development for mangrove management in Indonesia. As the vastest mangrove in the world, developed MHI formula from Indonesian mangrove could be encouraged as an international standard. In 2020, RCO-LIPI through RTRC MarBEST under the auspices of COREMAP-CTI project organized the National Mangrove Monitoring Training and the International Training Course on Mangrove Health Index (MHI). In that year a smartphone-based app, namely MonMang was launched with various functionalities to record, to analyze, to interpret data simultaneously on the field site, and to be completed real-time. A year later, the global capacity building program was still focused on mangrove in the Mangrove Monitoring International Training 2021 to disseminate the platform at a regional level with a series of specific subjects of expertise. These activities have been in line with the strategic needs of strengthening mangrove ecosystem from local (coastal village) and national scopes to a global scope. Capacity building programs become an appropriate way of sharing knowledge while synchronizing mangrove management actions to optimize mangrove utilization, and sharing as well as integrating data both nationally and internationally.

Image 1. Program and Strategy for Mangrove Governance Based on Village



Source: researchgate.net

Pre-Monitoring Preparation

Management of conservation areas and coastal areas specifically for sustainable mangrove ecosystems requires quality human resources both in terms of potential identification and implementation of regional policies. Identification of the potential of mangrove areas is the most important initial stage in determining the policies implemented in the area. Improving the quality of human resources, especially in identifying the potential and health conditions of mangrove communities, truly matters in supporting the accuracy of the information production. The more professional human resources are involved in management activities, the more optimal the effectiveness of mangrove community management will be. The training courses conducted to assess the condition of the mangrove community provides an opportunity to improve the quality of human resources in the area management. For its implementation, there are several stages that must be passed to get more professional human resources. This will cause the accuracy of the resulting data and information to be higher. One of the most important mechanisms in the implementation of monitoring the health condition of the mangrove community is the preparatory stage. At this stage, everything that is needed, both technical and non-technical, should be prepared properly and thoroughly. Errors made at this stage will cause the monitoring mechanism to be not optimal and hampered.

Data Retrieval

Indonesia is regarded to have the most extensive mangrove area in the world by 22.6% globally (Giri *et al*., 2011) and considerably rich in biodiversity. Consequently, it delivers many significant functions

for the atmosphere's health. Nevertheless, the mangrove area has been decreasing for decades due to increasing coastal area developments (Richards and Friess, 2016; Tilman *et al*., 2017). This condition is also worsened by the massive use of plastic products in the nearby cities that has been considered as one of the main causes of marine pollution (Karapanagioti and Werner, 2018). The mangrove area and functions even have been reduced by land use changes and illegal logging (Sasmito *et al*., 2019). Moreover, Indonesia has no scientific-based standard for mangrove health. Some studies showed that multi-variables relationship were more representatives to figure out ecosystem health.

The increasing population and industrialization in coastal areas have caused mangrove forests to be increasingly threatened. Therefore, sustainable management efforts are needed that include the identification of potential and balanced utilization. Monitoring activities are one of the efforts in management that can be used to identify the potential and current conditions of the mangrove community. By knowing the existing potential, the policies used for management can also be carried out more effectively. The accuracy of data and information in identifying the potential of the area is very dependent on the quality of human resources who carry out monitoring. To obtain quality human resources, training activities for monitoring are very necessary so that these human resources are able to master data collection techniques appropriately. To support the preparation of professional human resources in identifying the potential of mangrove communities in Indonesia, training activities are indispensable.

Early Knowledge of Mangrove Community

In addition to becoming one of the coastal ecosystems providing various ecological and physical benefits for surrounding communities, mangrove ecosystem provides habitat for thousands of species and becomes feeding and nursery grounds for both marine and terrestrial organisms. Surprisingly, mangrove ecosystem is considered to remarkably provide coastal protection services on abrasion, salt water intrusion and natural disaster (tsunami, typhoon) effect to nearby residents (Sandilyan and Kathiresan, 2015). In terms of climate change issues, mangrove is contributed to reduce atmospheric greenhouse gas concentration, carbon dioxide (CO_2) that has been considered as a trigger for recent global warming (Dharmawan, 2018). Mangroves have a crucial function to mitigate sea level rise effects in archipelagic countries. In addition, coastal communities also avail themselves of mangroves as the provider of alternative food sources and livelihood for enhancing social economy, even though the magnitude of its functions to communities is related to the ecosystem healthiness (Spalding *et al*., 2014).

Recently various threats triggered by increasing dependence on coastal resources have caused the degradation of the quality of mangroves in Indonesia. Sustainable management of mangrove communities is needed to maintain their function within the scope of coastal ecosystems. Mangrove community monitoring activities are required to determine the current condition of the community. The

condition and potential information obtained can be used in effective sustainable management activities in the area. This monitoring activity must be carried out by well-trained human resources that know more about the mangrove community. Therefore, to start monitoring mangrove communities they must be given initial knowledge about mangrove communities. The problems encountered are related to occupational health and safety from the understanding of the mangrove community. Some basic topics are connected with risk identification, emergency procedures, identification and operation of occupational health and safety equipment and violations of occupational health and safety procedures (Dharmawan and Pramudji, 2014).

Data Analysis

Mangroves as one of the coastal ecosystems have a very real function for the balance of ecosystems and the socio-economics of coastal communities. The mangrove ecosystem physically functions as a coastal protector from the dangers of coastal abrasion, storms and tsunamis. Mangroves also act as a habitat for economic biota that can be utilized by coastal communities as a livelihood or food source. Coastal communities also use mangroves as forests to produce firewood and wood for building materials. The increasing number of people causes the number of people, who benefit from the mangrove ecosystem to increase. Therefore, currently mangrove management must be more precise and sustainable to maintain the function of mangroves for the community and the balance of coastal ecosystems. Sustainable management requires identification of the potential and health condition of mangrove communities as initial information in determining policies. Identifying the potential of mangrove areas requires skilled human resources that understand how to analyze the current conditions of the monitored mangrove communities. The accuracy of the obtained data is highly dependent on the professionalism of the data takers and analyzers. Data analysis is one of the crucial stages in determining the current status of the health of the mangrove community. The results of field data analysis will be used to interpret the results that represent the health condition of mangroves in the area, and eventually will be reported. Therefore, the data analysis stage is expected to produce professional human resources in supporting area management.

CONCLUSION AND RECOMMENDATIONS

The mangrove ecosystem is one of the strategic ecosystems in coastal areas. Aside from being a support for the sustainability of the ecological system that takes place in it, mangroves also provide benefits for the surrounding environment. Mangrove ecosystems also determine the survival of coral reef and seagrass ecosystems and altogether protect the coastal area behind them from the dangers of waves, strong winds and tsunamis. However, mangroves are also an area for the social and economic life of the

surrounding community. These various things indicate how important it is to preserve mangrove ecosystems in tropical countries. The balance of the mangrove ecosystem is determined by the main factor forming the system, namely the mangrove community. The increasing pressure on the mangrove community has so far caused the decline in the quality of mangrove vegetation. This can be seen from the decline in the area of mangrove communities globally. Indonesia as the owner of the most extensive mangrove ecosystem in the world, has the highest rate of decline in mangrove area compared to other locations. However, the mangrove community in Indonesia has a very high species diversity considering that it is at the center of the world's mangrove diversity. For this reason, a management effort is needed to protect the existence of mangroves in the world.

Management activities that encompass mangrove ecosystems include all activities carried out to maintain a balance between utilization and protection of the existing potential. Identification of the potential of an area is the first step in implementing management. After knowing the potential that exists, it can be determined policies and management programs that will be implemented. Furthermore, evaluation is needed to find out the results of the well-done management. The monitoring of mangrove community health is one of the identifications and conditions of potential vegetation to support management activities that are carried out regularly within a certain period of time.

To improve human resources and to increase public understanding on the potential of mangrove communities in their management, LIPI's Research Centre of Oceanography (RCO-LIPI) carried out training activities for monitoring the health of mangrove communities both nationally and internationally. These activities were based on the Decree of the Minister of Environment of the Republic of Indonesia No. 201 of 2004 concerning standard criteria and guidelines for determining damage to mangrove ecosystems; and the Presidential Regulation of the Republic of Indonesia Number 73 of 2012 concerning the national strategy for mangrove ecosystem management.

The following are some recommendations to make such specific capacity building programs sustainable in order to strengthen mangrove ecosystem:

1. To widen more collaborations among scientists within and outside the western pacific region on the long-term monitoring of mangrove ecosystem.
2. To facilitate easier access and dissemination of information related to mangrove ecosystem and the status of biodiversity and ecosystem health in order to be widely distributed, transferred and applied within the western pacific region and beyond.
3. To establish more networks and coordination among students, researchers, government institutions, private sectors and other stakeholders for marine biodiversity and conservation as well as environmental protection.

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