Case study on net fisheries

in the Gulf of Thailand

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GLOBAL MARINE AND POLAR PROGRAMME

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Contents

estimated 99% of sea birds will have ingested plastic and can become entangled in plastic waste items (Wilcox et al, 2015).

A range of policies, crucial to reducing plastic litter from marine regions, has been implemented mainly including ex-ante and ex-post solutions. Ex-ante solutions include technical and regulatory measures such as eco-design, improved waste management, recycling, bans on single-use plastic, extended producer responsibility, taxes, subsidies, and fishing gear marking; and ex-post measures include beach, river, and ocean clean-ups (UNEP, 2019; Schnell et al., 2017; European Investment Bank, 2021).

The fishing industry, being adversely impacted by plastic debris, can play an important role in addressing the plastic pollution problem as they work in remote coastal waters, where plastic waste is often neglected (Cho, 2009, Cho, 2011). Consequently, several schemes have been devised to engage fishers in ocean protection. One of which, developed by KIMO (Local Authorities International Environmental Organization) in Thailand, is the Fishing for Litter (FFL) scheme which focuses on involving commercial fishers in the removal of ocean litter already present in the marine environment. FFL focuses on collecting marine litter during day-to-day fishing activities whereby fishermen make purposeful trips to collect litter in specific locations and get paid for their efforts (UNEP, 2015; Van Breusegem et al., 2015). Evidence about the tonnage collected and the success of FFL and similar schemes has been well documented (Cho, 2005, Cho, 2009; KIMO, 2014; Van Breusegem et al., 2015).

This issue brief presents the results of a study that estimated the impact of marine macroplastic on the Thai net fisheries operating in the Gulf of Thailand. The study has estimated the reduction in the net fisheries' revenue due to the plastic stock and annual flow into the fishing zone/Thai Exclusive Economic Zone (EEZ) (Gulf of Thailand). This brief has also analysed the benefits of an initiative started in Thailand to reduce the amount of marine plastic in the sea, called 'return garbage to the shore'. Finally, the case study also discusses the impact of marine plastics on natural assets, marine biodiversity, and ecosystems.

2. Study area: The Gulf of Thailand

Thailand is located in Southeast Asia with a population of 69.63 million in 2019 (Worldometers, 2019). Marine fisheries are important both economically and socially for Thailand. Fisheries contributed 0.8% of the total GDP of Thailand i.e. USD 3,560 million in 2018

4.3. Alternative scenarios

The impact of marine plastic pollution on fisheries will change according to the amount of plastics present in the Thai EEZ. Change in impact percentage is estimated following plastics stock estimates according to alternative scenario 1 and alternative scenario 2. A cost of 2.79% has been incurred on the total fisheries revenue due to the presence of macro plastics in the Thai EEZ (see Table 3, alternative scenario 1). Thus, macroplastics leakage can be calculated at a cost of Thai Baht 1.4 billion (USD 34 million) to Thai fisheries in 2019. Whereas, alternative scenario 2, assumes an impact of 0.6% upon total fisheries revenue due to marine plastics leakage in Thai EEZ (Table 3, alternative scenario 2). Plastic leakage generated damages of Thai Baht 246 million (USD 7.3 million) to Thai fisheries in 2019. The results are sensitive to the amount of plastic and where it is found.

4.5. Indirect economic impact

When fisheries production is impacted, it is not only the fishermen who suffer the loss, but also the supporting industries, such as fish

5. Broader impacts of marine plastic pollution

5.1. Marine ecosystems

Beyond the direct impact on fish stocks, there are a number of challenges that could lead to serious impact on the future of fisheries and marine natural assets. These include the degradation of fisheries habitat, namely; coral reefs, seagrass beds and mangroves. There are

5.3.

5.10. Depletion of natural capital assets

Marine natural capital is the stock of marine natural assets which is the source of a wide range of marine ecosystem 'goods and services' and enable humans to live and exploit the natural world (Buonocore et al., 2020). Marine natural assets (including marine sediment carbon, coral reefs, cold corals, seagrasses, mangroves, saltmarshes, tidal flats, seamounts, cold seeps, and hydrothermal vents) support livelihoods and drive economic growth in Thailand. Along these lines, the total economic value of coastal and marine resources in Thailand was estimated at USD 27.67 billion for 2016 (UNESCAP, 2017). However, rapid economic development has often led to unsustainable exploitation of these natural resources. Marine-based natural capital is subject to considerable stress due to various human activities and pollution generated from these activities (Buonocore et al., 2020). Figure 5 below shows areas where there is 'high stress' on natural capital due to human activities (also known as hotspots). Some regions have more than one hotspot which means that there is an even higher level of stress; and related resources are at a higher risk of depletion. Table 7 represents the number of hotspots and the percentage of surface area affected. Given that many activities (such as import, export, tourism, fisheries, etc) are dependent on the integrity of these assets, there is a dire need to protect these resources.

Table 7: Gulf of Thailand hotspots showing surface area of natural capital depletion

Number of hotspots	Percentage of surface area
1 hotspot	69%
2 hotspots	9%
3 hotspots	12%
4 hotspots	9%
5 hotspots	1%

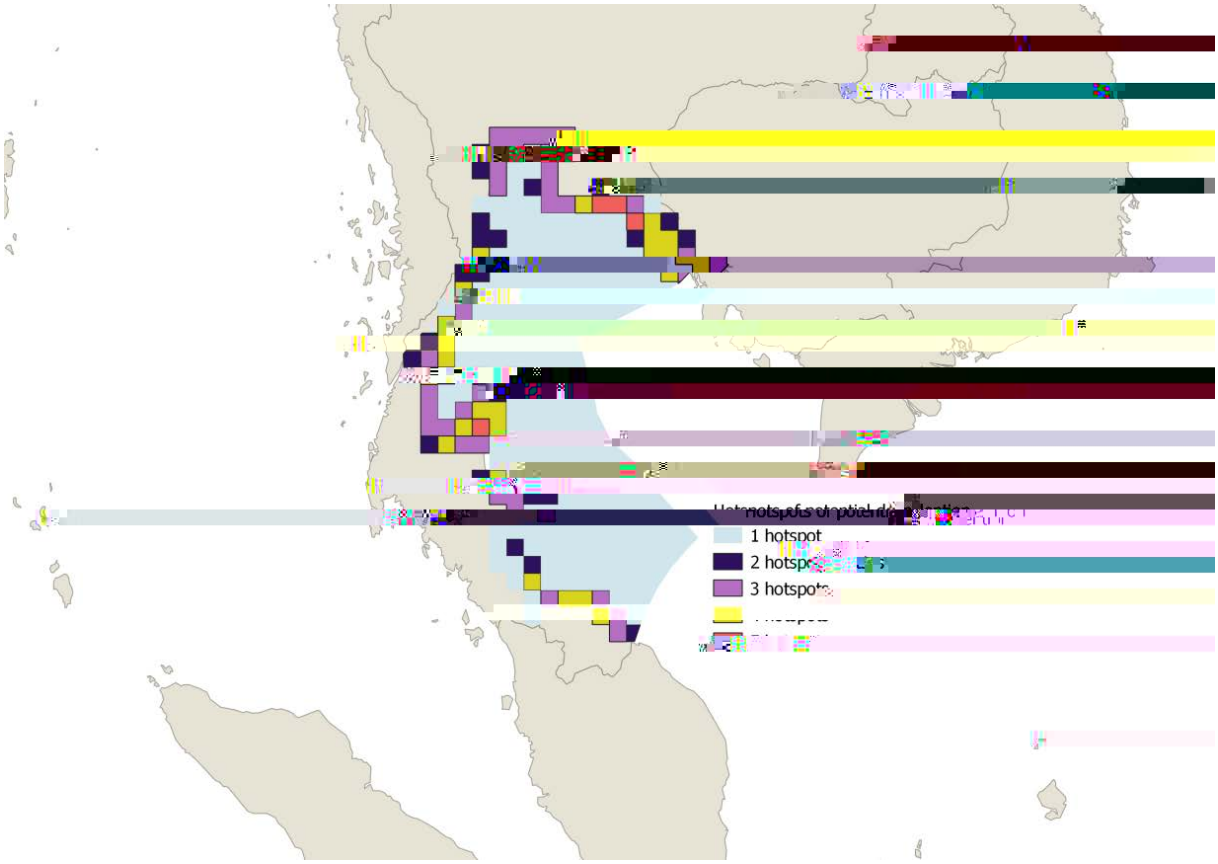

Figure 5: Number of hotspots of potential depletion of natural capital assets where there is high human pressure. Source: WCMW, 2021

6. Reducing plastic leakage and its impact: case study of 'Return garbage to the shore initiative'

There was an initiative launched by the Thailand Department of Fisheries in 2019 to engage fishing vessels to collect plastic litter from the sea and fishing activities, and bring this litter back to shore. The government utilized 22 Port-in Port-out centres (PIPO) previously established in the Gulf of Thailand (Figure 6) to help monitor the "return garbage to the shore" program. At the time of this research, there were 842 commercial vessels involved in the fishing for litter activities in the Gulf of Thailand. Data collected from this research shows that 75% of this plastic waste was generated from their own fishing activities and the remaining 25% was picked up from the sea. In one year 2019-2020, 74 tonnes of marine waste were collected during fishing activities in the Gulf of Thailand, out of which 18 tonnes were collected directly from the sea (25%) and 56 tonnes generated by the vessels (75%).

Moreover, according the data, 63% of it was composed of plastic waste this means that currently 47 tonnes of total plastics waste is collected from the Gulf of Thailand by 842 vessels.

This initiative will provide two direct economic benefits. First, this initiative will reduce the amount of stock in the fishing zone. This means that there are fewer plastics in the Thai EEZ to impact fishnets, catch and vessels and hence the cost of dumped catch, net repairs and fouling will reduce. Reduction in plastic will reduce the impact on fisheries revenue.

Secondly, there would be revenue generated from the plastics collected when sold. This will further help fishermen to increase their profits. Recycling units, plastic product manufacturing units are always interested in finding a good deal to buy plastic waste. Also, the Thai government can incentivise this initiative by fixing an amount that will be paid for every tonne of plastic brought back to the shore. This will motivate the fishers and help to generate some revenue.

Table 8: Scenario A: Business-as-usual scenarios (BAU) of return garbage to shore initiative

Plastics leakage in 2019 (in tonnes)	111,8613
Cost of plastics leakage in 2019 (Thai Bahts)	54,118,387
Number of vessels participating in the initiative	842
Amount of plastics brought back to the shore (in tonnes)	47
Cost of plastics leakage (after collecting 47 tonnes of plastics) (Thai Bahts)	54,095,648
Avoided cost (Thai Bahts)	22,739

Table 9: Number of vessels participating and plastic collected in each of the four scenarios

	Scenario A: BAU	Scenario B	Scenario C	Scenario D
Number of commercial vessels	842	2,028	4,056	6,760
Number of artisanal vessels	0	3,932		

7. Summary and final remarks

Marine plastics affect Thai fisheries directly through damage to ships, plastic in fishnets, and the impact of lost fishing gear. Plastics present in the sea not only negatively affect the economy, but also impact individual households' livelihoods and food security, especially in coastal communities.

As for the direct impacts, Thailand's net fisheries are responsible for 88% of marine capture, and incur an estimated loss of 1.88% on the fisheries revenue. Considering the revenue generated by the fishing sector, marine macroplastics pollution are responsible for revenue losses to Thai fisheries of Thai Baht 772 million (USD 23 million) to Thai fisheries (operating in the Gulf of Thailand) in 2019 due to the presence of 1,597,154 tonnes of macroplastics stock in Thai EEZ. Out of 1,597,154 tonnes of macroplastics stock, 111,861 tonnes were added to the Gulf of Thailand in 2019. Based on 2019 figures, it is estimated that plastic leakage contributed to a 0.13% of impact on Thai fisheries.

types of fishing gear, and freezing the number of trawlers, anchovy purse seiners, and anchovy lift nets. There is also a ban on the use of push nets. Other than these regulations, they have taken measures to reduce the efficacy of fishing nets to reduce/limit fish catches (DOF, 2015-2019). The participation of the local community is very important in order to ensure that these regulations are agreed upon and followed.

It should be noted that this study only examines official fisheries, not illegal, unreported, and unregulated fishing. This may have a bigger impact on fish stock depletion; and a higher plastic leakage level (including ghost fishing and illegal fishing gear). Moreover, an estimated 64,000 tonnes of gear is thrown into the ocean annually by vessel operators who fear getting caught fishing illegally by regulatory authorities (FAO, 2021). Global losses from illegal fishing cost up to USD 36.4 billion each year due to the over extraction of the fish population (World resource institute, 2014).

Lastly, the current estimates were calculated using the Value Transfer Method (VTM) combined with data from secondary sources. In order to get more exact estimates, it is recommended to collect data directly with fishermen and the Thai fishery institutions on the amount of fish catch, vessel impacts, and related factors.

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Annex

1.A. Estimation of tonnes of plastics in Thai EEZ on the basis of baseline scenario

Marine regions	Plastics (in tonnes)
Sea surface	17,895
Coastline and seafloor	1,679,289
Coastal waters	1,579,259

Based on baseline study UNEP GRID-Arendal, 2018

The table represents the estimated amount of macroplastics present in different marine region of Thailand, according to the estimates by UNEP GRID-Arendal, 2018, which is the baseline study for this report. The sum of plastics present on sea surface and coastal waters is considered for the impact analysis, which is represented as below:

Total amount of plastics impacting fisheries (in tonnes)
1,597,154

1.B. Estimation of tonnes of plastics in Thai EEZ on the basis of Alternative scenario 1

Marine regions	plastics (in tonnes)
Seafloor	3,543,293
Shoreline	19,932
Marine organism	3,579
Sea surface	7,158
Water column	3,579

Based on Alternative scenario 1 (plastic distribution estimates presented by Boucher and Billard, 2020)

Alternative scenario 1: Total amount of plastics impacting fisheries (in tonnes)
10,737

1.C. Estimation of tonnes of plastics in Thai EEZ on the basis of Alternative scenario 2

Marine regions	plastics (in tonnes)
Shoreline	4,914,288
Coastal water (less than 200 m)	10,607

Based on Alternative scenario 2 (plastic distribution estimates presented by Lebreton et al., 2019)

Alternative scenario 2: Total amount of plastics impacting fisheries (in tonnes)
10,607

2. Methodology for Impact analysis

The problem is solved using value transfer and the direct rule of three. The 'direct rule of three' helps solving the problems based on proportionality. It states

If, A B

& X Y

Then, $X = \frac{A * Y}{B}$

Where A, B, X and Y are random variables. If the values of A, B and Y are known, one can estimate the value of X. The direct rule of three states that B is related to A in the same proportion as Y is related to X.

Coming back to the current relation, revenue is the function of price of the fish catch in market and quantity of fish catch

Revenue = price X quantity

The relation between amount of plastics and amount of fish, which both have an influence on the estimated impact, can also be written as:

$$Impact\ 1 = PI_x * FC_x$$

Where, impact 1 is the impact% of marine plastics on fisheries

PI_x is the amount of plastics present in the Thai EEZ in tonnes in X country

And FC_x if the amount of fish catch in tonnes inn X country

Plastics' impact is not only related to the amount of catch, but also the number of vessels and the total size of the fishing area where the marine plastics is located. This relation can be represented by the equation below. Aside from this, the impact size is also a function of attributes such as size of fishnets used, time spent on sea by each vessel, zone with plastic accumulation, etc. The data on all these variables were not available, thus, not included in the current study.

$$\text{Impact } 1 = \frac{PI_x}{(V_x * EEZ_x)} * \frac{FC_x}{(V_x * EEZ_x)}$$

Where, V_x is the amount of vessel in the Thai EEZ and EEZ_x is the size of Thai EEZ in km² of X country (it is considered that EEZ is equal to Thai EEZ).

The aim is to translate the impact of the given dataset to Thai fisheries(operating in the Gulf of Thailand). This is done with the help of data of Scottish fisheries. Given that both countries have a different amount of plastics present in the Thai EEZ and it catches different number of fishing, the relation of two countries can be stated as follows:

$$\text{Impact } 1 = \frac{PI_{Scotland}}{(V_{Scotland} * EEZ_{Scotland})} * \frac{FC_{Scotland}}{(V_{scotland} * EEZ_{Scotland})}$$

$$\text{Impact } 2 = \frac{PI_{Thailand}}{(V_{Thailand} * EEZ_{Thailand})} * \frac{FC_{Thailand}}{(V_{Thailand} * EEZ_{Thailand})}$$

Applying the direct rule of three, and solving for '% impact 2' (i.e. impact on Thai fisheries), it can be represented as follows:

$$\%\ impact2 = \%impact\ 1 * \frac{\left[\frac{PI_{Thailand}}{(V_{Thailand} * EEZ_{Thailand})} * \frac{FC_{Thailand}}{(V_{Thailand} * EEZ_{Thailand})}\right]}{\left[\frac{PI_{Scotland}}{(V_{Scotland} * EEZ_{Scotland})} * \frac{FC_{Scotland}}{(V_{scotland} * EEZ_{Scotland})}\right]}$$

3. Input data from Scotland

Scotland fisheries overview

Mouat et al., 2010 conducted a study through a survey on the Scottish fisheries to understand the extent by which this sector is impacted by marine litter. It concluded that 5% of marine litter has impacted Scottish fisheries in 2008. Considering 80% of all the marine litter is composed of plastics (Dunlop et al., 2020), it can be inferred that the impact of marine plastics on Scottish net fisheries was 4%.

Table 1: Overview of data from Scottish net fisheries in 2008 (Source: Scottish Government statistics, 2008)

Vessels	Annual catch (tonnes)	Value (in £ 2008)	Fishing zone (km²)
653	331,440	315,203,000	462,263

Amount of plastics present in Scottish EEZ

Every year, there is a certain amount of plastic that is leaked into the ocean due to the factors such as inadequate waste management system, illegal waste disposal, littering, urbanization etc. This leaked plastics impact many economic activities including fisheries (Boucher et al., 2019). The estimated amount of plastics present in the EEZ of Scotland was 24,161 tonnes in 2008 (calculation based on the estimates in GRID-Arendal, 2018). Thus, the assumption is that in 2008 the impact on Scottish fisheries of 4% was due to the presence of estimated 24,161 tonnes of plastics in their EEZ.

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