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Addressing Challenges of Coastal Communities through Ocean Research for Developing Economies

Characterisation of the inshore marine sectors of Da Nang, Vietnam

A report from the ACCORD project

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Executive summary

Da Nang is a pioneer site in Southeast Asia for the implementation of Integrated Coastal Management and the first city in Vietnam to become an Environmental City in 2020. At the same time, the city of Da Nang in Vietnam is experiencing substantial changes in its urban landscape due to socioeconomic growth in line with three primary pillars: tourism, high-tech industry, and marine economy. These pillars are likely to bring negative environmental consequences, of which marine water quality is a key concern. Thus, this study carried out a characterisation of the inshore marine sectors and developed understanding of the impacts of poor water quality and Covid-19, with the aim of informing marine-coastal management.

The sectors of artisanal inshore fisheries, aquaculture and marine tourism were assessed through surveys; blue carbon and policy mapping via desk-based research; and resilience of fishers and aquaculture farmers to Covid-19, and other major shocks, was studied via in-depth interviews and focus groups. The results provide a wealth of information, highlighting strengths and weaknesses in each sector, and areas for further research and management-policy advancement. The estimated monetary values for Blue Carbon in Da Nang are quite low, but it is important to remember that marine habitats provide a host of other services. Aquaculture farming are the most disadvantaged marine sector in Da Nang in several aspects, but they would mainly benefit from policies that legalise aquaculture and support training in sustainable practices. Inshore artisanal fishers evidence overall good conditions, but the marine environment would benefit from greater monitoring and enforcement of fishing policies. Son Tra Peninsula is a key location in Da Nang, as it supports a large proportion of marine tourism and artisanal fishing. Thus, the area needs special attention for conservation to ensure protection of the marine environment in the face of expected expansion of marine tourism. In all three marine sectors there is an almost total dependence on these activities for household livelihood, thus households would benefit from income diversification or support, especially in times of stress, and more equitable support system from the government.

All marine sectors showed a trend towards not expecting future change in their respective sectors. However, aquaculture stands out for a tendency to expect an increase of demand for the sector despite its current unrecognised status. While fishers tend to have conflicting views on expected changes which seems to reflect uncertainty or lack of knowledge. All three sectors mentioned natural disasters as a main threat to their livelihood; marine tourism operators and aquaculture farmers also highlighted water pollution; and fishers emphasised the threat from destructive fishing. These threats evidence key areas to develop in Da Nang city: adaptation and preparedness for natural disasters, updating and implementing water quality monitoring, enforcing water quality policies, and enforcing fisheries policies including patrolling.

The three sectors had an overall positive view on the water quality status for Da Nang Bay, as well as thinking that their activities did not have much impact on water quality. However, there was evidence of misinformation and conflicting views regarding their effect on water quality and other sources. Thus, there is a need for environmental education and awareness raising regarding different sources of pollution, impacts of pollution and impacts of their livelihoods on water quality and how to reduce them. There was a dominant view across sectors that sewage and industrial waste were two of the main causes of marine water pollution in Da Nang Bay. This highlights the need to take enhanced action for water quality improvement by improving sewage treatment.

Impact of Covid-19 on fishers and aquaculture farmers were mainly felt on income, which was due to a lowering of price received for stock/catch and no access to buyers. Fishers' food security and social networking were also affected. Aquaculture farmers were able to maintain good food security

through their own stock and perceived increased environmental security from reduced industrial effluents during lockdowns. However, the pandemic was perceived to be less impactful than natural disasters.

Finally, a detailed content analysis of Integrated Coastal Zone Management-related policies is recommended as it would provide a deeper understanding of the extent to which policy makers and deliverers in Vietnam, and Da Nang specifically, have included tourism, fisheries, aquaculture, and blue carbon within their coastal management policies, and how (un-) successfully the policies interact and complement one another in order to facilitate sustainable coastal management.

Introduction

Marine ecosystems provide a range of ecosystem services that contribute to human well-being (Costanza 1998; Liquete et al. 2013; MEA 2005). The ecosystem services approach refers to the interdependencies between nature and human well-being (Steger et al., 2018). Examples of ecosystem services include fishery resources, recreation, water quality, coastal protection, and carbon sequestration. Marine ecosystem services are, however, under pressure across the globe due to unsustainable anthropogenic activities and ineffective ecosystem management (MEA 2005; IPBES 2019). There have been several attempts to undertake marine ecosystem service assessments (e.g. Norton et al., 2018; Hattam et al., 2015; Turner et al. 2015) and researchers have rarely used existing frameworks without first modifying them to suit the specific circumstances.

In the last years, efforts have been made to include ecosystem services in different decision-making processes and to contribute to the assessment of their impacts (Geneletti 2020). Several local experiences have proven the effectiveness of the ES approach in driving policy changes toward more sustainable outcomes in different contexts and scales (Ruckelshaus et al. 2015). Decisions usually affect not a single but a bundle of ES (Spake et al. 2017), hence assessments able to account for multiple ES and their multiple values are needed to investigate synergies and trade-offs potentially arising from decisions (Geneletti et al. 2018). This study is a first step in a marine ecosystem service assessment for Da Nang Bay, Vietnam. The marine ecosystem services selected were artisanal fisheries, tourism, aquaculture farming and carbon sequestration. These services were selected based on the main activities carried out within Da Nang Bay, in line with wider ACCORD activities and Vietnamese project partners interests. The research was framed within the hypothesis of poor water quality in the Bay. In this study, water quality refers to the presence or absence of water pollutants which can include microbes, nutrients, heavy metals, organic chemicals, oil, sediments, and at times heat (accessed 06/04/2022 https://www.un.org/waterforlifedecade/quality.shtml).

In summary, this study aimed to carry out a characterisation of the inshore marine sectors – fisheries, tourism, aquaculture, and blue carbon – within a context of poor water quality and Covid-19 for improved marine-coastal management in Da Nang, Vietnam. The specific objectives were to a) characterise four inshore marine sectors or ecosystem services in Da Nang Bay; b) study fishers and aquaculture farmers' resilience to Covid-19; and c) implement a preliminary policy and actor mapping surrounding the Integrated Coastal Zone Management (ICZM) of Da Nang Bay.

Background: Da Nang Bay, Vietnam

Da Nang city is located in the South-Central coast of Vietnam. It is one of three key urban centres in Vietnam, with the fourth largest seaport, and one of the main regional centres in Southeast Asia (UN-HABITAT 2014). The city has a Tropical Monsoon climate that has a mean precipitation of 30 – 533mm/month (UN-ESCAP 2020). Da Nang has a population of 1.1 million in 270,000 households and encompasses 1,285km^2 of which 980km^2 is land area. It is composed of eight districts, six urban: Hai Chau, Thanh Khe, Son Tra, Ngu Hanh Son, Lien Chieu, and Cam Le; and two rural: Hoa Vang and

Hoang Sa islands. These districts are divided into 56 local areas: 45 wards (urban) and 11 communes (rural). The largest river in Da Nang is the Han, which flows through the city centre to discharge into Da Nang bay. The Cu De River catchment to the north is much smaller, but still provides an important water supply. Industrial zones are centred along the North-West bay area with further activity found on the eastern bank of the Han River. The city's business districts, and high-density residential zones can be found on the western bank (UN-ESCAP 2020).

Since being designated as a Class I city in 1997, Da Nang City has experienced significant socio-economic changes (UN-HABITAT 2014). Da Nang's urban landscape has seen a rapid transformation, especially in terms of growth in infrastructure projects, real-estate development, and the expansion of the service sectors (Dieu 2016; UN-HABITAT 2014). Over the last few decades, the city has focused on bringing in local and foreign investors for the development of marine tourism (UN-HABITAT 2014). The main tourist investment focuses on (1) transforming Son Tra into a high-class ecotourism centre; (2) transforming Da Nang Bay into a unique "marine city" with architectural and service highlights; (3) downtown with shopping centres and traditional restaurants; and (4) recreational projects, peripheral tourism, and inter-regional projects (DASI 2018). In March 2020, the Prime Minister signed Decision No. 393 approving adjustments to the 'Da Nang City Socio-Economic Development Master Plan toward 2020' with a vision to 2030. The adjusted master plan focuses on developing three primary pillars: tourism, high-tech industry, and marine economy. It was expected that by 2020, GDP of Danang's service sector will account for 55.6%, industry and construction 42.8%, and agriculture accounts for 1.6%. UN-ESCAP 2020).The Master Plan for Drainage and Storm Water, and the Environmental City Plan were created to take steps to solve this problem (UN-HABITAT 2014).

Pressures on Da Nang include population increase, environmental issues, resource depletion and biodiversity decline, climate change and extreme weather events (Dieu 2016). Da Nang City has a mean annual urban population growth rate of 3.5% and it is expected to more than double from current levels to reach 1.5 million people by 2025. Water pollution is currently the result of domestic and industrial water uses, upstream agricultural runoff, and waste from the hospital and service industries. One of the most immediate threats is the high level of faecal coliform which is leached into nearby surface water sources. This problem is exacerbated by combined sewage overflow, which is made worse during the wet season due to the city's limited capacity to manage storm water (UN-HABITAT 2014).

Da Nang City has six industrial zones with centralized wastewater treatment systems. The Da Nang City Socio-Economic Development Master Plan toward 2020 aligns national socio-economic targets with Da Nang's city planning and presents the urban development agenda to 2020. Goals include 100% wastewater treatment and 70% solid waste recycling by 2020. Currently, 94% of units in all of the city's industrial parks are connected to wastewater treatment systems, and 50% of wastewater is treated by following regulatory standards. Limitations can be seen at the Da Nang aquaculture industrial park and Tho Quang ship station, which have struggled with complicated water pollution problems in the nearby residential areas. Further, pollution of rivers and beaches due to tourism development activities along the coastline require stronger environmental regulations. In particular, eco-tourism in the Son Tra Peninsula, Ba Na - Nui Chua and Hoa Spring has affected natural eco-systems and biodiversity. Since 2012, the Drainage and Wastewater Treatment Company has been responsible for installing wastewater treatment plants. This has included a sewerage system in the Tho Quang industrial park, and an interdisciplinary working group has been established to directly monitor industrial parks (UN-HABITAT 2014).

As part of the city's environmental monitoring programme, marine monitoring has been conducted since 1995. The monitoring frequency and parameters have been adjusted many times. However,

monitoring has not yet met the needs of the city, especially as a Class-1 city. Problems have included: no guaranteed high-quality information, lack of sampling and analysing equipment and a lack of data processing procedures. In 2006, supported by the Integrated Coastal Management Project in Da Nang (ICM), the local environmental monitoring programme had a substantial boost. In 2014, the Da Nang People's Committee issued Decision No. 5117/QĐ-UBND on approving the Project "Building an air and water environment monitoring network in Da Nang City" which is still in operation. The coastal monitoring programme consists of 10 monitoring locations, 12 monitoring parameters (i.e., pH, temperature, electrical conductivity, salinity, Dissolved Oxygen, turbidity, flow rate, Total Suspended Solids, Chemical Oxygen Demand, NH4+, oil and grease, and faecal coliforms) and a frequency of 12 times per year. However, there is a need for biological monitoring beyond coliforms as in recent years the Da Nang coastal area has repeatedly experienced a few environmental incidents which had a severe impact on the city's tourism activities. For example: abnormal red patches all over the sea in Da Nang Bay and itchy rashes, on residents and foreigners after swimming in the ocean (2017); and about 2 tonnes of dead fish drifting ashore in Da Nang Bay (twice in 2018) mainly *Konosirus punctatus* (DASI 2018).

Da Nang city was the national pilot site in Vietnam for the implementation of Integrated Coastal Management in 2000, in formal partnership with PEMSEA. The Prime Minister approved the Integrated Coastal Management Program for the North central region and central coastal provinces until 2010 and orientations until 2020 on 9th October 2007 (Cuong and Cu 2014). The People's Committee of Da Nang established the ICM Project Coordinating Committee (Decision 7997/QD-UB, 2000) to guide development and implementation of their Coastal Strategy. One of the key outputs of the project was the coastal use zoning plan, which was approved by the People's Committee on 10 October 2005 through Decision No. 7825/QDUB. As a follow-on to the ICM program, Da Nang was the first city in Vietnam that became an Environmental City in 2020 (Environmental City Initiative, PEMSEA 2015). The city's Integrated Coastal Zone Management Program (ICZM) has provided a platform for stakeholder involvement and inter-agency and multi sector coordination for integrating environmental concerns into economic development plans (UN-HABITAT 2014).

Methodology

Different designs and methods were employed for each area of study, see following sections for further information. Overall ethical approval was obtained with Hanoi University of Public Health on September 17th, 2020 (No. 389/2020/YTCC-HD3) and from the Faculty Research Ethics and Integrity Committee of University of Plymouth, UK on August 7th, 2020 (No. 19/20-1294). Note that all of these activities were affected by Covid-19 restrictions in Da Nang, thus limiting the time available for sampling, data collection and subsequent analysis.

Surveys for the sectors of marine tourism, aquaculture and fisheries were designed to capture a characterization of each sector, the importance of the sector for respondents' income, and respondents' perceptions on marine water quality. All data for the three marine sectors was collected by Dr Kinh and her students and colleagues from the University of Da Nang between 18th September - 18th of October 2020, within Vietnamese ethic approval restrictions due to Covid-19. Note that sample size was particularly limited by the small window for fieldwork given by the Hanoi University ethics panel. Questions for the tourism, aquaculture, and fisheries sectors, unless otherwise specified, covered the period from September 2019 to September 2020 so some effects of Covid-19 will be present in the data. Note that fishing occurs throughout the year if the weather allows it, but there were fishing bans during Covid-19 lockdowns. Aquaculture farming generally occurs from December to August every year, as September to November is the rainy/cold season. The tourism season is mainly during summer vacation i.e., June to August and national holidays. Note

that throughout the results only median is reported when mean and median are the same or quite similar.

Marine and coastal tourism

Dr Kinh identified marine and coastal tour operator companies via university colleagues and an official list from the Department of Tourism in Da Nang. Operators on the list were contacted for an interview but many were not operational, some being forced to close due to Covid-19 impacts, but it is estimated that there are approximately 15-20 companies in operation (pers. comm. Department Tourism). A total of 10 interviews were carried out by Dr Kinh (3) and University Senior lecturer Mr. Nguyen (7) between September 29th and October 2nd, 2020 with either the owner or business manager of a tour operator company. Interviews were arranged over the phone (from list) and then carried out at respondents' houses (as offices were closed due to Covid-19). Due to the sample size, analysis was limited to percentages and indication of trends in the data.

Aquaculture

Aquaculture farm owners or managers were identified by looking at google earth maps, reports from the Department of Agriculture and Rural Development (DARD) on illegal and legal location of farms and from talking to staff. DASI also had relevant information. Four aquaculture sites covering finfish, crustacean and mollusc farming were identified and visited, with ten interviews carried out at each site. A total of 40 interviews were carried out by Dr. Kinh (11), MSc student Ms. Le (14), Mr. Nguyen (9) and MSc student Mr. Hoang (MSc student) (6) between September 26th and October 1st, 2020.

Respondents self-defined type of production as: 'integrated' when they cultivated different species year-round at different times, e.g. work 2 months and rest 1 month; 'semi-intensive' was defined as combining both industrial feeding powder and natural feeds, and the density is less than intensive but relatively high; 'extensive/organic' when farmers didn't use industrial food but reduced feeding was given by farmer-made organic feed e.g. minced small dry fish (fishmeal) with bran (rice husk), plus pond was left as natural as possible (provides higher price to farmer). Two growth stages were reported; 'grow out' where farmers purchase immature species and farm then and when mature they hire labourers to catch fish/shrimp; and 'mixed stages' where different stages of growth are staggered in the same pond. Irrespective of production type and growth stage, all farmers purchased immature species from a company for their farms.

Artisanal inshore fisheries

Fishers were first identified from Dr Kinh's existing 50 fisher contacts from previous research. These fishers then introduced her to other fishers via snowballing. DASI staff, who manage fishers through the ICZM implementation, helped confirm that all fishing areas were being covered. Dr Kinh, Ms Le, Mr Nguyen, and Mr Hoang with support from 2 other MSc students obtained fishers' contact details and arranged interviews. Interviews were most often held at a fisher's home, but some were carried out at landing sites. Fisher interviews were carried out between September 25th and October 22nd, 2020.

Blue carbon habitats and valuation of stocks

There are three key blue carbon habitat types in Vietnam: seagrass, mangrove, and seaweed. Although at a global level these habitats are well studied, country specific data on their extent, composition and condition is sparse. Similarly, information on carbon sequestration and storage rates in Vietnam is also limited (Howard *et al.*, 2014). Whilst it is possible to draw some generic conclusions regarding blue carbon and climate regulation given the habitat type, vegetated coastal habitats vary vastly in their carbon sequestration ability as well as the carbon stock they can hold on to due to different biotic and abiotic factors such as species or sediment type (Bedulli *et al.*, 2020).

For example, it is likely that some seagrasses, such as *Posidonia* sp., *Thalassodendron* sp. and *Enhalus acoroides* contribute more to C deposits than other seagrasses (Macreadie *et al*., 2014). As a result, it is difficult to draw country specific conclusions from global data. This study therefore aimed to assess specifically how much Danang Bay can contribute to climate regulation through the management of blue carbon habitats.

A preliminary assessment of blue carbon and climate regulation was done for Da Nang Bay covering seagrass, mangrove, and seaweed (i.e. macroalgae). Due to Covid-19, field sampling was not possible, so a desk-based approach was used to assess blue carbon habitats in Danang Bay. Our Vietnamese academic partner in the ACCORD project, Dr. Kinh (Da Nang University), provided information on blue carbon habitats. A recent regional biodiversity assessment report provided information on seagrass beds (Duc and Minh, 2018). The World Atlas of Mangroves was used to assess mangrove habitats in Danang bay (accessed 18.08.2021). The website www.sealifebase.org was used for seagrass species in Vietnam (accessed 20.07.2021). Finally, a literature search was carried out for published materials on blue habitats in Danang Bay, using Google Scholar, Science Direct and Web of Science. Search terms included location (Vietnam, Southeast Asia, Asia), group or species (seagrass, seagrass bed, seagrass meadow, and species names), and carbon (carbon sequestration, sequestration rate, carbon stock).

The primary benefit of the service of carbon sequestration and storage is a stable and equable climate, which can be valued monetarily facilitating transparency in the discussion of trade-offs between different management and development options. Carbon sequestration, storage rates and stocks can be valued using a proxy such as a carbon price. In line with a mix of other policies, carbon pricing can aid the reduction in greenhouse gas emissions by placing a fee on carbon emissions or by incentivising emission reductions. A wide range of studies present different approaches to estimating carbon prices (Rogelj *et al*., 2018). Values vary depending on the methodology applied, models used, scenarios explored, and socio-economic, technology and policy assumptions. As such, it is preferable to use a country specific carbon price. For the past five years numerous Vietnamese government departments, including the Ministry of Natural Resources and Environment of Vietnam (MONRE) and the Ministry of Finance (MOF), have collaborated with the Partnership for Market Readiness (PMR) to design a domestic emissions trading scheme and a crediting mechanism. In November 2020, Vietnam's National Assembly adopted the revised Law on Environmental Protection, Article 139, which provides a mandate for the organization and development of the carbon market. Vietnam is one of the first developing countries to adopt carbon pricing, to guide a cleaner post-pandemic recovery and enable the achievement of the ambitious Nationally Determined Contributions (NDCs). However, current carbon prices specific to Vietnam are not available and in their absence, it is recommended to use a global price as per the 2018 IPCC special report (IPCC, 2018). This report advised undiscounted values for a below -1.5°C pathway range from 2010 USD135–6,050/tCO_2-eq in 2030 and 2010 USD245–14300/tCO_2-eq in 2050.

Extent and classification of blue carbon habitats

A survey carried out in 2017 showed that seagrass beds in the Son Tra peninsula had diminished by 90% compared to previous records, with only 1 ha remaining in scattered places (Tin *et al.*, 2021 and references therein). Duc and Minh (2018) found that seagrass was distributed from the shore to a depth of 6-7 m, most abundant at 3-4 m. They also found that there was a reduction by approximately 40-50 ha from a previous survey in 2000. They considered the removal of seagrass and construction of coastal infrastructure as the main causes for this loss. Of the 14 seagrass species found in Vietnam (Nguyen *et al.* 2002; www.sealifebase.org, accessed 20.07.2021), only three have been found in Da Nang Bay in the most recent survey (Duc and Minh, 2018): *Halophila ovalis* (sinus grass), *Halophila decipiens* (single sinus grass) and *Halodule pinifolia* (sea needle grass). While one area covers 0.7 ha of seagrass (Bai Bei), with *H. ovalis* dominating, an area of 0.3 ha is covered in Bai

Moi, dominated by *H. decipiens*. This area is sparsely covered at a depth of roughly 6 m (Duc and Minh, 2018).

Seaweed is known to occur within Da Nang Bay, in particular around the Son Tra peninsula. However, species composition changes seasonally and data are not available (Dr Kinh, pers. comm.). Seaweed was not mentioned in a recent survey of Da Nang Bay (Duc and Minh, 2018) although Sealifebase.org lists 54 species of seaweed for Vietnam. The Allen Coral Atlas shows corals and seaweeds together. Thus, it is not possible to assess the extent of seaweed from the Atlas and we also lack species classification and seasonal variations. Similarly, a small assemblage of less than 100 mangroves remains in the Han River estuary (Dr Kinh, pers. comm., 01.09.2021). But no evidence of mangroves has been found for Da Nang Bay in recent local surveys (Duc and Minh, 2018) or in global surveys, such as the recent edition of the World Atlas of Mangroves (Spalding *et al.*, 2010; accessed 18.08.2021). Thus, both seaweed and mangrove are excluded from subsequent blue carbon analysis.

Resilience to Covid-19

There is a general consensus that *"resilience is about the inherent capacity (ability) or strength of individuals, communities and institutions to withstand/cope, recover, adapt and transform in the face of specific shocks"* (UNDP, 2013). In order to measure resilience at a community or household level, there is a need to identify good indicators of resilience. They can be universal indicators measuring absolute and comparable resilience levels, which then facilitates our understanding about whether resilience is rising, falling, or remaining stable. For example, a study by UNDP Drylands Development Centre (2013) hypothesised that households could be considered resilient when they managed to feed themselves and meet their basic needs without external aid in both stressful and normal non-stressful circumstances (UNDP Drylands Development Centre, 2013).

Along with the evolution of resilience, there have also been an ever-increasing number of frameworks developed to understand, evaluate and measure resilience, which even experts and scientists are feeling overwhelmed by (Twigg, 2009; Tyler *et al.*, 2016). Few of these frameworks are built on earlier ones, leading to a plethora of principles, qualities, dimensions and characteristics to demonstrate what resilience is about (Lisa *et al*., 2015). In this research, among various existing resilience frameworks, the Technical Assistance to Non-Governmental Organisations (TANGO) resilience assessment framework will be applied following an informal literature review (Figure 1). Adapted from several pre-existing livelihood frameworks, a disaster risk reduction framework and integrating climate change elements, TANGO aims to support policy makers and practitioners in tackling the factors and processes underlying vulnerability and resilience (Lisa *et al.*, 2015; TANGO International, 2012).

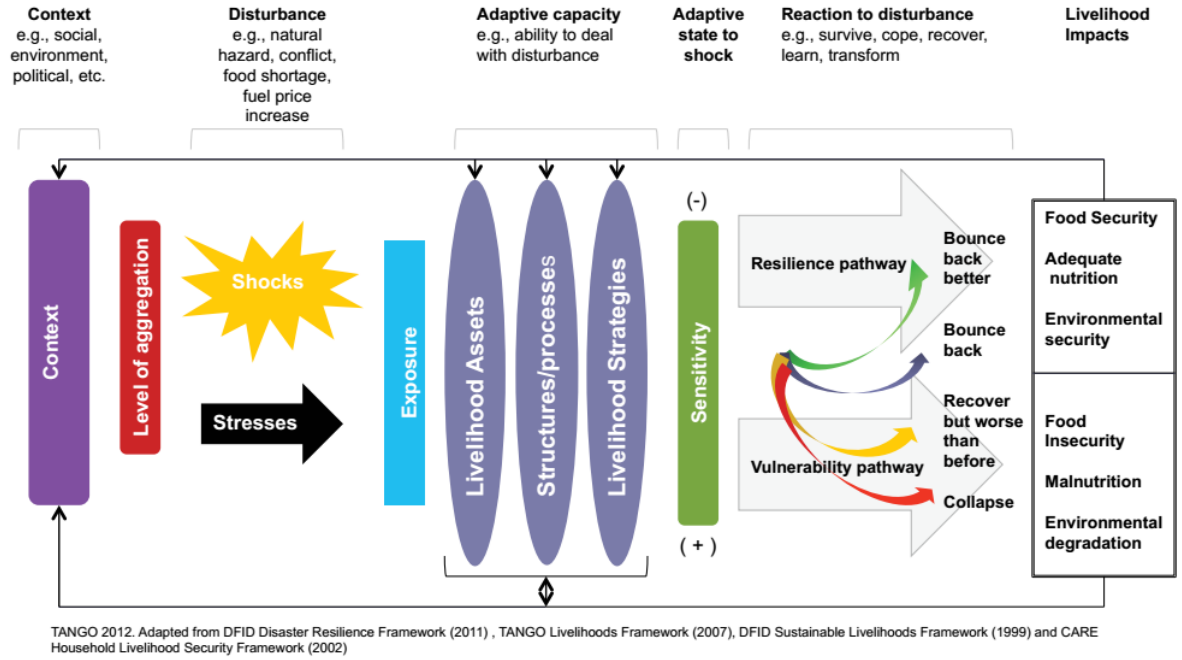

Figure 1. The TANGO Resilience Assessment Framework used by USAID (source: TANGO International 2012).

Regarding fishing communities, they primarily depend on marine resources for their livelihoods. Over the years, despite drastic changes such as unstable domestic and international economies, strict legislations, environmental issues, technological advances, and shrinking access to and availability of natural resources (Conway & Cramer, 2018), fisheries has always played a crucial role in supporting a great sense of community in those coastal communities (Mederer & Barker, 2000). Fishing communities have suffered from climate change, natural disasters, and extreme phenomena (like COVID-19). Their resilience is a prerequisite for adapting to such changes.

The TANGO framework was used to develop the interview questions and then to analyse and measure resilience at a community level. At the same time, the research team determined through a desk-based review and site visits, plus the marine sector interviews, which 10 coastal fishers and 10 aquaculture farmers would participate in the resilience to COVID-19 research. The selection was made to include diverse locations but depended upon the willingness of respondents. Aquaculture areas included fish farming in Man Quang Bay (Tho Quang Ward – Son Tra District) and Cam Le River; and shrimp farming in Dong No and Truong Dinh. The artisanal fishing areas included Thanh Khe District and Man Thai Ward – Tho Quang Commune (Son Tra District).

First, there were individual in-depth interviews (at homes or working environments) and then two focus group discussions, in October-November 2020. Previously, there had been two Covid-19 outbreaks in Da Nang city, the second lasting 3 months after the 2020 New Year's holiday. In-depth interviews were aimed at understanding what serious stresses/shocks the interviewees had experienced, how they had overcome those stresses/shocks, and how they evaluated their ability to deal with stresses/shocks over time and individually. Questions in the focus groups were tailored to gain insights into stakeholder assistance offered (if any) to fishers and aquaculture farmers during COVID-19 restrictions. Focus groups covered three themes: perceptions of stakeholder support to deal with COVID-19, recommendations to stakeholders', and lessons learned for future pandemic response. Focus groups were recorded, transcribed, and translated into English for qualitatively analysis using NVivo software.

Policy mapping

In Da Nang the local authorities manage, regulate, and facilitate a wide range of coastal activities. These include land use planning, water supply and quality, drainage, coastal protection, amenity provision, and environmental health, among others. The complexity of managing these multiple activities and the issues that can arise from them can be eased through the application of Integrated Coastal Zone Management (ICZM) (Celliers *et al.,* 2013). Conceptually, ICZM principles apply to addressing sustainable coastal management challenges (Ramesh *et al.,* 2011). Because of Da Nang's pioneering and innovative use of ICZM over the last 20 years, these challenges can be examined in practice, in relation to local government involvement in coastal management. ICZM therefore provides an ideal vehicle for examining Da Nang's policy and legal framework, encompassing coastal management roles and responsibilities.

Policy mapping was applied with the following aims: a) to examine policies impacting coastal management in Da Nang, with a focus on the city's ICZM for promoting sustainable coastal management; and b) to provide an overview of the level of policy integration around coastal management, particularly on tourism, fisheries, aquaculture, blue carbon, and water quality. Specific objectives of the policy mapping include: i) to apply the Rapid Policy Network Mapping methodology to policies related to the Integrated Coastal Zone Management Strategy for Da Nang that were relevant; ii) to visualise the policy landscape impacting ICZM in Da Nang through the production of policy instrument and actor maps; and iii) to identify gaps in policy instruments and actors that could negatively impact the implementation of the ICZM plan for Da Nang.

Policy actor and instrument criteria were collated in pre-prepared templates in Microsoft Excel, following the Rapid Policy Network Mapping approach used by Bainbridge *et al.* (2011, 2014). The policy mapping took place between January and August 2021. The 'instrument map' plots policy documents by domain (columns) and category (rows). Domains represent levels or scale of authority i.e., moving from international directives to regional guidance to national laws and resolutions and lastly to municipal (Da Nang City) decisions. Policy instruments are then aggregated according to the following six categories: i) cross-sectoral policies (comprised the three sub-categories of ICZM- for Integrated Coastal Management/ biodiversity/ natural resource management/ climate change/environmental protection; Economic- for economic development; and Planning); ii) tourism; iii) fisheries; iv) aquaculture; v) water quality; and vi) Blue carbon. These three sub-categories reflect the thematic diversity in cross-sectoral policies which requires the development of various tools to address this complexity.

The 'actor map' plots the breadth of actors involved in policy development of ICZM ranging from international, to regional, national, and finally down to municipal policy scales. The actor map is based mainly on the first twenty policy instruments listed in the policy instrument template after which a saturation point was reached where the same actors were repeated within instruments. We will therefore not capture all actors engaged in ICM in Vietnam and Da Nang specifically. The actor map uses the policy domains of the instrument template (international, regional, national, municipal), with all actors linked to the policy process flow. However, actors are aggregated in categories to reflect their roles in relation to the policy process, as follows:

a) Influencer: An organisation, entity or individual which is legally, morally, or practically required, invited, or obliged (including by its Constitution e.g., Third Sector Organisations) to be involved in the official policy process. It is assumed that Influencers can affect the outcome of the policy process using legitimate means based on their opinions and views.
b) Owner/Decision-maker: An organisation, entity or individual which has the authority to decide which can affect the policy creation, transposition and/or delivery as concerns intellectual or practical components or which owns all, or component parts, of the policy

process within a specified boundary. Decisions may be made by Owner/Decision maker's following consultation and/or negotiation however it is assumed they have the ultimate authority to decide outcomes.

c) Influencer/Deliverer: An organisation, entity or individual which is legally, morally, or practically required, invited, or obliged to be involved (including by its Constitution e.g., Third Sector Organisations) in policy delivery. They can only affect the outcome of the policy process based on the delivery of actions, processes, or reporting. They cannot, in principle, affect the creation or outcome of the policy process based solely on their opinions and views.
d) Deliverer: An organisation, entity or individual which is legally, morally, or practically required, invited, or obliged to be involved (including by its Constitution e.g., Third Sector Organisations) in the official policy process. They can affect the creation or outcome of the policy process using legitimate channels based on their opinions and views and are also engaged in delivering an action, process, or report which facilitates the creation, transposition interpretation, and/or implementation of the policy.

Relationships between actors were identified, revealing communities of actors from different domains that could be recognised as a coherent group. There is no hierarchy between actors, reflecting relative importance or status, within the vertical structure of either map.

Following the process described by Rosendo *et al.* (2018), a preliminary policy content analysis was also initiated. A total of 65 policy instruments (15 not accessible) were examined in NVivo using the following search terms to reflect the key sectors of focus for this project: tourism, ecotourism, eco-tourism, tourist; fish*; aquaculture, fish* farm*, mariculture; and blue carbon, mangrove*, seagrass, saltmarsh, salt marsh.

Results

Marine and coastal tourism

Demographics and experience

A total of 7 men and 3 women were interviewed as owners or managers of a marine tour operator company, with a median age of 39 (range 22-60 years old) and a median household size of 5 (range 4-11). Respondents had varied levels of schooling but were all literate: 4 completed primary school, 2 completed high school, and 4 completed college or university.

The tour operator companies managed by respondents had been operating a mean of 12 years (median 18; range 1-20) possibly indicating that more experienced companies were managing to survive Covid-19 impacts. The respondents had been working in the industry for a mean of 3.5 years (range 1-6; median 4) indicating that the older companies have had at least one change in owner or manager. None of the respondents were part of a marine tourism association, likely evidencing the lack of organisation within this sector.

Effort and employment

The respondents were asked about all marine and coastal tourism activities they had offered in the last year, with a range between 1-4 activities and a median of 2 as listed in Table 1. Day huts and food services were most common, followed by boat, snorkeling and fishing trips. Day huts and food services and fishing trips were mainly taken up by national tourists (82% and 53% respectively); while boat trips for transport and guided boat tours were mainly taken by international tourists (53% and 21% respectively). There is a growing trend towards offering tourist activities specifically aimed at national tourists. This focus and the almost negligible presence of diving services is likely due to

the neighbouring Cu Lao Cham Islands Marine Park and Biosphere Reserve, which are closer to Hoi An town, and have many attractions. The greater focus on national tourists is not a new thing, as found by Mitchell and Phuc (2007). These authors highlighted how international tourists often don't spend the night in Da Nang, resulting in a much lower tourist expenditure, and that (in 2017) the Cham Museum was the only attraction in Da Nang for many international tourists.

Table 1. Marine tourism activities offered in Da Nang city. [1]One respondent only offers huts, no food.

		Mean % customers (range)	
Activity	Tour operators offering activity	National	International
Day huts and food service[1]	4	82 (70-88)	7.5 (5-10)
Boat trips/transport for tourists	3	27 (15-30)	53 (30-70)
Snorkelling trips	3	7.5 (5-10)	7 (5-9)
Fishing trips	3	53 (1-100)	0
Rentals (e.g., jet ski, kayak)	2	2	9
Surfing rentals/lessons	2	5.5 (1-10)	90
Guided boat tours	2	9.5 (5-14)	21 (20-22)
Diving trips/lessons	1	1	3

Marine and coastal tourism activities were offered for a median of 8.5 months in a year, with 3 operators offering activities all year round and 1 offering activities for 11 months (3-12 months range). The median trip duration was 2.6 hours but could range from 0.5 to 5 hours. Time spent preparing for tourism activities (e.g., planning, booking, marketing) per week ranged from 7-56 hours (note: 56 hrs = 8hrs every day of the week), with a mean of 40 hrs (median 42). This evidences the need to have a full-time employee dedicated to preparing activities, plus at least one other to go out on activities. Operators employed a mean of 5.1 employees in the last year (including self), with a range from 1-12 staff.

Figure 2 shows the general locations of where tourism activities were carried out. The most common destination was on or around Son Tra Peninsula/ Hon Sup Bay with 7 instances: 2 snorkelling trips, 3 fishing trips and 2 rentals). The second most common destination was Cu Lao Cham Islands, departing from Thuan Phuoc bridge and via Nguyen Van Troi bridge (6), for all guided boat tours (2) and diving trips (1), and some snorkelling (1) and boat trips (2). Surfing (1 at My Khe beach and 1 unknown) and hut and food services (1 at Bai Ran Beach, 1 at Ghenh Rang Beach-Son Tra and 2 at Da Beach-Son Tra) took place on beaches between Son Tra peninsula (inclusive) and Hoi An town. Only once was Da Nang Bay itself mentioned as a tourism destination, for a boat trip from Thuan Phuoc bridge via Nguyen Van Troi bridge and Da Nang bay (not in Figure 2).

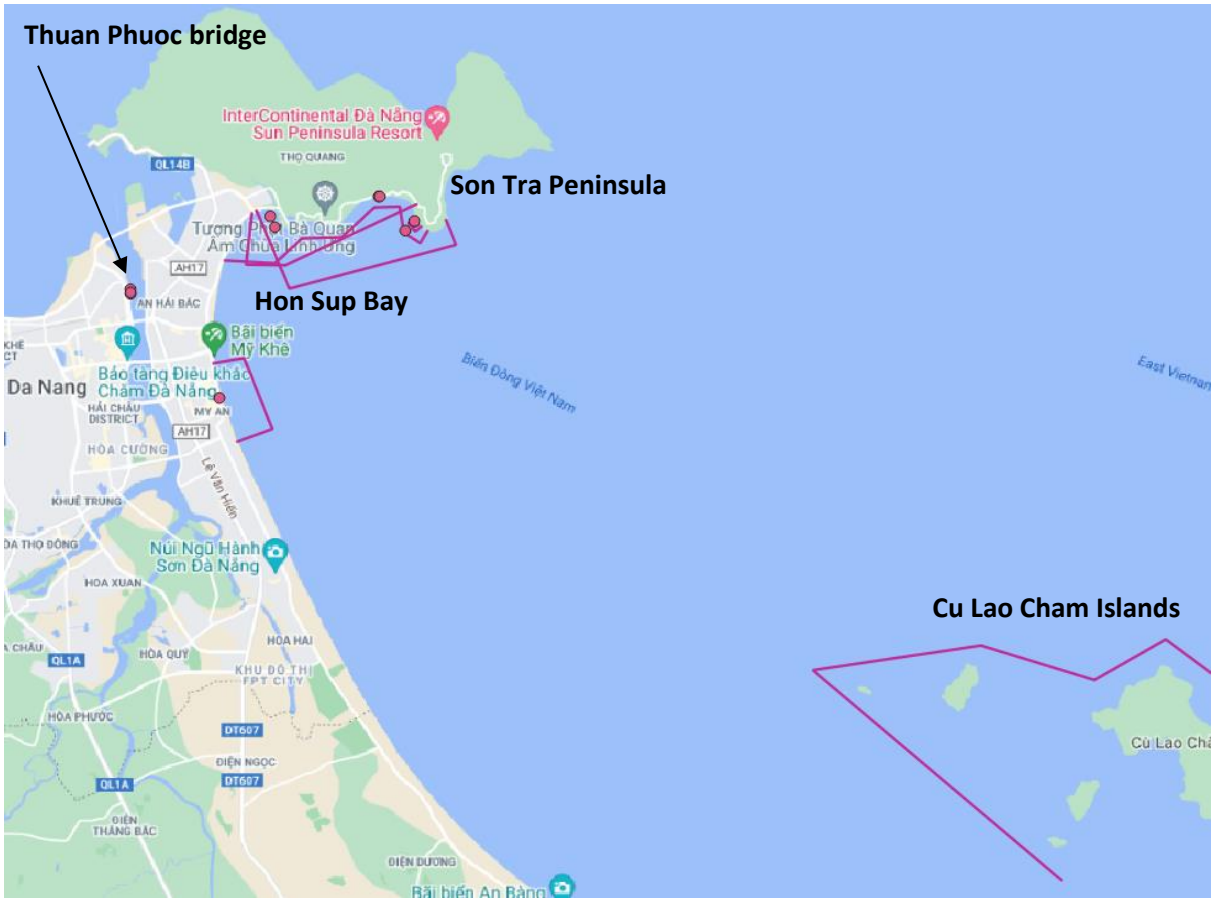

Figure 2. Map of where marine tourism activities took place in the last year from Da Nang city . Pink lines = delineate areas where tourists are taken; red dots = tour operation offices or places that gathers visitors to get on vessels for trips.

Costs

The total mean expenditure for tour operators was Vietnamese Dong VND 956,940,000 (median VND 695,500,000) with a maximum of VND 3,022,000,000. There was high variability within cost categories and not all respondents reported expenditure in all categories. Fixed, commercial, fuel and operational costs were reported as zero by 4, 3, 1 and 1 respondents respectively (Table 2). The lack of fixed and commercial costs might indicate the operators work in a casual or non-official manner. However, the lack of operational costs might indicate unwillingness to disclose costs, as these are unavoidable. The maximum for any category cost was reported for operational costs (also highest mean), whilst the 2nd maximum cost was for staff costs (also highest median cost) and fuel costs. These higher cost categories are as expected for marine tourism activities.

Table 2. Marine tour operators' expenditure in the last year (values in Vietnamese Dong VND).

Item	Mean	Median	Minimum	Maximum
Operational costs (e.g. food)	383,450,000	7,500,000	0	1,900,000,000
Staff costs (e.g. salaries, insurance)	289,300,000	335,500,000	15,000,00	500,000,000
Fuel costs (e.g. diesel, lubricants)	96,360,000	31,500,000	0	500,000,000
Maintenance costs (e.g. vessels, gear)	79,800,000	50,000,000	10,000,000	300,000,000
Investments (e.g. new engine, gear)	49,350,000	40,000,000	10,000,000	150,000,000
Commercial costs (e.g. marketing)	40,000,000	36,000,000	0	100,000,000
Fixed costs (e.g. banking, bookkeeping)	18,680,000	5,400,000	0	60,000,000

Income and loans

An indication of the income of marine tour operators was obtained through the mean price charged per activity per person (Table 3). Rentals and diving were the highest priced activity (VND 1,500,000-2,000,000), but these were only mentioned 1-2 times. These activities were followed by snorkelling trips and hut and food services (VND 533,333), and guided boat tours and boat trips (VND 350,000-333,333). The least costly activities were fishing trips and surfing (VND 266,667-100,000). However, snorkeling and fishing trips had the most variable prices. Despite not having the highest mean price, hut and food services were often ranked most important to income, followed by boat trips. Although diving had the 2nd highest price, it was the least important for income probably due to low availability of international tourists.

Table 3. a) Price in Vietnamese Dong charged per activity per person by tour operators in Da Nang city; b) Ranking of activities by importance for income (1 highest and 4 lowest).

Activity	a) Price VND/person			b) Rank by importance for income			
	Average	Minimum	Maximum	1	2	3	4
Rentals (e.g., jet ski, kayak)	2,000,000		2,000,000		II		
Diving trips/lessons	1,500,000		1,500,000				I
Snorkelling trips	533,333	300,000	1,000,000		II	II	
Hut and food services	533,333	500,000	600,000	IIII			
Guided boat tours	350,000	300,000	400,000		II		
Boat trips	333,333	100,000	500,000	III		I	
Fishing trips	266,667	50,000	450,000	II			
Surfing rentals/lessons	100,000			I			

Respondents were highly dependent on marine tourism, with a median of 100% of their income coming from this activity (mean 87%, range 20-100%). When asked about family members working in marine sectors, 1 family member was reported to work in aquaculture and 4 respondents reported family members working in marine tourism (3, 2, 2 and 1 family members respectively). There were no family members reported to work in fishing or gleaning. Further, only 1 respondent reported having an alternative source of income when tourism activities were not available, and this was aquaculture. Similarly, only 1 respondent had used their vessel for other purposes last year, earning VND 10,000,000 in income. These findings provide clear evidence of respondents' complete lack of income diversification and high reliance on marine tourism.

A total of 4 respondents had a current loan, 3 with a bank and 1 with a family member. Note that in the last year no one had paid back money towards their loan. This was due to the city government subsidizing bank loans i.e., extending loan contracts and lowering the interest rate, so they don't have to pay for the last year due to Covid-19.

Threats to livelihood and future changes

Respondents were asked about the three main threats to their marine tourism activities. Figure 3 shows that 'natural disasters' were most often identified as the main threat (40% as main threat and 20% as 2nd threat), followed by 'heavy weather', 'human disease' and 'marine pollution' with equal frequency (20% each). Although 'seafood decline' was mentioned most frequently only as a 3rd threat, it was mentioned by 30% of respondents. 'Seafood decline' refers to marine life declining, which makes it expensive to purchase, affecting fishing trips and food provision to tourists. 'Marine pollution' was mentioned at all three levels of threat for a cumulative mention of 70%. Note that marine pollution might include litter and/or sewage, as these were not distinguished. Irrespective of the type of pollution, this most often mentioned threat is something for which measures could be

taken to reduce its incidence. Reasons behind the selection of chosen threats include natural disasters and heavy weather events destroying infrastructure and affecting income; planning policy being unreasonable; threats impacting on livelihood and income; threats affecting service quality and reducing the number of customers.

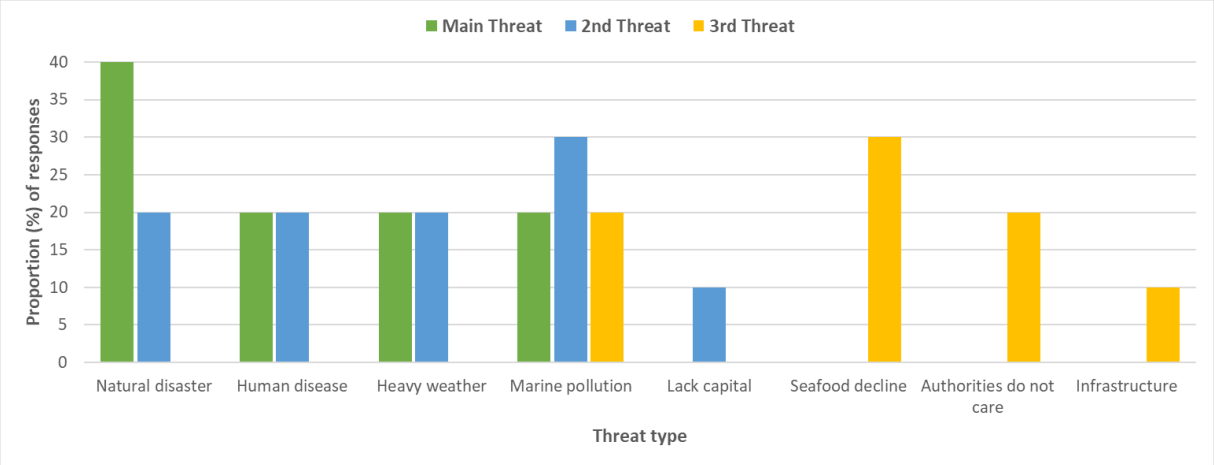

Figure 3. Proportion of responses for the three main threats to marine tourism operators' livelihood in Da Nang city. Note that 'infrastructure' can refer to new hotels and resorts and conflict or competition between big and small operators/businesses.

When asked about the demand for marine and coastal tourism activities over the next five years, respondents were very positive. No decrease in demand is expected and most expect an increase or at least that demand remains unchanged (Figure 4). These findings stand out as interviews were carried out while the Covid-19 global pandemic was having an impact on Vietnam tourism, plus most respondents' reported issues of marine pollution threatening their activities.

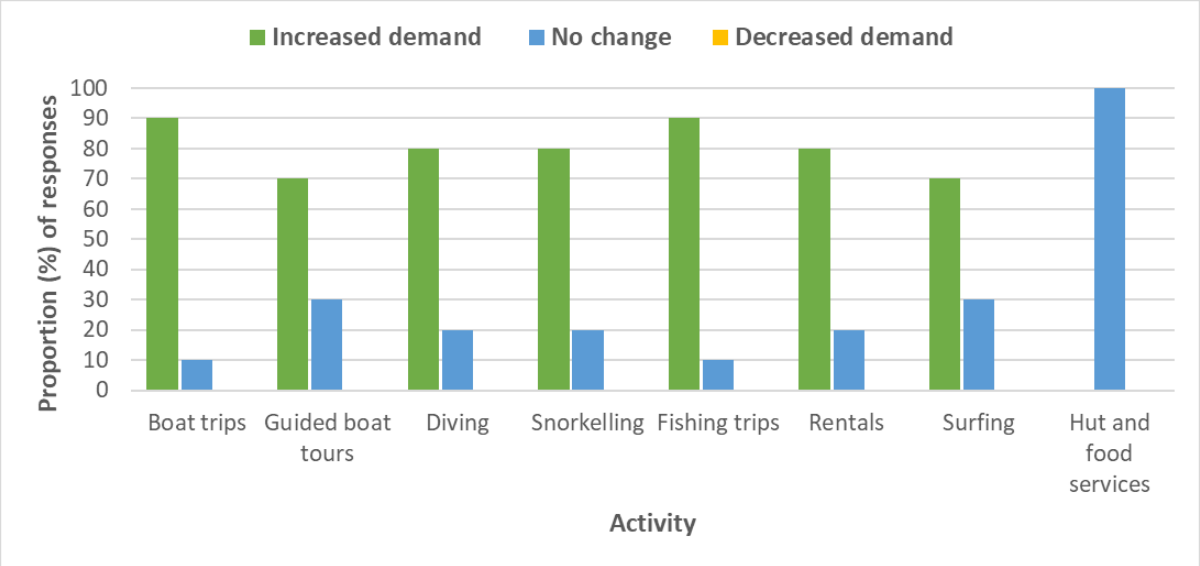

Figure 4. Respondent opinions on the change in demand for the different marine tourism activities offered in Da Nang city.

Water Quality and waste

Although in the previous section marine pollution was the overall most often mentioned threat to marine and coastal tourism, respondents reported that there are no areas that they avoid due to

poor water quality. However, when asked if they had ever had to move to a different location due to perceived poor water quality one respondent said that (s)he had to do so 2-3 times per season at least on one occasion. This is in line with their perception of the water quality of places where they most commonly operate. Where 1 is poor and 5 is excellent, most respondents thought the water quality was good or average (Figure 5a). Although respondents did believe that water quality has some effect on the experiences of the tourists that they take on tours or trips, they mainly believed that it had little to fair effect (Figure 5b).

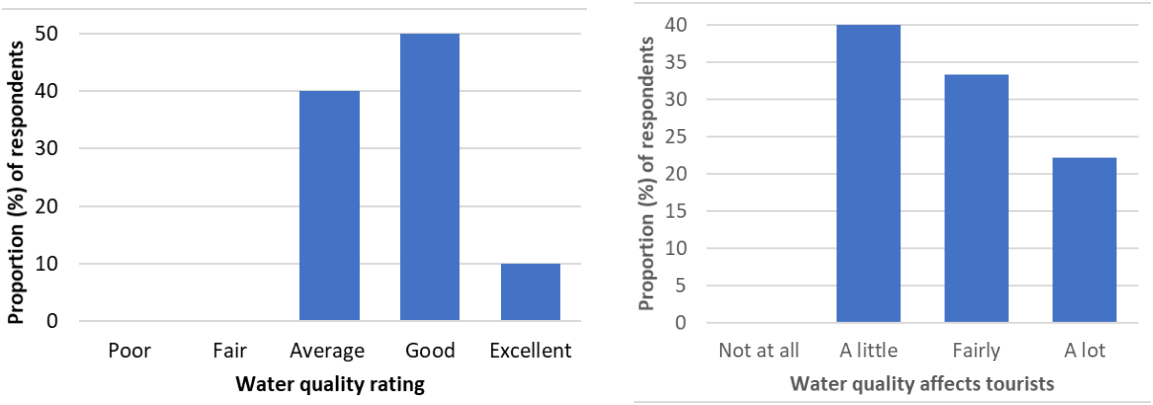

Figure 5. a) Water quality rating given by marine tour operators for areas where they operate; b) respondents perception of the impact that water quality has on tourists (n=9).

To further understand respondents' perceptions, we explored what information they use to assess water quality in the places they most commonly operate. Figure 6 shows that respondents most often use visual or olfactory evidence for pollution. However, this means that natural processes, such as sedimentation and algal blooms, might be misinterpreted as pollution. Note that all respondents mentioned at least one way of assessing water quality, but none of them mentioned using presence of algae or scum, official data on water quality or whether visitors develop health problems e.g., ear infections, stomach upsets.

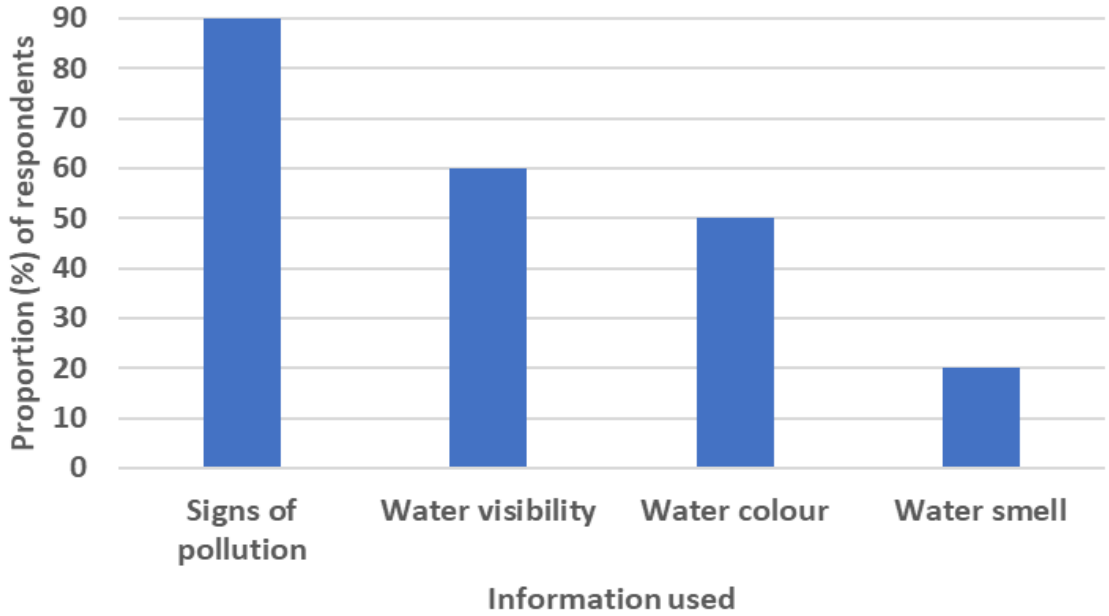

Figure 6. Information used by marine tour operators to assess the water quality of places where they operate. Signs of pollution was a general category that included litter, sewage, oil slicks, dead fish.

Except for one person, respondents did not think that their activities affect the quality of the water where they operate. On the other hand, they believed that the biggest impact on water quality where they operate was mainly due to wastewater from houses and hotels or industry, followed by waste brought to the beach during storms and fishing activities (Figure 7). An important finding is that there is a partial awareness in the marine tourism sector on the threats to water quality and highlights a need for environmental education.

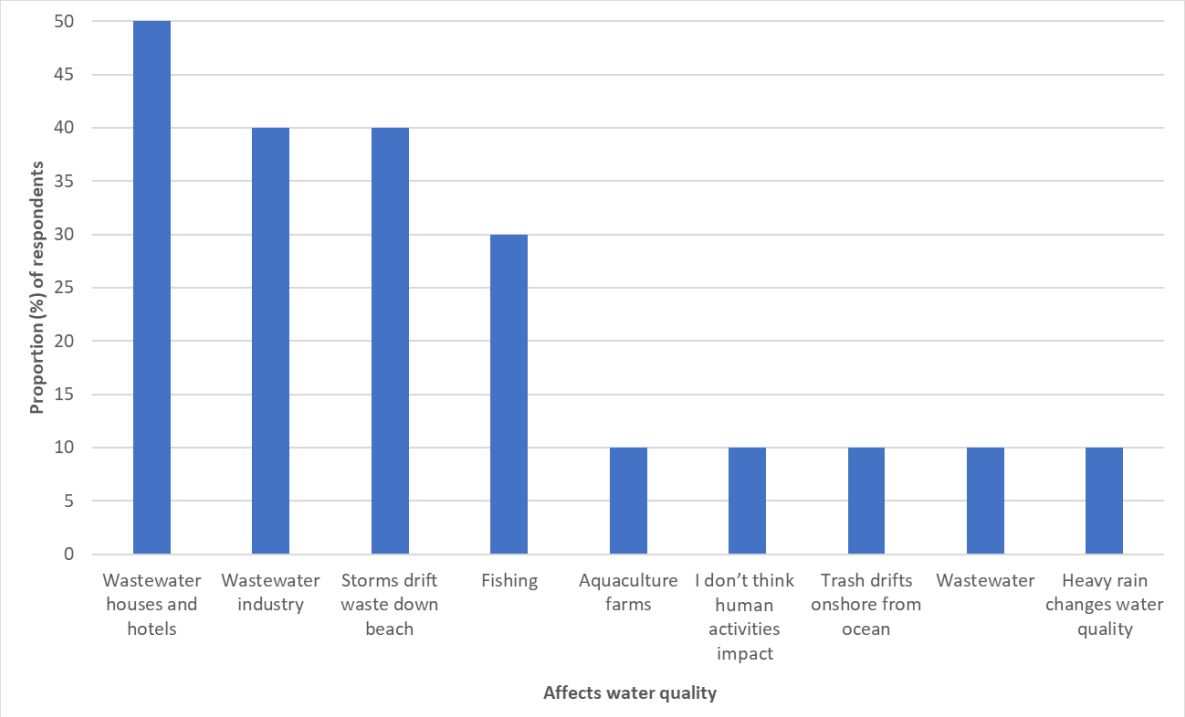

Figure 7. Marine tour operators' views on what has the biggest impact on water quality where they operate in or close to Da Nang city.

When asked about waste disposal when out on a trip or tour, respondents evidenced proper disposal in most cases with high levels of land-based refuse system usage (Figure 8). There are, however, some issues with waste being left at the boat landing site (i.e., food and human waste, and packaging) or being throw into the sea (i.e., food waste and packaging).

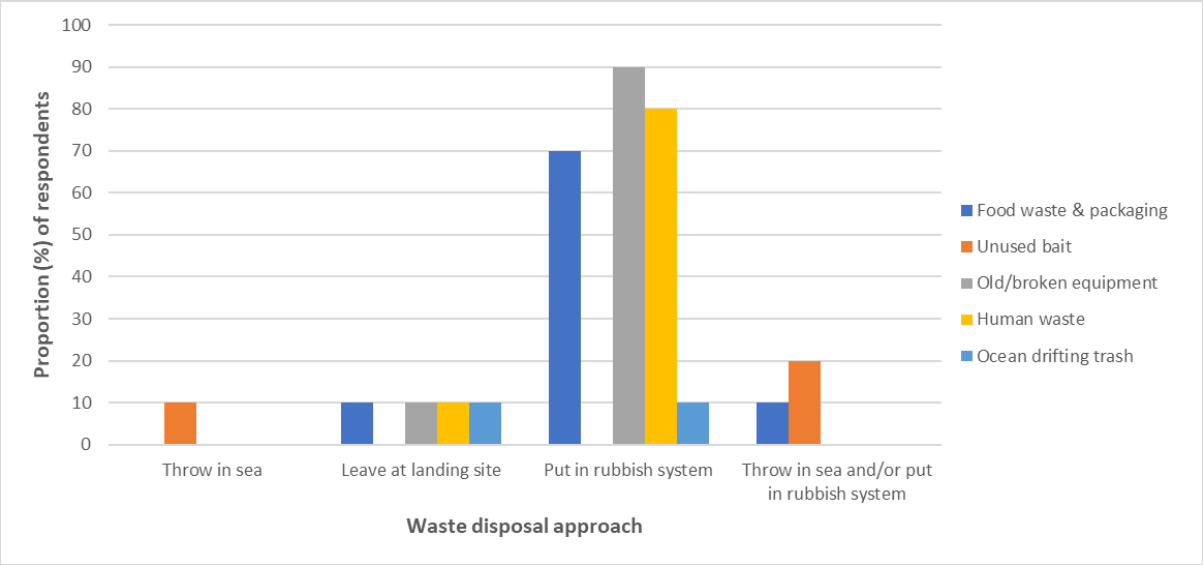

Figure 8. Waste disposal approaches by marine tour operators during their trips or tours.

Aquaculture

Demographics and experience

A total of 40 aquaculture farm owners or managers were interviewed, 38 men and 2 women. The median age was 44 with a range between 28-70 years old and a median household size of 5 people (range 1-10). Although three quarters of respondents had an education (70% completed high school and 2.5% had a postgraduate university degree), 27.5% had no education at all.

The respondents have been working in aquaculture for a median of 3 years (range 1-7) indicating that the older farms have had at least one change in owner or manager. Two respondents (5%) were part of the aquaculture association of Truong Dinh hamlet which is the only place where aquaculture is officially allowed in Da Nang. All were single farm locations that have been in operation for a median of 6.5 years (mean 9) but with a wide range from 2 to 27 years. Farms had between 1 and 30 ponds, cages, or racks (median of 6) and they ranged widely in area from 40 - 40,000m^2 (median 330m^2 and mean 2,799m^2). Most of the respondents (93%) worked in-situ at their farm.

Effort and employment

The aquaculture farms were located in three areas of Da Nang Bay with different levels of salinity: 9 in freshwater, 8 in brackish water and 23 in seawater. The production method used was integrated in more than half of the farms (57.5%), followed by semi-intensive (25%), and extensive (2.5%)(Table 4). There weren't any farms that identified as intensive, and 6 farms (15%) were not sure how to define themselves. Most farms had mixed stages of growth (28 farms or 70%), while 12 (30%) had grow-out only. No farms reported being exclusively for hatchery or nursery. Our research partner, Dr. Kinh reports from personal communications that having mixed stages in one farm ensures there is daily or weekly income as they always have something to sell. Farms were mainly dedicated to the farming of fish in cages (82.5%), followed by crustaceans in ponds (20%) and molluscs in racks (5). No respondents reported the farming of seaweed or other invertebrates. Note that six integrated marine farms had more than one species type, all including fish: 2 grow-out farms had fish and molluscs, 1 mixed stage farm had fish and crustaceans, and 3 mixed stage farms had fish and molluscs.

Table 4. Distribution of aquaculture farms by water type, production method, growth stages and species type farmed in Da Nang Bay.

Water type	Production	Growth Stage	Fish-cage	Crustacean-pond	Mollusc-rack
Fresh	Semi-intensive	Grow-out		2	
Fresh	Semi-intensive	Mixed stages		2	
Fresh	Extensive	Mixed stages		2	
Fresh	Integrated	Grow-out	1		
Fresh	Unsure	Mixed stages	1	2	
		Total-Fresh	2	8	
Brackish	Semi-intensive	Grow-out	3		
Brackish	Semi-intensive	Mixed stages	2		
Brackish	Integrated	Mixed stages	1		
Brackish	Unsure	Mixed stages	2		
		Total-Brackish	8		
Marine	Semi-intensive	Grow-out	1		
Marine	Integrated	Grow-out	5		2
Marine	Integrated	Mixed stages	16	1	3
Marine	Unsure	Mixed stages	1		
		Total-Marine	23	1	5
		Total-Species	33	9	5

Table 4 shows that fish in cages are farmed in all water types, with all production methods except extensive, and at both growth stages reported. Crustaceans are farmed in ponds in fresh and marine waters, with all production methods, and at both growth stages reported. Molluscs were the rarest, only with integrated farming in marine waters, at both growth stages.

Figure 9 shows the general location of respondents' aquaculture farms in Da Nang Bay, and to the researchers' awareness all major aquaculture areas were covered. The most common locations were the fish market area close to the port, Son Tra, Cu Đê River, Cầu Đỏ river and Đô Tỏa river that feed the Hàn River. Although Truong Dinh hamlet is the only place where aquaculture is officially allowed, it seems that aquaculture is unofficially allowed as some farms have been operating for several years.

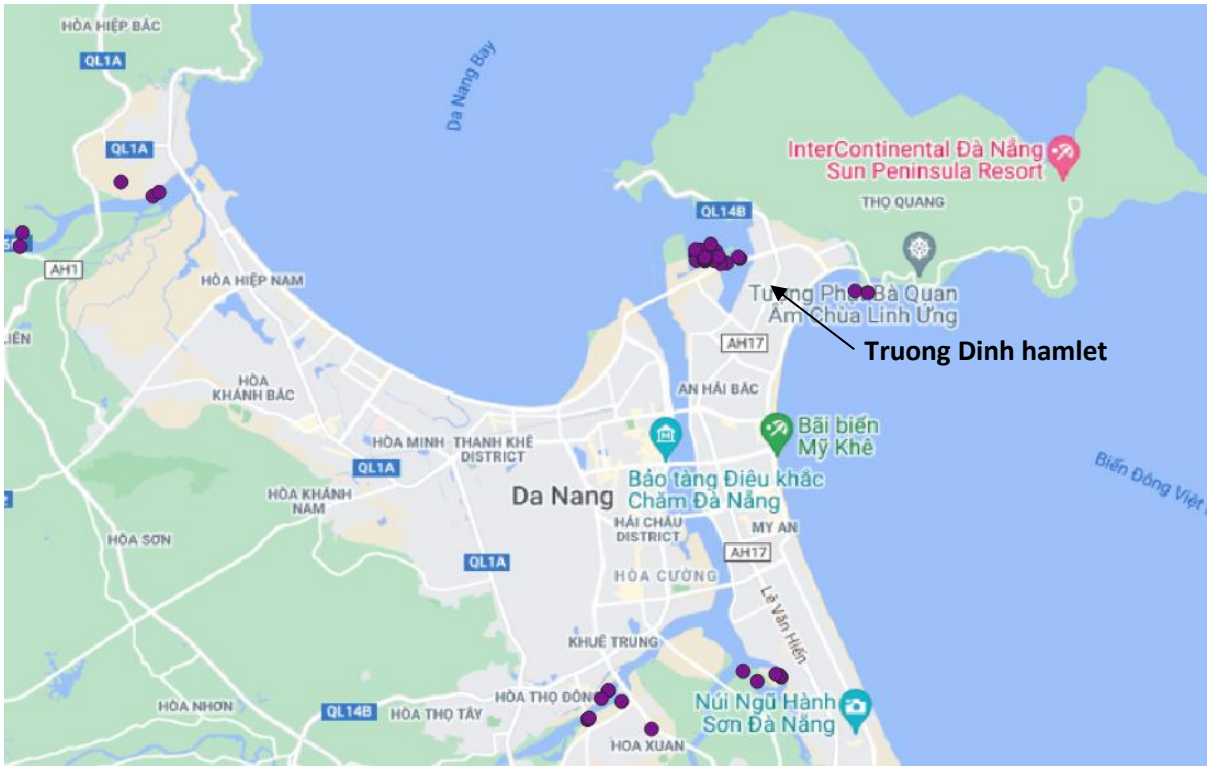

Figure 9. Map with general location of respondents' aquaculture farms in Da Nang Bay.

Respondents spent a median of 49 hours per week (mean 82) working on their farm, with a wide range between 14 and 168 hours. Note that a full week has 168 hours which means that those respondents at the top end of the range probably live on the farm and counted all their time as farm work, hence the high mean figure. Farms were most often operated by 1 or 2 people as the entire staff median was 1 (including the respondent; mean 1.8) with a range of 1-5 people. This is interesting considering farm sizes mentioned above. Similarly, onshore activities (e.g., sale, marketing) were most often carried out by a median of 1 person with a range of 1-3 people.

Costs

The total mean expenditure for aquaculture famers was Vietnamese Dong VND 669,200,000 (median VND 515,000,000) with a maximum of VND 2,664,000,000. There was high variability within cost categories and not all operators reported expenditure in all categories. Fixed, commercial, staff, fuel, and maintenance costs were reported as zero by 40, 39, 27, 5, and 1 respondent respectively. The lack of fixed costs might indicate that farmers work in a casual or non-official manner, or at a very small scale. The lack of commercial costs might be due to buyers coming to the farm to purchase products on a frequent basis. Absence of staff costs is an indicator of one person farms or family run farms. No fuel costs might indicate a land-based farm. However, the lack of all these costs might just indicate unwillingness to disclose information, e.g., maintenance costs are unavoidable. The highest maximum for any category cost by far was reported for operational costs (also highest mean/median), whilst the 2nd highest maximum cost was for fuel costs (also 2nd highest mean) and staff costs (but with a median of zero) (Table 5).

Table 5. Aquaculture farmers' expenditure in the last year (values in Vietnamese Dong VND). [1]Note that 'other costs' includes two reports of bottled water purchase and one for solar power.

Item	Mean	Median	Minimum	Maximum
Operational costs (e.g., seed)	500,125,000	455,000,000	110,000,000	1,500,000,000
Fuel costs (e.g., diesel, lubricants)	60,850,000	10,000,000	0	500,000,000
Staff costs (e.g., salaries, insurance)	48,750,000	0	0	420,000,000
Maintenance costs (e.g. repair cages)	32,375,000	30,000,000	0	70,000,000
Investments (e.g., new gear)	24,325,000	20,000,000	3,000,000	80,000,000
Commercial costs (e.g. transport, ice)	1,500,000	0	0	60,000,000
Other costs[1]	1,275,000	0	0	34,000,000
Fixed costs (e.g., banking)	0	0	0	0

Staff salary was calculated most commonly as negotiated shared benefits among family members (25%), a regular set salary (10%), a percentage of total value of sales (2.5%), or a percentage of total value of sales minus costs (2.5%). More than half of respondents did not employ staff and worked alone (60%). Sometimes owners and staff can benefit from free stock from the farm. However, the respondents reported very low consumption of their own produce (median 2kg per week, range 0-5 kg) and almost negligible amounts of stock given to staff (median 0kg, range 0-3 kg).

Income and loans

Respondents mainly sold their stock to one buyer, although it could range from 1 to 5 buyer types. The most common buyer by far were traders (median 85%), followed by wholesalers, restaurants, local markets, and fishmongers (Table 6). Respondents did not report selling stock to processors, auctions or exporters likely indicating that they only supply the local region. The dominance of trader buyers likely results in them driving prices, often to the detriment to aquaculture farmers.

Table 6. Proportion (%) of aquaculture stock bought by different buyers in Da Nang.

Buyer type	Mean	Median	Minimum	Maximum	Frequency
Trader	64.75	85	0	100	29
Wholesaler	13.5	0	0	100	11
Restaurant	7.75	0	0	100	10
Local market	8	0	0	100	7
Fishmonger	4.25	0	0	80	6
Final consumer	1.25	0	0	20	4
Family/friend	0.5	0	0	20	1

Respondents only provided total stock volume for all species together and this ranged between 500 and 20,000kg, with a median of 4,000kg. Farms most often had three species (42.5%), followed by one (32.5%), two (20%) and four species (10%). Single species farms were either shrimp (*Litopenaeus vannamei*) or fish (e.g., red Tilapia) and farms with 2-4 species were all fish except for one farm with shrimp and *Mugil cephalus* (only report for this species). The five most farmed species were Epinephelinae (47.5%), followed by Red Tilapia and *Siganus* (27.5% each), *Caranx* (25%) and Otolithoides (22.5%). There used to be clam and oyster farming near Man Quang Bay but in 2020 it stopped as they did not get as much benefit as other species, plus a typhoon affected operations (Dr Kinh, pers. comm.).

An indication of the income of aquaculture farmers was obtained through the price received per kilogram of each species. The highest price was reported for red Tilapia and *Scatophagus* (VND 450,000/Kg), followed by Epinephelinae and *Siganus* (VND 350,000/Kg) (Table 7). These four species also had the highest price variability (VND 200,000-410,000/Kg) which makes them highly volatile,

but high-reward species grown in brackish and marine water. Further, the highest median price was reported for *Scatophagus* (VND 350,000/Kg), followed by *Siganus* (VND 200,000/Kg), followed by Epinephelinae and *Rachycentron* (VND 150,000/Kg). Otolithoides, *Litopenaeus vannamei* (freshwater only), *Lates calcarifer* and *Rachycentron* had the lowest price variability (VND 50,000-80,000/Kg), indicating that *Rachycentron* gives the highest reward for low-volatility species. Irrespective of prices, respondents estimated that the survival rate for their stock was on mean 62% (median 60%) with a range of 40-98%. This mean survival rate is on the low side compared to other Vietnamese studies (e.g., Engle *et al.* 2017).

Table 7. Price of farmed species in Da Nang; water types: F=freshwater, B=brackish, or S= seawater.

Frequency	Species name	VND price/Kg				Water type
		Average	Median	Minimum	Maximum	
19	Epinephelinae	178,947	150,000	150,000	350,000	B, S
11	Red Tilapia	156,636	45,000	40,000	450,000	B, S
11	*Siganus*	195,455	200,000	150,000	350,000	B, S
10	*Caranx*	144,000	130,000	120,000	250,000	F, S
9	Otolithoides	134,444	130,000	100,000	150,000	S
8	*Litopenaeus vannamei*	102,000	96,500	90,000	150,000	F
7	*Rachycentron*	160,000	150,000	120,000	200,000	S
7	*Scatophagus*	350,000	350,000	250,000	450,000	F, B, S
3	*Lates calcarifer*	116,667	100,000	100,000	150,000	F, B
1	*Mugil cephalus*	100,000				F
1	*Penaeus monodon*	250,000				F
1	Carangidae	170,000				S

Respondents were highly dependent on aquaculture farming for their income with a mean of 92% of their income coming from this activity (median 100%, range 50-100%). When asked about family members working in marine sectors, there were 14 reports for family members working in aquaculture ranging from 1 to 4 family members with a median of 1. No family members were reported to work in marine tourism, fishing, or gleaning. Ten respondents (25%) reported having an alternative source of income when aquaculture farming was not available. These respondents reported alternative income from fishing trips (3), buying and selling fish (2), animal husbandry (2), fishing (1; e.g., some farmers in Man Quang Bay originally were fishers and sometimes go fishing), drinking shop (1) or diving for marine species to sell (1). This shows more options than those available to tourism operators or fishers and evidences a potential for diversification. Further, a total of 11 respondents (27.5%) had used their farm for other purposes last year, earning a median of VND 35,000,000 in income (mean VND 77,636,364; range VND 20,000,000 - 500,000,000). These findings provide clear evidence of respondents' potential or resourcefulness at income diversification, although there is almost complete reliance on aquaculture for their livelihood at present.

Half of respondents (52.5%) had a current loan, 35% with a bank, 5% with a family member, 5% with a trader, 5% with illegal bank, and 2.5% with a feed supplier. Unlike the marine tourism sector that was subsidised by the government, all respondents had paid back an amount towards their loan in the last year: mean VND 107,842,105 (median VND 100,000,000; range VND 10,000,000 - 300,000,000). Only one respondent reported having received a subsidy over the last year, for VND 2,000,000 but we did not ascertain the reason. Although Dr. Kinh (pers. comm.) mentioned that it may be a poor family or that the government staff made a mistake, as it is very hard for aquaculture farmers to get support from the government.

Threats to livelihood

Respondents were asked about the three main threats to their aquaculture farming. Figure 10 shows that 'local government prohibits aquaculture' was most often identified as the main threat (57.5%), followed by 'water pollution' (20% as main threat and 65% as 2nd threat) and 'natural disaster' (10% as main threat and 20% as 2nd threat). 'Water pollution' was most mentioned overall for a cumulative 85%. Most assume water pollution is from wastewater and one respondent mentioned the Ngu Hanh Son wastewater treatment plant as the source specifically. Although 'high mortality of fingerlings' and 'loan policy does not fund illegal farming' were mentioned as tertiary threats, they were mentioned 25% and 22.5% respectively. The two most often mentioned threats regarding the 'local government prohibits aquaculture' and 'water pollution' are both threats for which measures could be taken to reduce their impact on aquaculture. The reasons given for the chosen threats were that they affect the survival rate of stock (27 times), loss of income (19), they cannot repay loans (18), fear of losing livelihood (15) and calamity (1). These preliminary findings evidence areas where the sector could be supported and managed for sustainability and profit.

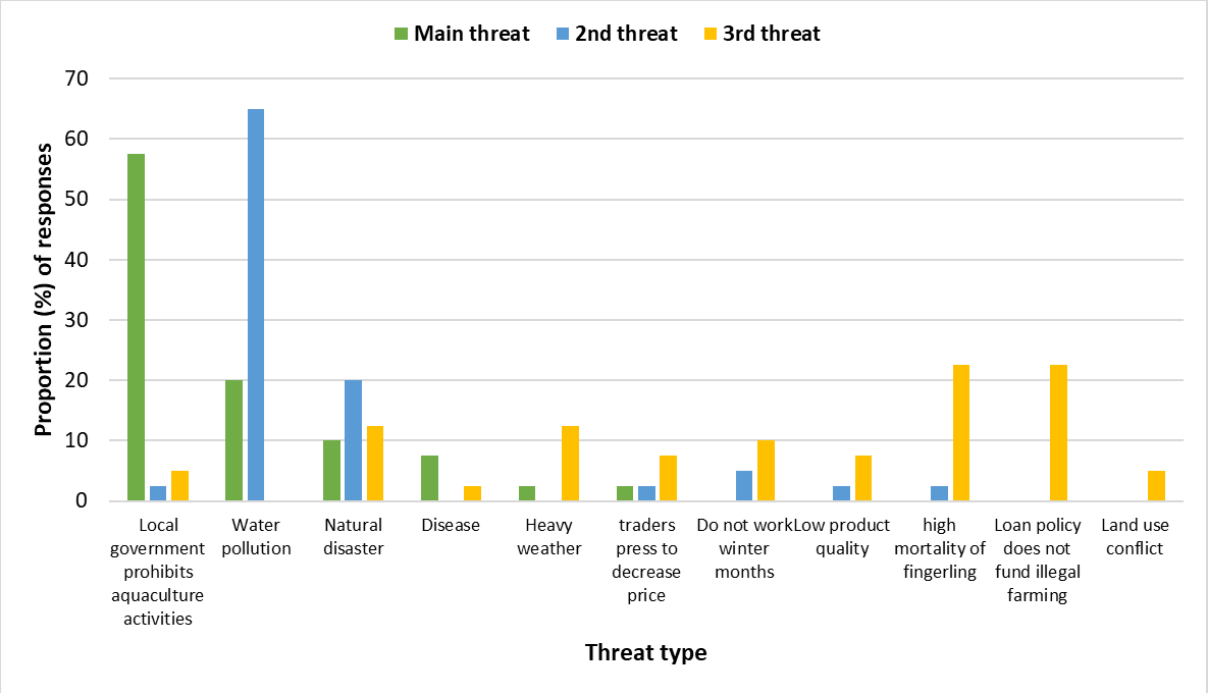

Figure 10. Proportion of responses for the three main threats to aquaculture in Da Nang Bay.

When asked about the demand for aquaculture activities in the next five years, respondents were mainly positive or neutral in their views. There was an expected increase in demand for 'offshore aquaculture' (50%; currently not present), followed by 'aquaculture in Da Nang Bay' (45%; refers to Man Quang Bay - part of Da Nang Bay- where aquaculture remains illegal), 'farmed fish' (43%) and 'aquaculture tourism' (40%; currently not present) (Figure 11). These findings are interesting considering that the local government currently prohibits aquaculture in all but one location. The only predominant view (68%) was that 'land-based aquaculture' will not change in the next five years (In Dong No-Co Co river- some farms were removed, and the farmers compensated by Sun Group private company under the authority of the city master plan which dictates the area will be used for tourism/real-estate. However, some farmers were not satisfied, and they would like to see the plan stopped - Dr Kinh, pers. comm.). Then follows 'offshore aquaculture' (43%) and 'farmed fish' and 'aquaculture tourism' (both at 38%), which also had high proportions for no change. The highest mean decrease in demand was for 'aquaculture in the Han River' (43%; Da Nang city has constructed a dam to prevent salinization and upstream is Da Nang's water supply treatment plant,

so farmers in this area expect to be impacted negatively in the short-term). These largely evenly distributed findings evidence the uncertainty that respondents have in the future of their livelihood.

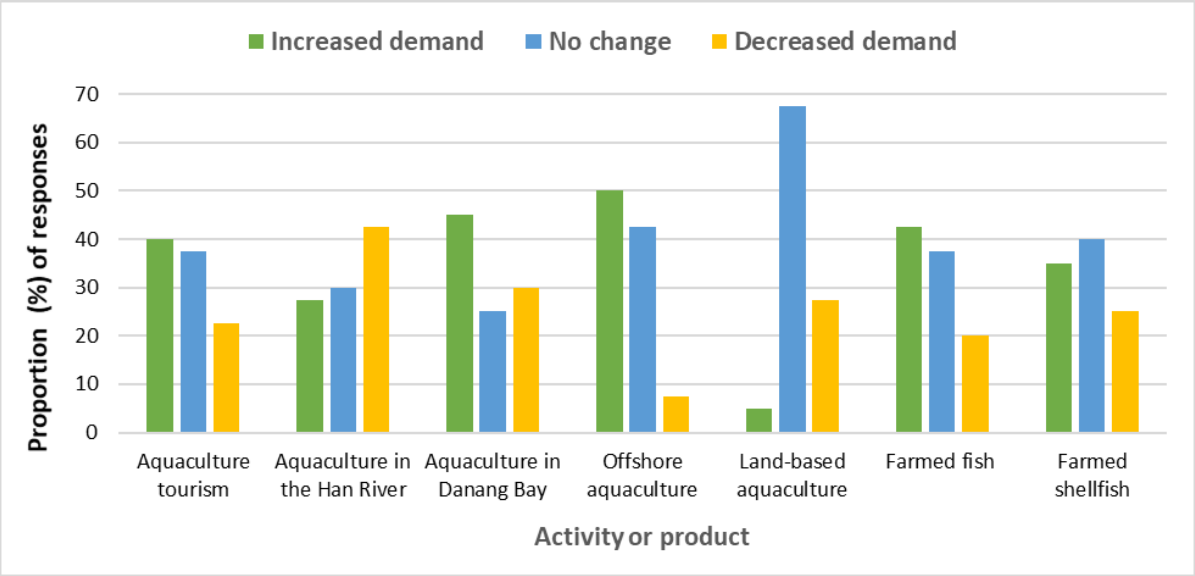

Figure 11. Aquaculture farmers' views on the future demand for aquaculture in Da Nang city.

Water Quality and waste

Half of respondents (53%) said there were areas that they avoid locating a farm because they believed the water quality is not good. Of these, 71% mentioned the Tho Quang Locks (by the port), 24% around the Ngu Hanh Son wastewater treatment plant, and 5% mentioned the Nguyen Tri Phuong bridge (Figure 12). However, these locations are just a few metres from where many aquaculture farms are located (see Figure 9).

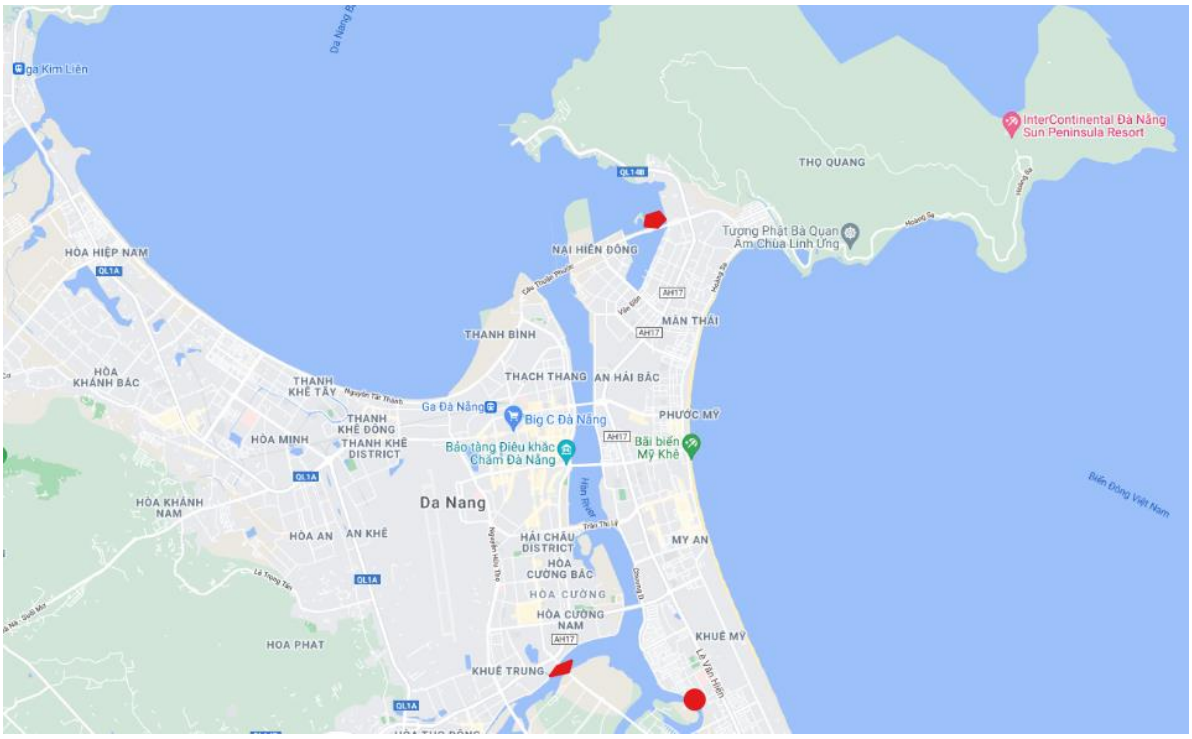

Figure 12. Map showing the three areas (red) avoided by aquaculture farmers due to perceived water pollution in Da Nang.

Additionally, 28% mentioned having had to relocate their farm because they considered that the water quality at their preferred site was not good enough. Despite avoiding areas and relocating, respondents still reported poor to fair water quality around their farm (Figure 13a) but they mainly did not believe that water quality affected the stock they farmed (Figure 13b).

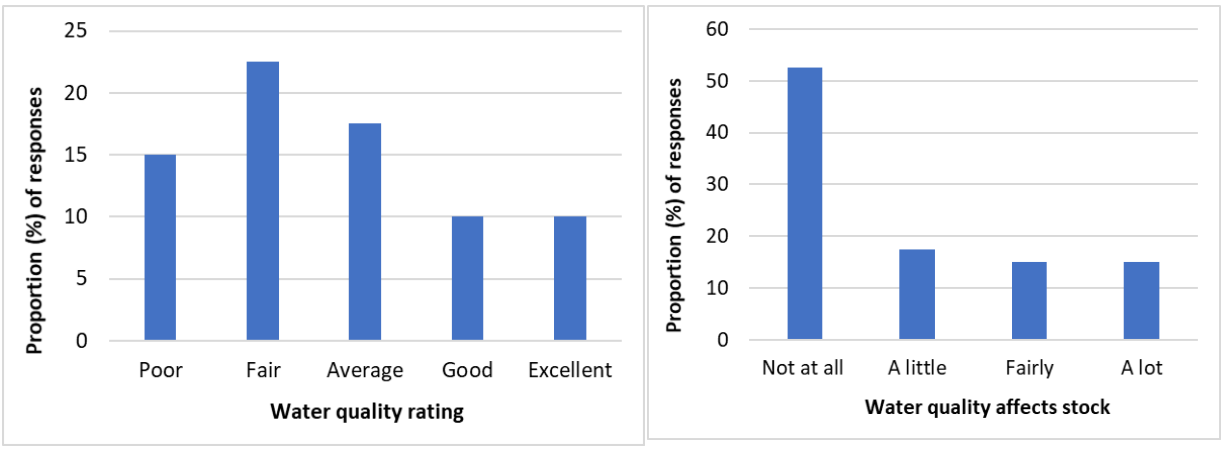

Figure 13. a) Water quality rating given by aquaculture farmers for areas where they operate; b) perception of the impact that water quality has on their stock.

To further understand respondents' perceptions, we explored what information they use to assess water quality in and around their farms. Figure 14 shows that respondents most often use visual evidence for pollution, either in the water or on their stock. The latter is an interesting finding as above most respondents did not think that poor water quality affected their stock. The former means that natural processes, such as sedimentation and algal blooms, might be misinterpreted as pollution. A quarter of respondents (23%) reported assessing water quality through 'sense and experiences' which was vague and likely overlaps with other options. No respondents mentioned official data on water quality and four mentioned not assessing water quality at all.

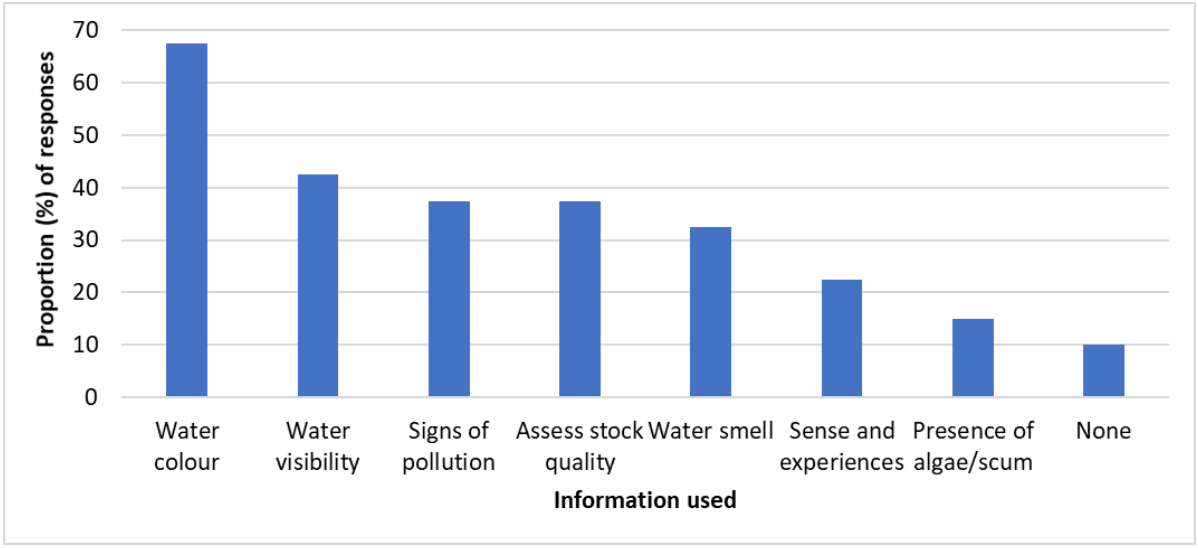

Figure 14. Information used by aquaculture farmers to assess the water quality in and around their farms; 'signs of pollution' is a general category including litter, sewage, oil slicks, etc.

Respondents were also asked about the techniques used to manage water quality at their farm. The most frequently mentioned technique was aeration or paddle wheels (40%), followed to a lesser extent by aeration and moving rafts (10%), water exchange, and digging a well for freshwater plus paddle wheels (both 7.5%) (Figure 15). There was one report of 'occasionally testing the water temperature, pH and salinity' but this was excluded from the Figure as it is not a technique for improving water quality, but of assessing it. A quarter of respondents (23%) did not use any technique for water quality management.

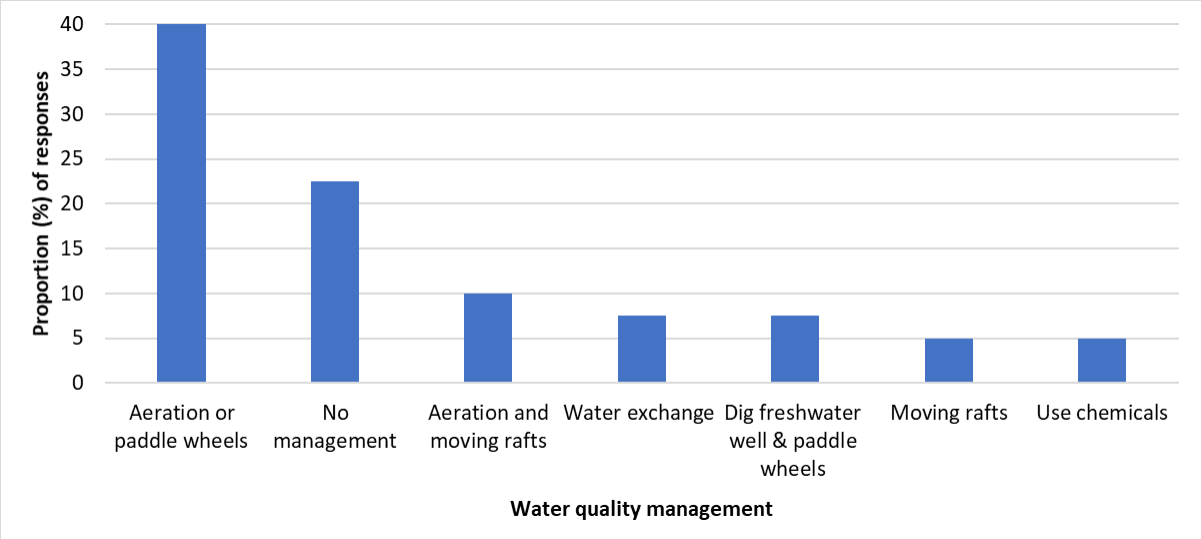

Figure 15. Proportion of responses for techniques used to manage water quality at aquaculture farms in Da Nang Bay.

When asked about the impact of farming activities on water quality, most respondents thought they were 'not applicable' to them or not impacting on water quality (Figure 16). The 'use of lime and chlorine to treat ponds after each season' and 'use of chemotherapeutants' was rarely present, and no respondents reported the use of pesticides or antifoulants. 'Use of feed' (98%) and 'stock escapes' (100%) were the most unlikely to be perceived as impacting water quality. Only 38% perceived antibiotics as impacting water quality, followed by sludge (23%) and other less mentioned activities. These findings evidence general lack of awareness of the impacts of aquaculture farming on water quality in Da Nang Bay.

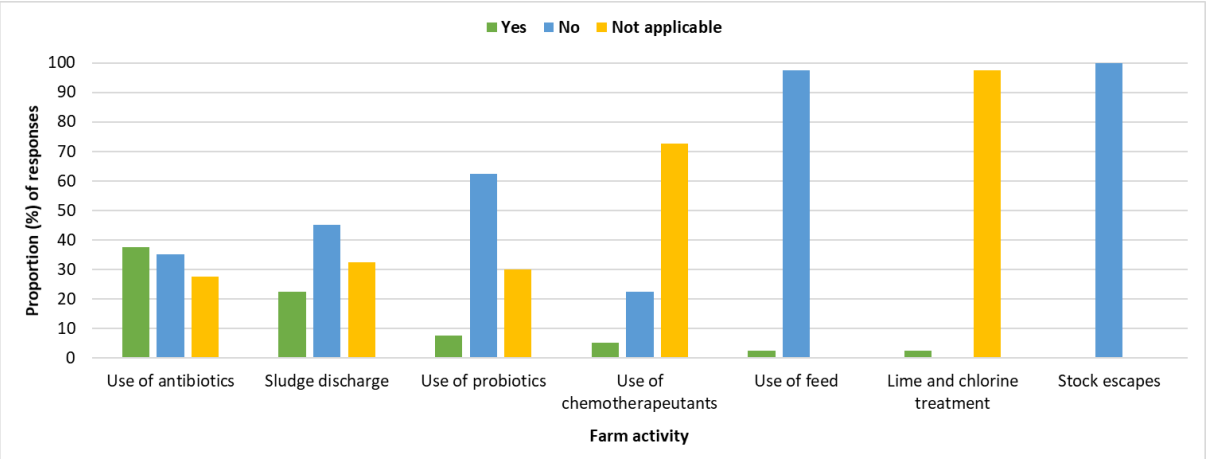

Figure 16. Perceived impact on water quality around farm from different aquaculture activities or inputs in Da Nang Bay.

Respondents reported that the biggest impact on water quality around their farm was from wastewater from houses and hotels (60%) or from industry (50%), followed to a lesser extent by other aquaculture farms, upstream rainwater and/or sudden water temperature change, and other reasons (Figure 17). Others referred to heavy weather (2.5%), tourism (2.5%), wastewater from agriculture (25%), wastewater of farm (2.5%), nearby construction (2.5%) and salinisation (2.5%). No one mentioned fishing as impacting water quality and 7.5% of respondents thought that human activities do not impact water quality.

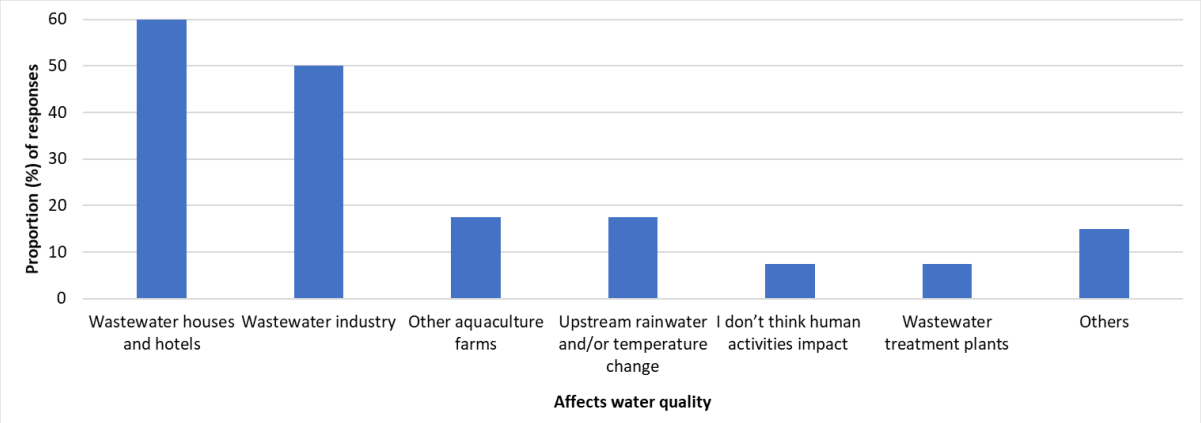

Figure 17. Aquaculture farmer views on what has the biggest impact on water quality in and around their farm.

Artisanal inshore fisheries

Demographics and experience

A total of 150 fishers, all owners of their vessel, were interviewed: 148 men and 2 women. The mean age of respondents was 49 years old (median 50) with a range between 23 – 76 years old and a median household size of 5 (range 3-15). Education levels were low, most respondents had only been to primary school (89%) and the rest had no schooling. More than two thirds of respondents (70%) had been fishing for over 20 years, with a range between 1 to over 20 years. Only 6% of respondents have fished for 10 years or less and 18% of respondents were part of a fishing group.

Effort and employment

A total of 21 gear types were mentioned by fishers and although fishers used a range of 1 to 7 gear types, the median was 2 types. More specifically, 47% of respondents used one gear type, 40% used two types of gear, and 13% used three or more gear types. Gear types can be classified into nine main categories using the FAO guidelines (FAO 2021; Figure 18): Gillnets and entangling nets (23% of the gear used by respondents), hooks and lines (18%, e.g., handline), miscellaneous gears (17%, e.g., push net, compressor diving, blasting), seine net (13%), trawls (10%), lift nets (7%), dredges (5%), Traps (5%, e.g., pots) and falling gear (3%, e.g., squid net). Gillnets are a common gear within Vietnamese small-scale fisheries, often used to catch mackerel, shrimp, cuttlefish and shrimps (SEAFDEC 2016; FAO 2019). Interestingly, 16% of respondents declared using forbidden, destructive gear e.g., blasting, fishing with led lights. The latter are of concern as gears using artificial light to attract fish (except squid handline) are banned in Vietnamese coastal waters.

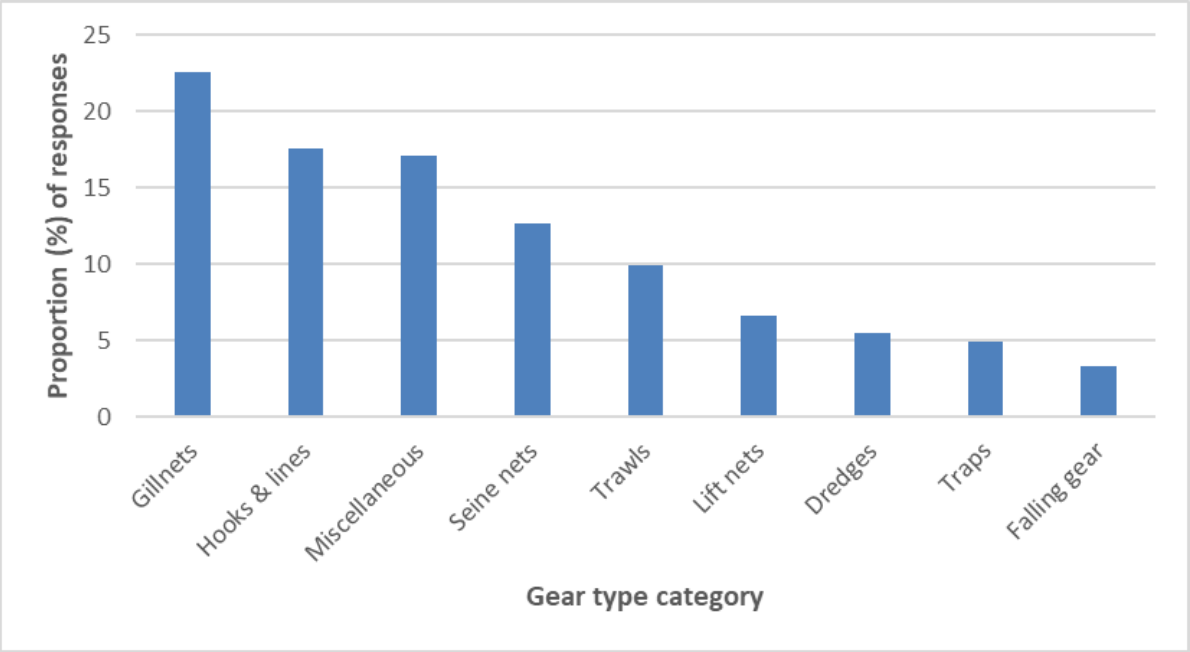

Figure 18. Proportion of each fishing gear used by artisanal inshore fishers from Da Nang city.

Fishers worked a mean of 5.89 days per week, with a median of 7 days and a range of 3-7 days. Half of them (51%) worked seven days a week and 20% worked five days a week. Thus, half of interviewed fishers put in non-stop effort for their livelihood every single day of the week. The mean/median length of a fishing trip was 12 hours and ranged from 2-24 hours. A third (34%) of fishing trips lasted between 10 -12 hours, while 15% lasted 24 hours.

Figure 19 shows the general location of respondents' fishing grounds in Da Nang Bay. The most common locations were within Da Nang Bay and around Son Tra Peninsula. There is a particular concentration of fishing at river mouths. There is a clear overlap with areas known for water pollution, mainly due to discharge points of sewage treatment plants (see Figure 23).

Almost half of fishers worked alone (41%) throughout the entire year; followed closely by 39% of fishers working with two crew members. Results regarding the size of the crew for an average fishing trip are similar, as well as for onshore activities (Figure 20). These results are in line with data at national level, describing the Vietnamese fleet as being mainly small-scale, operating in coastal nearshore water (FAO 2019; SEAFDEC 2016; Research Institute for Marine Fisheries 2003). Onshore fishing activities were limited, with 84% of respondents working 1 hour or less (mean/median = 1 hour, range 0-24 hours). Interestingly, 8% of respondents declared not doing onshore work and one respondent mentioned working 24 hours.

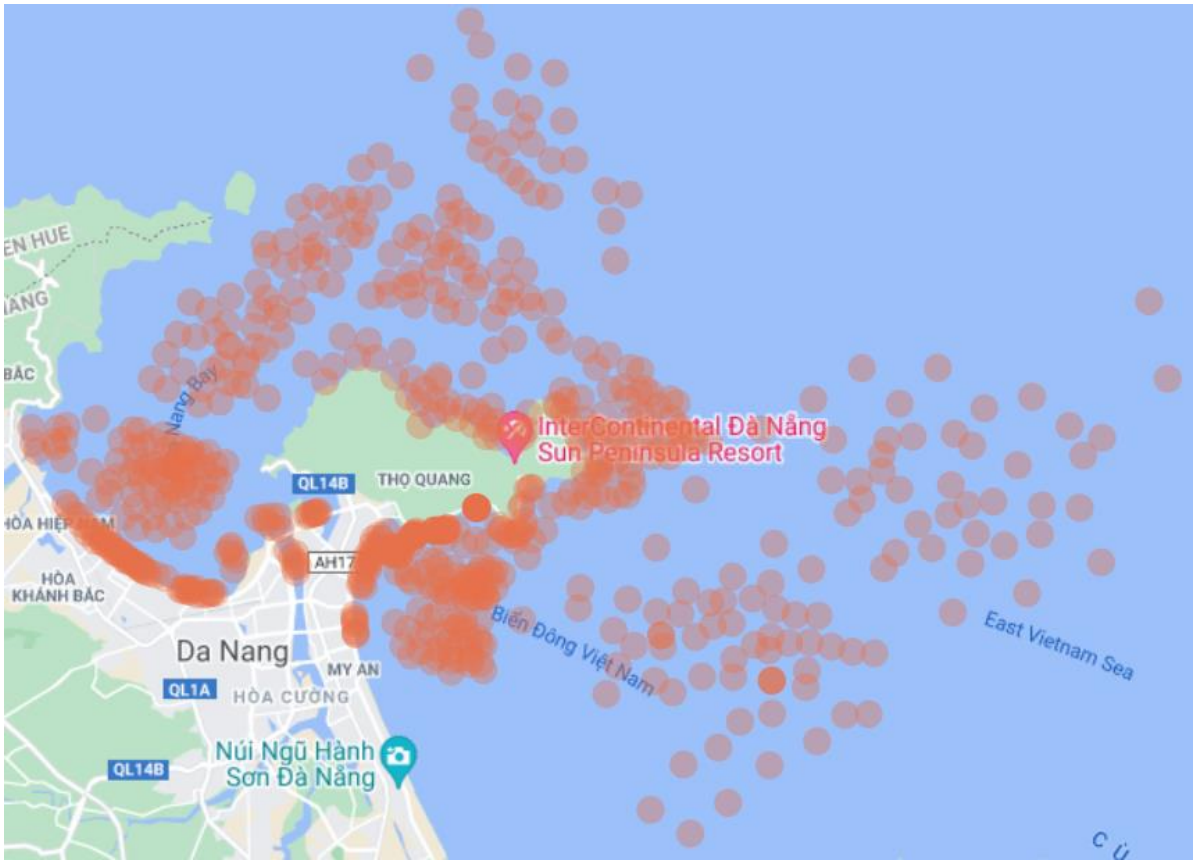

Figure 19. Map with location of where inshore artisanal fishers operate in and around Da Nang.

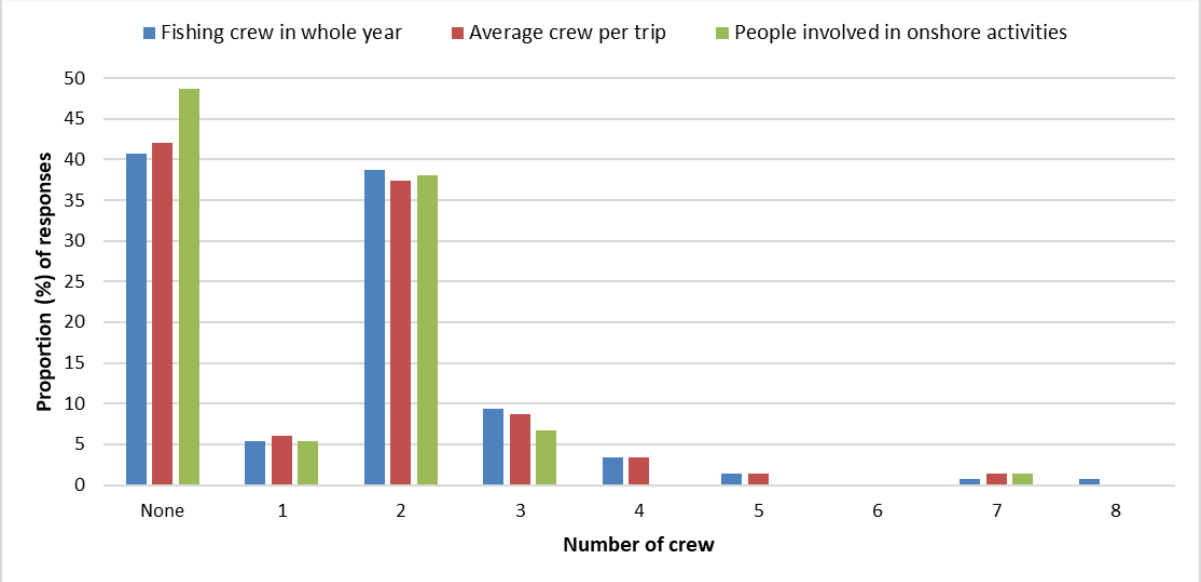

Figure 20. Proportion of crew members joining the respondent throughout the year, crew joining on an average fishing trip, and crew involved in onshore activities.

Costs

The total mean expenditure for fishers was Vietnamese Dong VND180,853,600 (median VND142,500,000) with a range between VND18,000,000 and 525,000,000. There was some variability within cost categories evidenced by similar means and medians (Table 8). The complete lack of fixed costs might indicate that all artisanal fishers work in a casual or non-official manner.

Crew, commercial and fuel costs were reported as zero by 63, 42 and 1 respondents respectively. The lack of crew costs indicates lone fishers, and no fuel costs might indicate human-powered vessels. Absent commercial costs might be due to short fishing trips and on the beach buying of fish. The maximum for any category cost by far was reported for crew costs (also highest mean/median), whilst the 2nd maximum cost was for fuel costs (also 2nd highest mean/median) followed by operational costs.

Table 8. Inshore artisanal fishers' expenditure in the last year (ordered by mean; values in Vietnamese Dong VND).

Item	Average	Median	Minimum	Maximum
Crew costs (e.g. salaries, insurance)	75,674,333	69,500,000	0	300,000,000
Fuel costs (e.g. diesel, lubricants)	46,970,000	36,000,000	0	200,000,000
Operational costs (e.g. batteries)	29,760,667	25,000,000	100,000	150,000,000
Maintenance costs (e.g. repairs)	14,641,000	10,000,000	650,000	50,000,000
Commercial costs (e.g. ice, boxes)	7,797,600	4,000,000	0	65,000,000
Investments (e.g. new gear)	6,210,000	5,000,000	1,000,000	30,000,000
Fixed costs (e.g. banking, accounting)	0	0	0	0

Crew salary was calculated most commonly as a "percentage of total value of catch minus costs" by 87% of the 80 respondents that had a crew. While 11% gave crew a "percentage of total value of sales" and 2% worked with a family member. Sometimes fishers and crew can benefit from free catch. However, respondents reported very low consumption of their own catch (median 1kg per average fishing trip and range 0-2 kg) and almost negligible catch given to the crew (median 0kg, mean 0.54, and range 0-5 kg).

Income and loans

Respondents mainly sold their catch to 1 buyer type (median), although it could range between 1 and 3 buyer types. The most common buyer by far were traders (48% of catch and highest maximum amount), followed by the wholesalers (23%) and local market (19%) (Table 9). Respondents did not report selling stock to exporters or any other buyer types likely indicating that they are subject to middlemen prices.

Table 9. Proportion of fish stock bought by different buyers per average trip at Da Nang Bay (ordered by frequency).

	Kg sold (%)	Median	Mean	Minimum	Maximum	Frequency
Local market	1519.5 (19)	0	10.13	0	250	73
Trader	3924 (48)	0	26.16	0	400	40
Wholesaler	1857.5 (23)	0	12.38	0	300	38
Final consumer	436.5 (5)	0	2.91	0	60	25
Fishmonger	277 (3)	0	1.85	0	200	6
Restaurant	8 (0)	0	0.053	0	4	3
Processor	100 (1)	0	0.67	0	100	1
Auction	60 (1)	0	0.4	0	60	1
Total	8182.5 (100)					

Respondents caught a median of 4 different species but could range between 1 and 10 species (S.D.=1.6). Seven respondents only provided total volumes, so were excluded from this section. A total of 72 different species were caught, including fish (54%), molluscs (25%), crustaceans (18%), cartilaginous fish (1.5%) and Echinoidea (1.5%) (Table 10). The most often reported species were

Sepioteuthis, squid, *Metapenaeus*, *Portunus peta* and *Sepia*. However, the highest median price in VND/Kg was VND1,500,000 for *Panulirus ornatus, Synanceia,* lobster and *Panulirus Homarus.* Three out of the five most caught species - *Metapenaeus*, *Portunus peta* and *Sepioteuthis*– and one of the highest priced species – lobster – exhibited the biggest difference between minimum and maximum price. The latter two species also had the highest standard deviations. On the other hand, *Synanceia* and *Panulirus ornatus* did not exhibit any price variation. The lowest average and median prices were VND7,000 and 8,000 respectively for *Umbonium vestiarum* (low standard deviation= 2236).

The largest overall volume quantities were reported for anchovy (541,900Kg), *Stromateoides* (201,680Kg), *Acetes* (113,500Kg), *Paratapes undulatus* (95,000Kg), and *Sepia* (56,290Kg). Similarly, the highest volumes and highest volume variability were reported for *Stromateoides* (max 200,000Kg, variability 199,950Kg), anchovy (150,000Kg, 149,100Kg), *Sepia* (50,000Kg), *Acetes* (50,000Kg, 49.970Kg) and *Paratapes undulatus* (30,000Kg, 26,000Kg). Similarly, the highest standard deviations were found for *Stromateoides* (53,417.78), anchovy (36,767.81), pilchard (21,767,1), *Acetes* (16,886.04) and *Sepia* (10,369.46). However, the highest median volume was reported for lobster, *Panulirus ornatus*, *P. Homarus, Synanceia* (all 1,500,000Kg each) and *Haliotis ovina* (1,000,000Kg). Although we tried to assess the relationship between gear types and species caught, no patterns/trends were visible.

Table 10. Type, volume and price per kilogram of species caught by Da Nang inshore fishers; Grouping: M=mollusc, C=Crustacean, F=fish, E=Echinoidea, CF= Cartilaginous fish; Max=maximum, Min=minimum; [1]note that price is per seed; Mean volume and Standard deviation (S.D.) rounded to 2nd decimal.

			Price: Vietnamese Dong VND/Kg					Volume: Kg					
Species	**Grouping**	**Frequency**	**Mean**	**Median**	**Min**	**Max**	**S.D.**	**Sum**	**Mean**	**Median**	**Min**	**Max**	**S.D.**
Sepioteuthis	M	28	606785.7	450000	450000	4500000	763263.2	3380	120.71	450000	30	300	67.60
Squid	M	27	129230.8	120000			49146.56	34400	1274.07	120000	100	10000	2552.35
Metapenaeus	C	25	218400	200000	180000	400000	42591.08	5170	206.8	200000	50	500	121.68
Portunus peta	C	23	215652.2	200000	150000	250000	26255.06	4140	180	200000	40	350	81.58
Sepia	M	23	174782.6	180000	150000	200000	14730.79	56290	2447.39	180000	30	50000	10369.46
Trachurus	F	22	131818.2	100000	80000	300000	64485.98	7200	327.27	100000	100	1000	230.80
Leiognathus	F	21	74761.9	80000	50000	100000	14703.42	8150	407.5	80000			185.16
Trichiurus	F	20	156500	150000	140000	180000	14608.94	7180	359	150000	100	800	212.10
Rastrelliger	F	19	80526.32	80000	70000	100000	5242.65	6950	365.79	80000	200	800	177.99
Tinca	CF	19	183684.2	180000	150000	200000	12115.43	3350	176.32	180000	100	300	51.01
Batoidea	F	18	146111.1	150000	110000	180000	15392.47	3610	200.56	150000	80	350	86.19
Fenneropenaeus	C	18	486111.1	500000	400000	500000	28725.66	1740	96.67	500000	30	200	50.99
Harpadon	F	18	150000	150000			0	10140	563.33	150000	40	3000	640.74
Anchovy	F	17	15000	15000			1133.89	541900	31876.47	15000	900	150000	36767.81
Sardinella	F	17	15000	15000			0	30600	1800	15000	200	9000	2493.99
Terapon	F	17	146470.6	150000	110000	170000	15788.12	1760	103.53	150000	50	200	45.41
Decapterus	F	15	21333.33	20000	20000	30000	2968.08	17400	1160	20000	200	10000	2466.87
Ephinephelus	F	14	262857.1	250000	250000	300000	21636.36	1160	82.86	250000	40	200	45.48
Stromateoides	F	14	212857.1	200000	200000	250000	18156.83	201680	14405.71	200000	50	200000	53417.79
Chanos	F	13	183076.9	180000	180000	200000	7510.68	850	65.38	180000	10	150	36.19746
Atule	F	12	168333.3	175000	150000	200000	17494.59	1720	143.33	175000	30	300	87.10843
Carangoides	F	12	195000	200000	180000	200000	9045.34	890	74.17	200000	30	150	32.32
Mugilidae	F	11	128181.8	120000	120000	150000	14012.98	11780	1070.91	120000	50	10000	2965.66
Rachycentron	F	11	129090.9	120000	120000	160000	15782.61	5800	527.27	120000	100	2000	591.34

			Price: Vietnamese Dong VND/Kg					Volume: Kg					
Species	**Grouping**	**Frequency**	**Mean**	**Median**	**Min**	**Max**	**S.D.**	**Sum**	**Mean**	**Median**	**Min**	**Max**	**S.D.**
Oryzias	F	10	184000	180000	180000	200000	6992.06	540	54	180000	20	100	29.14
Portunus sanguinoletus	C	10	85000	80000	30000	120000	23687.78	11660	1166	80000	50	10000	3106.77
Sphyraena/Barracuda	F	10	248000	250000	230000	250000	6324.56	990	99	250000	50	300	77.67
Belonidae	F	9	97777.78	100000	80000	100000	6666.67	17080	1897.78	100000	30	10000	3277.37
Sciaenidae	F	9	242222.2	250000	180000	250000	23333.33	500	55.56	250000	20	100	27.44
Sillaginidae	F	9	153333.3	150000	150000	180000	10000	1040	115.56	150000	50	200	70.38
Acetes	C	8	21875	20000	15000	30000	5938.68	113500	14187.5	20000	1500	50000	16886.04
Sparidae	F	8	185000	180000	180000	200000	9258.20	590	73.75	180000	30	150	40.69
Lutjanus	F	7	120000	100000	90000	150000	28284.27	490	70	100000	10	300	102.63
Paratapes undulatus	M	7	50000	50000	50000	50000	0	95000	13571.43	50000	4000	30000	9829.50
Pilchard	C	7	29285.71	30000	20000	35000	4498.68	55400	11080	30000			21767.11
Stomatopoda	C	7	115714.3	100000	60000	150000	35050.98	9200	1314.29	100000	100	5000	1793.67
Scatophagus	F	7	288571.4	280000	280000	300000	10690.45	540	77.14	280000	40	200	57.65
Umbonium vestiarum	M	7	7000	8000	2000	8000	2236.07	21100	3516.67	8000			2842.83
Thryssa setirostris	F	6	20000	20000			0	2400	400	20000	200	600	154.92
Ariidae	F	5	82000	70000	70000	100000	16431.68	500	100	70000	30	350	140
Turbinidae	M	5	22000	20000	20000	30000	4472.14	3400	680	20000	200	2000	746.32
Mullidae	F	5	126000	120000	120000	150000	13416.41	2150	430	120000	150	500	156.52
Siganus	F	5	150000	140000	140000	180000	17320.51	410	82	140000	50	150	43.24
Cynoglossidae	F	4	225000	250000	150000	250000	50000	720	180	250000	120	200	40
Synodontidae	F	4	155000	150000	150000	170000	10000	1000	250	150000	200	300	57.74
Echinoidea	E	4	18333.33	20000			2886.75	2000	500	20000	300	600	141.42
Apogonidae	F	4	125000	120000	120000	140000	10000	220	55	120000	20	150	63.51
Panulirus ornatus	C	3	1500000	1500000	1500000	1500000	0	65	21.67	1500000	15	30	7.64
Panulirus Regius	C	3	766666.7	800000	700000	800000	57735.03	130	43.33	800000	30	50	11.55

			Price: Vietnamese Dong VND/Kg					Volume: Kg					
Species	**Grouping**	**Frequency**	**Mean**	**Median**	**Min**	**Max**	**S.D.**	**Sum**	**Mean**	**Median**	**Min**	**Max**	**S.D.**
Perna viridis	M	3	86666.67	80000	80000	100000	11547.01	3000	1000	80000	500	1500	500
Platycephalidae	F	3	150000	150000	150000	150000	0	700	233.33	150000	200	300	57.74
Scomberomorus	F	3	193333.3	200000	180000	200000	11547.01	260	86.67	200000	30	180	81.45
Lobster	C	3	1300000	1500000	900000	1500000	346410.2	90	30	1500000	20	50	17.32
Paratapes undulatus	M	3	50000	50000	50000	50000	0	4000	1333.33	50000	1000	2000	577.35
Synanceia	F	2	1500000	1500000	1500000	1500000	0	8	4	1500000	3	5	1.41
Trochus niloticus	M	2	90000	90000	80000	100000	14142.14	900	450	90000	400	500	70.71
Anadara	M	2	100000	100000	100000	100000	0	370	185	100000	70	300	162.63
Meretrix meretrix	M	2	150000	150000	150000	150000	0	2500	1250	150000	1000	1500	353.55
Oyster	M	2	80000	80000	80000	80000	0	1000	500	80000	500	500	0
Haliotis ovina	M	1	1000000	1000000	1000000	1000000		5	5	1000000	5	5	
Panulirus homarus	C	1	1500000	1500000	1500000	1500000		10	10	1500000	10	10	
Leiognathidae	F	1	120000	120000	120000	120000		6000	6000	120000	6000	6000	
Babylonia areolata	M	1	500000	500000	500000	500000		10	10	500000	10	10	
Clam	M	1	150000	150000	150000	150000		1000	1000	150000	1000	1000	
Makaira	F	1	90000	90000	90000	90000		50	50	90000	50	50	
Turbo marmoratus	M	1	50000	50000	50000	50000		700	700	50000	700	700	
Cymbiola nobilis	M	1	180000	180000	180000	180000		300	300	180000	300	300	
Haliotis	M	1	900000	900000	900000	900000		2	2	900000	2	2	
Panulirus Regius seed[1]	C	1	20000	20000	20000	20000		300	300	20000	300	300	
Chaetodontidae	F	1	500000	500000	500000	500000		0	0	500000	0	0	
Panulirus ornatus seed[1]	C	1	100000	100000	100000	100000		60	60	100000	60	60	
Synanceiidae	F	1						40	40		40	40	
Totals		**635**						**1,329,170**					

Respondents were highly dependent on fishing for their income with a median of 100% of the household income coming from fishing (range 50-100%). When asked about family members working in marine sectors, households had up to 3 family members involved in one of these sectors, but the overall median was 0. Most respondents (88%) had family members working in fishing (range 0-3), 19.3% had family working in gleaning (range 0-3) and 1.3% had family working in marine tourism (range 0-1). No family members were reported to work in aquaculture.

Only 8 respondents (5.3%) reported having an alternative source of income when fishing was not available. These respondents reported alternative income from part-time labour job (3), fishing trips (1), catch and process snails for sale (1), coffee shop (1) and repairing home appliances (1) (one did not specify). This shows very little options than those available to marine tourism operators but like aquaculture farmers. Only two respondents (1.3%) had used their vessel for other purposes in the last year, earning VND1,500,000 or VND5,000,000 respectively. These findings provide clear evidence of respondents need for income diversification, as there is a complete reliance on fishing for their livelihood.

A total of 45 respondents (30%) reported having a current loan, out of these 27 had a loan with a bank, 11 with a family member, 2 through the poor household policy, 2 with social welfare bank offering very low interest, 2 with Thanh Khe District Farmers Association and 1 with an illegal bank Respondents paid back a median of VND50,000,000 (mean VND78,666,667) over the last year (range VND 0 - 350,000,000). For some reason, 8 respondents did not pay back their loan over the last year. Only four respondents (2.7%) reported having received a subsidy over the last year, with a median of VND570,000 (mean of VND1,610,000 and range VND300,000 - 5,000,000).

Threats to livelihood

Respondents were asked about the three main threats to their fishing activities. Figure 21 shows that 'destructive fishing' (most often done by outsiders to Da Nang) was most often identified as the main threat (35% and 13% of responses as 2nd threat), followed by 'natural disasters' (24% as main threat and most mentioned threat overall at 54%). The number of 'vessels doubling' was the third most mentioned main threat (19%). Although 'irresponsible authorities' was rarely mentioned as a main threat, it was the most often mentioned as 2nd threat (21%) and 3rd threat (29%). 'Water pollution' was the second most often mentioned tertiary threat. When explaining why the chosen threats were important to them (258 reasons given in total), respondents most often mentioned 'impact on income' (32% plus 4% mentioning 'impact on livelihood) and 'decline in fish stocks and/or destruction of habitats' (31%). Further, 15% of reasons refer to the lack of opportunities due to financial difficulties: 'no conversion option' (4%), 'financial and/or insurance issues' (6%), 'no subsidies or help' (5%).

All the most often mentioned threats at all levels refer to issues that can be dealt with by enforcement of existing policies (i.e., 'destructive fishing' and 'water pollution') and greater willingness of the local government to support the sector (i.e., 'irresponsible authorities', 'vessels doubling'). These preliminary findings on threats to fishing evidence areas where the sector could be supported and managed sustainably.

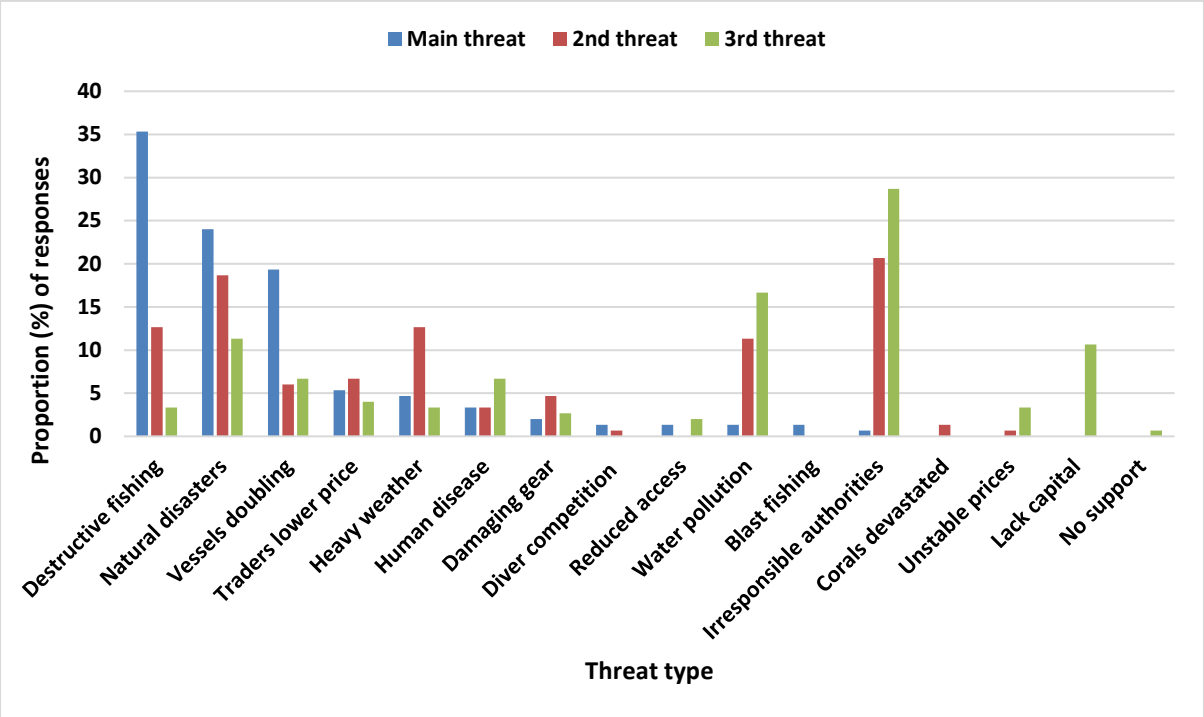

Figure 21. Proportion of responses on the main threats to artisanal inshore fisheries in Da Nang.

When asked about changes in the fishing sector in the next five years, respondents were mainly neutral in their views. Almost half of respondents (41%) think the number of inshore fishing vessels will increase but over a third (35%) think it will decrease (Figure 22). This finding is linked to the perceived threat of the number of vessels doubling (mentioned above), and it appears that there are mixed views on this issue being resolved over the coming years. Almost half of respondents do not forecast a change in the regulations on how they can catch their target species (48%), on what they can or cannot catch (49%) and the number of areas protected or closed to fishing (49%). These categories also evidence the highest levels of uncertainty, with 28%, 29% and 28% respectively. The highest level of expected decrease is for the number of offshore vessels (41%), although almost a third (28%) think there will be an increase.

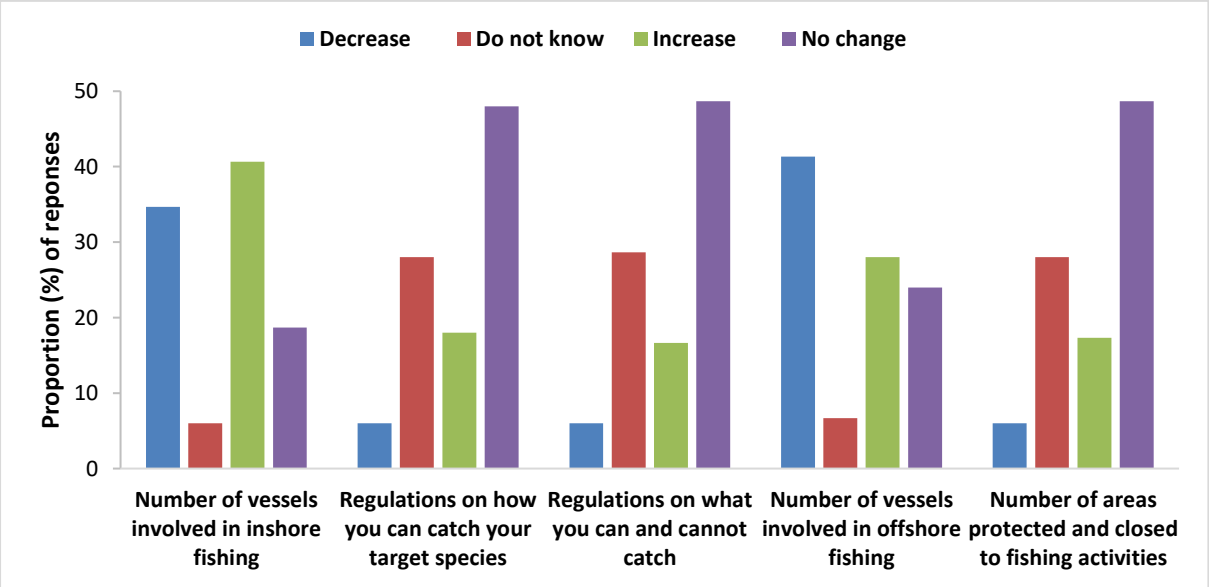

Figure 22. Respondent views on the future changes for the fisheries sector of Da Nang city.

Water quality and waste

More than a third of respondents (55 people or 35%) declared avoiding fishing in some areas because of suspected poor water quality. Most of those having avoided poor water quality areas (89%) mentioned at least two of these areas: Phu Loc bridge, Thuan Phuoc bridge and Tien Sa port, while only 11% mentioned "Thanh Khe beach" (Figure 23).

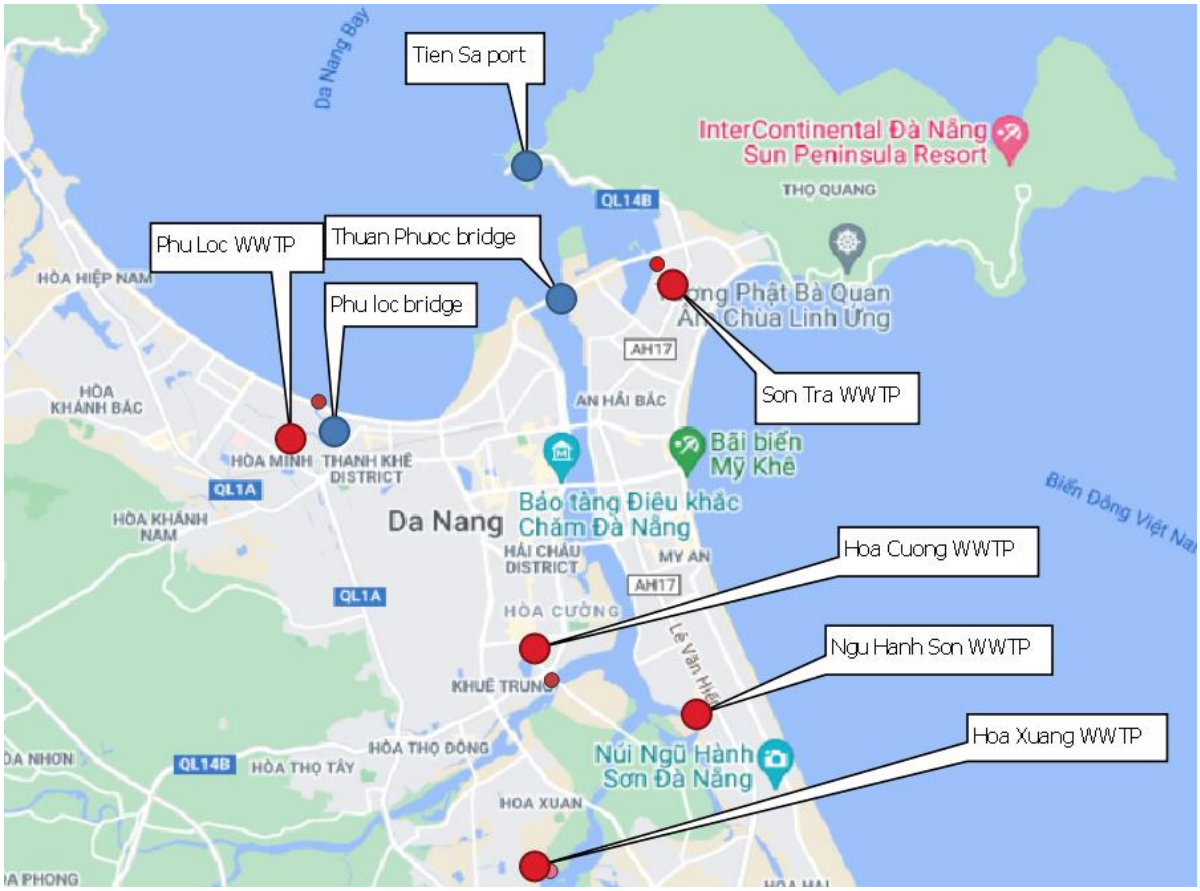

Figure 23. Map of areas avoided by inshore artisanal fishers due to perceived water pollution and location of sewage treatment plants in Da Nang; Blue dots=areas avoided, large red dots= sewage treatment plants, small red dots=discharge points.

Almost 50% of the respondents consider quality of the water in the places they most commonly go fishing as either good (30%) or excellent (27%). However, 29% consider water quality average and 11% as fair (Figure 24a). Further, most fishers believed that water quality did impact their targeted species to some degree: 27% thought there was a little impact, 23% a fair impact and 19% a lot of impact (Figure 24b). Around a third of respondents did not consider water quality had an impact at all (30%).

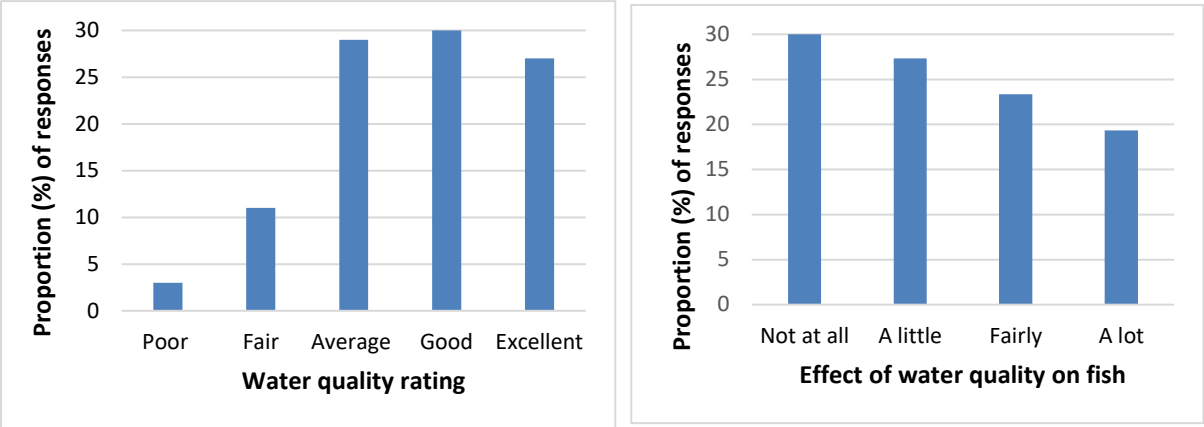

Figure 24. a) Proportion (%) of water quality rating given by inshore artisanal fishers for areas where they operate; b) Proportion (%) of the perceived impact level that water quality has on their catch.

Figure 25 shows that respondents most often use visual evidence for pollution, either as water colour, visibility or "look for signs of pollution e.g., sewage, litter, oil slicks". The former means that natural processes, such as sedimentation and algal blooms, might be misinterpreted as pollution. Unlike other marine sectors, 4 respondents mentioned official data on water quality as the information used and fourteen mentioned not assessing water quality at all.

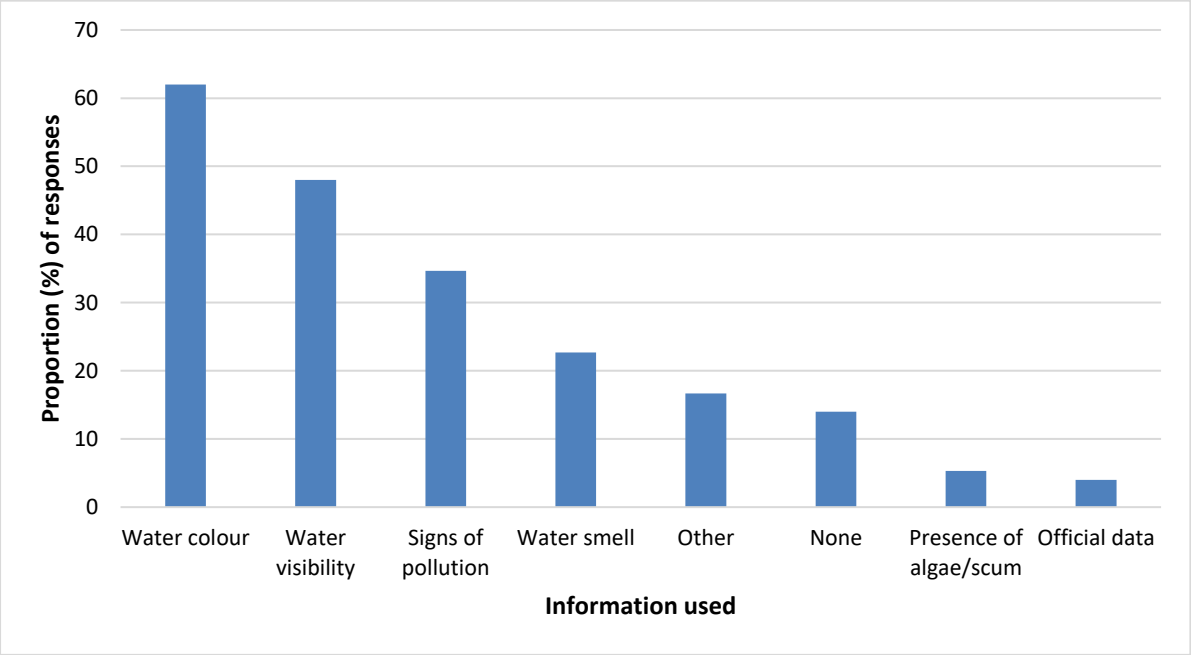

Figure 25. Proportion of responses for information used by inshore fishers to assess the water quality where they go fishing; 'signs of pollution' is a general category including litter, sewage, oil slicks, etc.

When asked about the impact of fishing activities on water quality, most respondents (83%) thought they were not impacting. On the other hand, when asked about what impacts the water quality in and around their fishing grounds respondents reported that the biggest impact was industrial waste (22%), followed closely by other fishing activities (21%) and sewage (undetermined source, 18%) (Figure 26). Other minor activities that were mentioned to affect water quality included tourism, aquaculture, agriculture, and trash brought by storms (source unspecified). A small proportion of respondents (16%) did not think that human activities impact water quality.

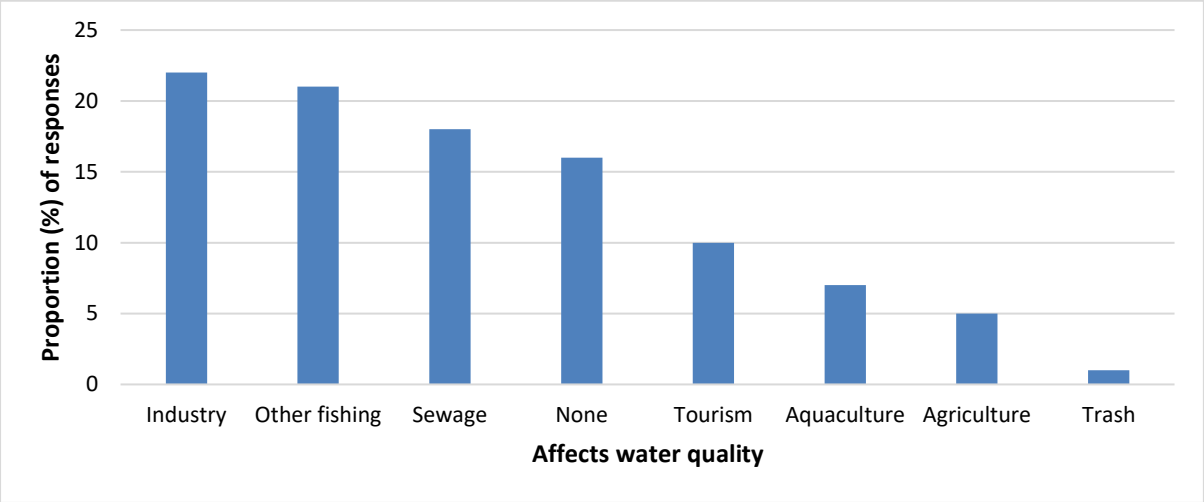

Figure 26. Proportion of fishers' views on what has the biggest impact on water quality in and around their fishing grounds (n=247).

In more than half of the cases, fishers reported not generating any waste in the categories of unused bait (55%), fish waste or rotten (55%), and human waste (54%) (Figure 27). Similarly, 45% reported not generating any equipment waste. Damaged gear is the only category that is generated by all fishers, but more than half the time it is placed in the rubbish collection system (55%); followed by equipment (35%) and human waste (26%). Food waste is most likely to be thrown in the sea (42%) followed by unused bait (23%) and fish waste (19%). Waste left on the shore most commonly includes damaged gear (35%), food waste (24%) and fish waste (17%). These results evidence that fishers are taking some actions to reduce their waste (or it is linked to short fishing trips) and it seems to indicate that they are aware of the biodegradable nature of food and fish waste. However, there is still a problem with all categories of waste being left on the shore or being thrown into the sea (e.g., gear) which contributes to water pollution and reducing amenity quality of shorelines.

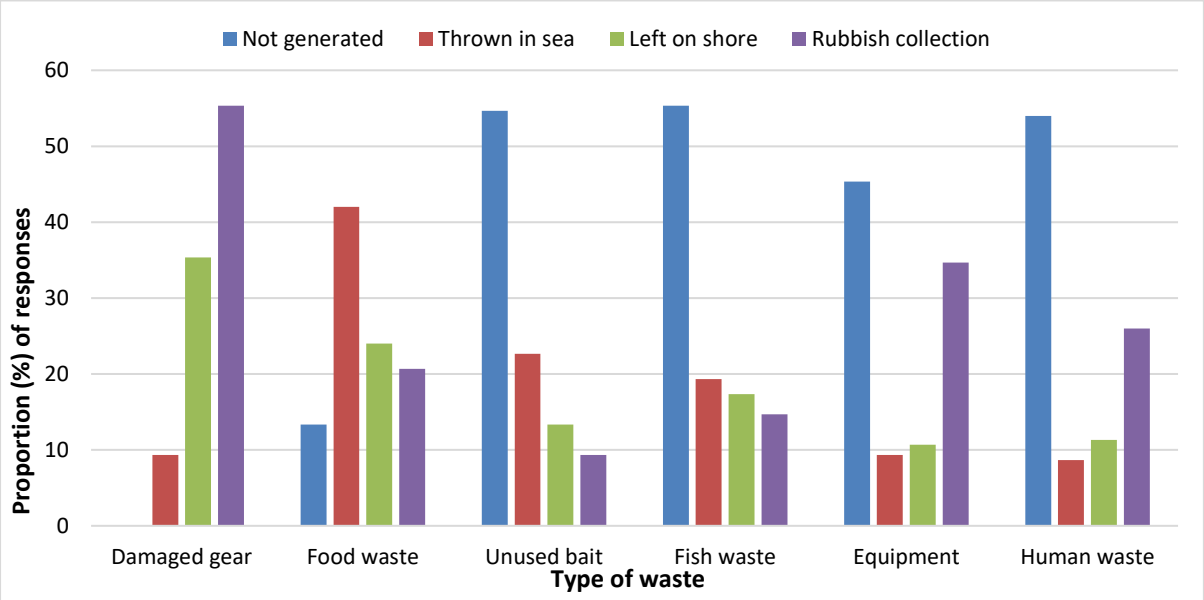

Figure 27. Proportion (%) of each of the different ways in which fishers deal with waste in Da Nang Bay.

Blue carbon valuation of stocks

Carbon valuation

Following the methodology of Garrard and Beaumont (2014), and using a global carbon price as advised by the IPCC special report (IPCC, 2018) it is possible to provide a first estimate of the monetary value of the carbon sequestration and burial in Da Nang Bay. A global mean for carbon burial rates by seagrasses is proposed by McLeod *et al.* (2011) as 138 ± 38 $gC/m^2/yr$. However, the carbon burial rate of seagrasses will vary by species. Current literature suggests that carbon burial rates of between 0.22± 0.04 $gC/m^2/yr$ and 19.08± 3.75 $gC/m^2/yr$ for *Halophila ovalis* (Bedulli *et al.*, 2020). This is substantially lower than the mean rate of carbon burial for seagrass but this difference may be explained by the comparatively small size of *H. ovalis* (Stankovic *et al*., 2017), with the lower biomass leading to a smaller organic uptake by the plants, and also due to the roots only penetrating to a shallow depth, up to 5-7 cm depth (Marbà *et al.,* 2010), resulting in shorter term storage. Carbon burial rates are not available for the species *Halophila decipiens* and *Halodule pinifolia*.

H. ovalis is currently the dominant seagrass species in Da Nang Bay. If we estimate a coverage of 1 ha this amounts to an annual burial of between 2.2 ± 0.4 kg C/yr and 190.8 ± 37.5 kg C/yr. This estimate needs to be converted to incorporate the weight difference between carbon and carbon dioxide, by multiplying by a factor of 3.67. Taking the lower carbon price of 2010 USD135/tCO_2-eq, as it is more representative of the earlier time scale, this equates to between 8.07 ± 1.47 $kgCO_2/yr$ and 699.6 ± 137.5 $kgCO_2/yr$, or between 0.008 ± 0.001 $tonneCO_2/yr$ and 0.699 ± 0.138 tonne CO_2/yr, for a value of between 2010 USD 1.08 ± 0.135 and 94.37 ± 18.63/yr. If Da Nang Bay was managed to secure the restoration of the seagrass beds to previous levels, then these values would increase by at least one order of magnitude. Note also that the monetary values relating to carbon burial alone are comparatively low, but it is important to remember that seagrasses provide a host of other services including habitat for charismatic species, improving water quality, and reducing erosion.

Resilience to COVID-19

Fishers: preliminary findings

All 10 interviewees stated that they suffered serious financial damage after the first two COVID-19 outbreaks. When the pandemic first started, they were still able to go fishing on day trips and sell fish on the shore as the local people were very anxious and tried to stock up on as much food as possible. However, during the second outbreak Da Nang was the epicentre and the city's government took stricter measures in social distancing and issued a fishing ban. Even if they could have managed to go fishing, they couldn't sell their fish. Under normal conditions, these inshore fishers sell fish at the beach and in local markets but during the pandemic they were banned from the beach. Fish sales in the markets didn't go well, as people went shopping less frequently, as the city's government imposed a restriction on the number of times per week local people were allowed to go to markets. Not only was fish consumption reduced, but the selling prices were cut by nearly 70% of normal prices. In some cases, some fishermen went fishing in the evening, came back early the next morning to sell their fish before patrol officers appeared.

Compared with natural disasters, the impact of COVID-19 was less dramatic and distressing because natural calamities take people's lives and cause serious damage to boats and fishing gear. The fishers' lives were still better than those of the unemployed during the COVID-19 pandemic because they were still able to earn enough money to feed themselves and their family from fishing. In terms of personal awareness, although the majority of fishers are illiterate, they all understood the threat posed by Covid-19, so they followed the government's regulations on social distancing. Prior to COVID-19 outbreaks, after a fishing trip, fishers often gathered for a coffee or a beer, but they

stopped meeting during the pandemic. This was the most noticeable change to the relationships among fishing communities. They also had to spend money more frugally because, apart from savings, they had no other preparations if the pandemic broke out again.

Fishers operate within the context of unequal government support to fishers across the city (i.e., Thanh Khe District fishers have support). Fishers set aside money when they have good catch days but on bad days, they will have to spend those savings to cover family expenses. Apart from this short-term saving, fishers do not practise any livelihood strategies. Some fishers had previously attempted a livelihood change but eventually they came back to fishing.

Aquaculture farmers: preliminary findings

The first two Covid-19 outbreaks/lockdowns in 2020 affected farming households, especially their income. Most farms operate by selling fish on a monthly basis. During the first COVID-19 wave, sales were delayed for 3 months and the farmers had to spend a large amount of money on fish food. The selling price was also quite low due to reduced consumption of farmed fish. During the second wave, Da Nang became Vietnam's COVID-19 epicentre, so it was impossible to sell fish despite the large quantities in their farms. The city managed to control the pandemic after over a month, so the farmers could sell their fish but still at the low price of approx. 32,000 VND/kg compared to the normal price at 52,000 VND/kg. Even though raw material prices did not increase, selling was difficult due to social distancing and the city lockdown. Traders took advantage of the pandemic situation to bargain for lower prices with the farmers. In normal situations, prices were already not ideal.

Regarding social changes in their farming communities, there was no reported change in the relationships between farming households. Under normal conditions, these aquaculture farmers work on their own farms and are not often in contact.

Similar to fishers, farmers save on days when they have good income but when they make a loss, they have to use these savings. Apart from this short-term saving, farmers do not practise any other livelihood strategies. One aspect that was unaffected for farmers was their food security, as they had plenty of fish on their farms for themselves and their families. A benefit for the farmers during the pandemic was that due to restrictions, certain factories halted their activities, and this resulted in reduced/absent wastewater discharges around the farming areas.

Policy analysis

Policy Instrument map

For the Rapid Policy Network Mapping approach, 80 policy instruments were identified from the various sources and utilised as being relevant to integrated coastal zone management. Table 11 shows the spread of instruments across policy domains and sectors. Just over half the instruments operate at the national policy level, mostly as *laws* set by the National Assembly (NA), *resolutions* determined by the NA and the Central Committee of the Communist Party of Vietnam (CPV), and *decisions* made by The Prime Minister. Twenty-two instruments refer to provincial or municipal level decision-making, principally as local authority *strategies* and *plans,* or *decisions* determined by the People's Committee of Da Nang city.

Table 11. Policy instrument distribution in the Da Nang instruments map.

Domain/ Sector	International	Regional	National	Municipal	Total
Cross-sectoral: ICZM	9	3	21	7	40
Economic			10	2	12
Planning			1		1
Fisheries			4	6	10
Aquaculture				2	2
Tourism			2	2	4
Water quality	3		3	2	8
Blue carbon			2	1	3
Total	12	3	43	22	80

Two-thirds of the instruments are cross-sectoral and in line with our objectives, half of the instruments are categorised as cross-sectoral-ICZM. While several instruments primarily concerning fisheries and water quality are apparent, there appear to be very few instruments targeted at tourism, blue carbon and, particularly, aquaculture. The two documents categorised as aquaculture instruments are both based around references to a specific Aquaculture Project in Da Nang (Decision 2029 - Approving the outline of the *'Aquaculture in Da Nang City until 2030 Project'* and the 2020 Year review Da Nang People's Council meeting notes) Following the link to the PDF of the policy instrument concept map for Da Nang Bay (Blue ovals = category; green oval = domain or scale; mint boxes = core ICZM instruments (solely on ICZM); Bold outline boxes = key instruments directly influencing the ICZM (but not solely on ICZM); black arrows = direct relationships between instruments; red text = document not available in English).

The instrument map (annexed to this report) shows quite a complex policy landscape comprising 80 different instruments ranging from the international to municipal scale. Twelve important international instruments, mostly conventions, are acknowledged within other national and/or municipal policies as having direct influence on policy creation and function. The clearest observation is that there are many relevant national-level cross-sectoral policy instruments (40% of all instruments), while there are fewer national level sector-specific instruments (mostly sector laws) i.e., fisheries (n=4), tourism (n=2), water quality (n=3) and blue carbon (n=2).

No key national aquaculture policies were identified, although it was observed in the policy instruments that aquaculture tended to be encompassed within fisheries instruments, and the sectors considered jointly, as 'aquatic resources'. For example, Decree 26 on the implementation of the Law on Fisheries includes a list of endangered, precious, and rare aquatic species that cannot be selected for aquaculture practices without written approval, and a central and provincial-level fund for protection and development of static aquatic resources was created by the Law for providing support through programmes, projects, and non-project activities.

While only one instrument is shown from the planning sector, it is apparent from review of cross-sector policies that Vietnam's national ICM strategy and Da Nang's ICM Strategy and Zoning Plan are important tools that inform coastal and maritime planning and are essential for integrating the national and municipal planning framework. Further, the instrument map highlights that integrating broader marine and coastal management policies and delivery mechanisms will be an important aspect of ICM strategies and plans, requiring consideration of how both horizontal *and* vertical integration can be enabled to ensure sustainable coastal management with limited resources.

Policy Actor map

The policy actor map charts the range of actors involved in the policy development of ICM. In total, 49 different actors are recognised as having some role to play in influencing or delivering ICM policy (Table 12). At the international scale, these are clustered around influencers and owners relevant to marine and coastal management policy and focus on support for developing ICM as well as how ICM sits within strategic global objectives. For example, the Royal Netherlands Embassy was critical to the development of ICM between 2002 and 2005 and influenced the Ministry of Natural Resources and Environment's (MONRE) first national ICM strategy in 2006, while the UN's Sustainable Development Goals provide a high-level steer for ensuring that coastal development policies align to global sustainability priorities. Interestingly, most actors are influencer/deliverers at the national or municipal level. The CPV at national level and the People's Committee of Da Nang at municipal level appear to be the primary decision makers in coastal management policy in their respective domains. The CPV is advised by various committees, e.g., National Committee on Climate Change, while the People's Committee of Da Nang is advised by a range of expert bodies, from engineering, education, technology, among others.

Table 12. Policy actor distribution in the Da Nang actor map.

Domain/ Role	International	Regional	National	Municipal	Total
Influencer/Owner	4		3	4	11
Owner/Decision-maker			3	2	5
Influencer/Deliverer		1	15	10	26
Deliverer			2	5	7
Total	4	1	23	21	49

The Actor map (annexed to this report) strongly suggests a focus of policy activity by influencers/deliverers, where a number of organisations, mostly government ministries at national level and local government departments at municipal level, have dual responsibilities for the provision of advice and guidance to decision-making bodies, as well as the subsequent determination of priorities and implementation of plans once the decisions have been made. An example of this dual role is evidenced in the Action Plan to Manage Marine Litter in Da Nang (Plan No. 123/KH-UBND dated 24 June 2021 of Da Nang City People's Committee) in which DONRE is given responsibility for advising the City People's Committee on the organization of an implementation plan, as well as coordinating, directing, and monitoring actual implementation of the Plan. MONRE, DONRE, VASI and DASI are the key critical actors responsible for delivery, management, and monitoring of integrated coastal management from national to municipal domains. Coordination between these actors and the other influencer/deliverer actors are frequently emphasised in policy instruments. For example, the National Strategy for Integrated Coastal Management to 2020 with a vision to 2030 established a Strategic Coordination Board with MONRE as lead and five other Ministries and numerous People's Committees as members. Link provided to the PDF of the policy actor Concept Map for Da Nang city, (blue ovals = role; green oval = domain or scale; black arrows = direct relationships between instruments).

While the People's Committee is the primary decision-maker on ICM policies in Da Nang, DONRE and DASI are the key policy actors that determine the level of success of these policies. This is likely to be reflected in any forthcoming revision of Da Nang's coastal strategy, as VASI and DASI were formed later than the current version of the strategy. Relatively few actors with sole responsibilities for delivery have been identified to date. It has been assumed that VASI and DASI, as divisions within their parent bodies, MONRE and DONRE respectively, have a more direct role in implementation of

coastal management policies. However, it is recognised that these actors may need to be regarded as having an equal role and function as the broader organisations in which they are situated.

A preliminary content analysis was carried out by searching for five main themes of this study. Table 13 shows the initial results of the searches performed across the policy instruments. Results reveal that each sector's collective search terms appear in a relatively equal number of policy instruments, with the exception of blue carbon which only appeared in 12 instruments. Note that this will reflect the total number of instruments accessible to the researchers. Despite there being a similar number of instruments across sectors, the fisheries sector had the highest number of mentions, possibly reflecting greater interaction across policies for this sector. It is noticeable that, of the relatively few blue carbon references, a high proportion of them (40%) are situated within regional instruments, the highest proportion of regional instruments for any sector. This indicates the importance that PEMSEA, through the Sustainable Development Strategy for the Seas of East Asia, attaches to developing blue carbon opportunities across the region, but which is not yet matched by national and municipal policy instrumentation in Vietnam.

Table 13. Initial results of policy content analysis through text query for five themes.

Units	Tourism	Fisheries	Aquaculture	Blue carbon	Water quality
No. of instruments mentioned	36	32	31	12	30
No. of mentions	286	555	231	48	211
Proportion (%) of mentions per domain:					
International	2	8	0.5	0	1
Regional	4	7	7	40	6
National	73	63	87	40	76.5
Municipal	21	22	5.5	20	16.5

Most mentions per sector occurred within national instruments. Notable is the much lower proportion of aquaculture references within municipal policy documents compared to the other sectors, possibly reflecting a greater challenge of integrating aquaculture and other sector policies at the local level compared to national directives. Another possibility is that some key municipal policies and strategies need to be updated to incorporate more recent developments and priorities, including management of the expanding aquaculture sector (Dao, 2018). This gap may become even more noticeable with the Ministry of Agriculture and Development's forthcoming national strategy for marine aquaculture development (Dao, 2018), although this new strategy will hopefully present recommendations and actions for enhancing devolved responsibilities, coordination, and monitoring.

Discussion

Marine sectors: comparison and recommendations

- Aquaculture farming seems to be the most disadvantaged marine sector in Da Nang city. This is evidenced by the activity being illegal throughout most of the city except one small area. Aquaculture farmers also had the highest levels of illiteracy and many farms seem to be located close to wastewater treatment plants (WWTP) discharge points (possibly influencing stock mortality rate). Farmers mainly sell to traders who have a large influence in price given for stock, often to farmers' detriment.
- Aquaculture farming in Da Nang would benefit from policies that legalise the activity (this was mentioned as the main threat to the sector) through sustainable practices (e.g., allocating good water quality areas for farming), training to improve buyer options/diversification (i.e., to elevate and stabilize price), and management practices to reduce stock mortality which is high compared

to the rest of Vietnam. The legalization of aquaculture could allow farmers to access government support packages, currently unavailable to them.

- Marine tourism seems to be a solid sector with a long history and support from the city government (e.g., loans subsidized by government during pandemic 2020). However, the sector is focused on national tourists, due to amenities present in Da Nang, which leads to lower income.
- Inshore artisanal fishers evidence a good diversity of gear types and species caught, as well as more diverse options of buyers that can maintain prices at competitive rates. Fishers also demonstrate greater organisation than other marine sectors.
- However, fishers reported the use of illegal fishing practices and fishing areas that overlapped with wastewater treatment plant discharge points. Fisheries would benefit, as well as the sea life, from greater monitoring and enforcement of fishing policies and legislation.
- Son Tra Peninsula is a key location in Da Nang city, as it supports a large proportion of marine tourism and artisanal fishing. Thus, the area needs special attention for conservation to ensure protection of the marine environment in the face of expected expansion of marine tourism.
- In all three sectors: marine tourism, aquaculture and artisanal fishing, respondents and their families depend almost entirely on these activities for their household livelihood. Although aquaculture farmers and fishers had a few options for alternative income (but few had access to them), all families involved in these sectors would benefit from income diversification or support, especially in times of stress/shocks, and more equitable support system from the government.
- All three sectors mentioned natural disasters as a main threat to their livelihood; marine tourism operators and aquaculture farmers also highlighted water pollution; and fishers emphasised the threat from destructive fishing (most often by outsiders). These threats evidence key areas to develop in Da Nang city: adaptation and preparedness for natural disasters, updating and implementing water quality monitoring, enforcing water quality policies including zoning, and enforcing fisheries policies including patrolling.
- All marine sectors seemed to be mainly neutral or expecting no change in their respective sectors. However, aquaculture stands out for a tendency to expect an increase of demand for the sector despite its current illegal status; and fishers tend to have conflicting views on expected changes which seems to reflect uncertainty or lack of knowledge.
- The three sectors had an overall positive view on the water quality status for Da Nang city, as well as thinking that their activities did not have much impact on water quality. However, there was evidence of misinformation and conflicting views e.g., view of good water quality but avoid certain areas due to pollution or claiming their farm does not affect water quality but saying other farms do. Thus, there is a need for environmental education and awareness raising regarding different sources of pollution (including non-visible ones), impacts of pollution and impacts of their livelihoods on water quality and how to reduce them.
- When looking at activities affecting water quality, there seemed to be a consensus across sectors in that sewage and industrial waste were two of the main causes of marine water pollution in Da Nang city. This highlights the need to take enhanced action for water quality improvement by improving sewage treatment.

Blue carbon: Is it significant?

- Our work on Blue carbon in Da Nang is speculative and conservative as there is a lack of current information on marine habitats. However, if Da Nang managed to secure the restoration of the seagrass beds and mangroves to past levels, then our calculations would increase by at least one order of magnitude. Nonetheless, the estimated monetary values would still be low, and it is important to remember that marine habitats provide a host of other services (including habitat for charismatic species attractive to tourists and improving water quality) that would greatly increase their value. A first step would be to assess in-situ the current coverage of all blue carbon habitats and carbon burial rates for species present.

Highly vulnerable sectors

- Impact of COVID-19 on fishers and aquaculture farmers proved to be highly dependent on the strictness of restrictions imposed by the government. Fishers and farmers did not have any livelihood strategies to deal with stresses/shocks beyond short-term saving. Impacts were mainly felt on income, which was due to a lowering of price received for stock/catch and no access to buyers. Fishers' food security and social networking were also affected. Although aquaculture farmers' income was affected, at least they had good food security with their ponds/cages full and increased environmental security from reduced industrial effluents. Overall, respondents did not perceive the pandemic to be as impactful as natural disasters (common in the study area) as the latter can take peoples' lives and destroy assets (e.g., boats, gear, ponds).

Policy mapping

- The instrument map reveals that approximately double the number of national to municipal policy instruments have been identified. While this pattern may reflect the actual policy landscape, it is possible that relevant policies determined at the municipal level (and district and ward level) have been more difficult for the researchers to identify and obtain.
- The number of instruments dedicated to integrated coastal management emphasises the reliance on this approach in responding to some of the key challenges that Da Nang faces, such as climate change impacts, marine and coastal environmental threats, biodiversity loss, sustainable development, and resource exploitation. Mechanisms need to continue to support horizontal and vertical integration in order to maximise very limited resources, while at the same time providing greater clarity and focus for implementing increasingly important policies.
- Da Nang's Coastal Strategy has recently passed its 20th anniversary and, while it paved the way for a national strategy, it requires updating, alongside the Coastal Use Zoning Plan, to reflect increasing threats to the city from, and impacts of, climate change, particularly on tourism and recreation zones. An update would also clarify the vital role that DASI plays in delivery and monitoring of integrated coastal management in Da Nang.
- Many of the policies included in the instrument map had an explicit implementation target date of 2020, albeit with a vision to a future date, often 2030. It is therefore anticipated that many policies will currently be in the process of revision to reflect developments in the city, as well as from external impacts such as that arising from the Covid-19 pandemic. These policy maps may therefore prove useful as reference points for those responsible for updating individual policies.
- A detailed content analysis of ICZM-related policies is recommended as a next step. This would provide a deeper understanding of the extent to which policy makers and deliverers in Vietnam, generally, and Da Nang specifically, have included key sectors - tourism, fisheries, aquaculture, and blue carbon - within their coastal management related policy instruments, and how (un-)successfully the policies interact and complement one another in order to facilitate sustainable coastal management.

Key future research recommendations

1. Assess ways in which aquaculture can be legalised and made both financially and productively sustainable within political constraints.
2. Explore the trade-offs and solutions of marine areas with conflicting activities, using Son Tra Peninsula as a case study.
3. Evaluate the socio-ecological resilience and potential solutions (e.g. financial incentives or mechanisms) for the different marine sectors to multiple stressors, particularly natural disasters and water pollution.

4. Study the links between the state of ecosystem services and human wellbeing; one way of doing this is to quantify the cost of health and wellbeing impacts of water pollution to inform policy and raise awareness.
5. A detailed content analysis of ICZM-related policies to provide an understanding of the extent to which policy makers and deliverers have included key sectors within their coastal management related policy instruments, and how (un-)successfully the policies interact and complement one another.

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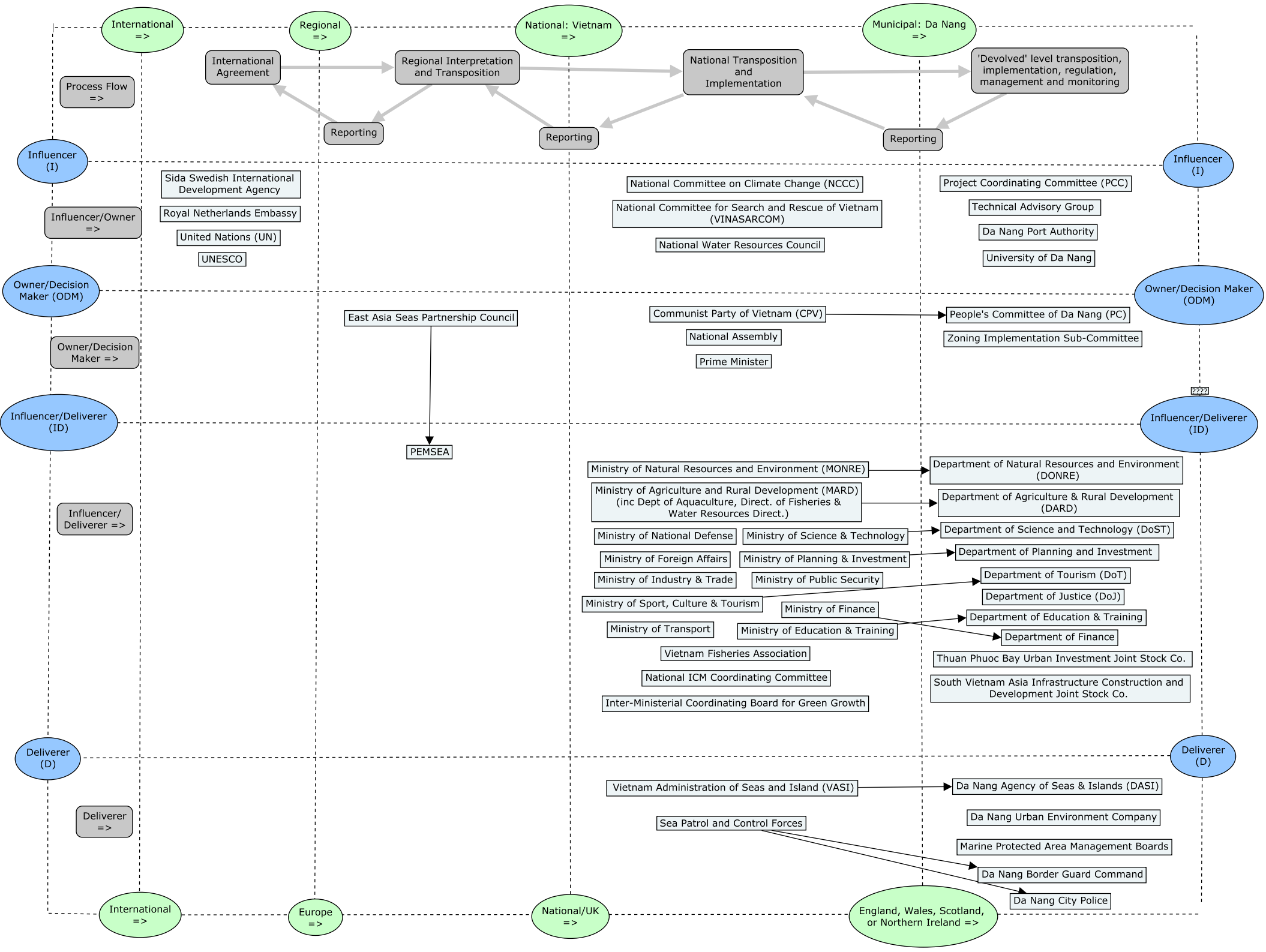
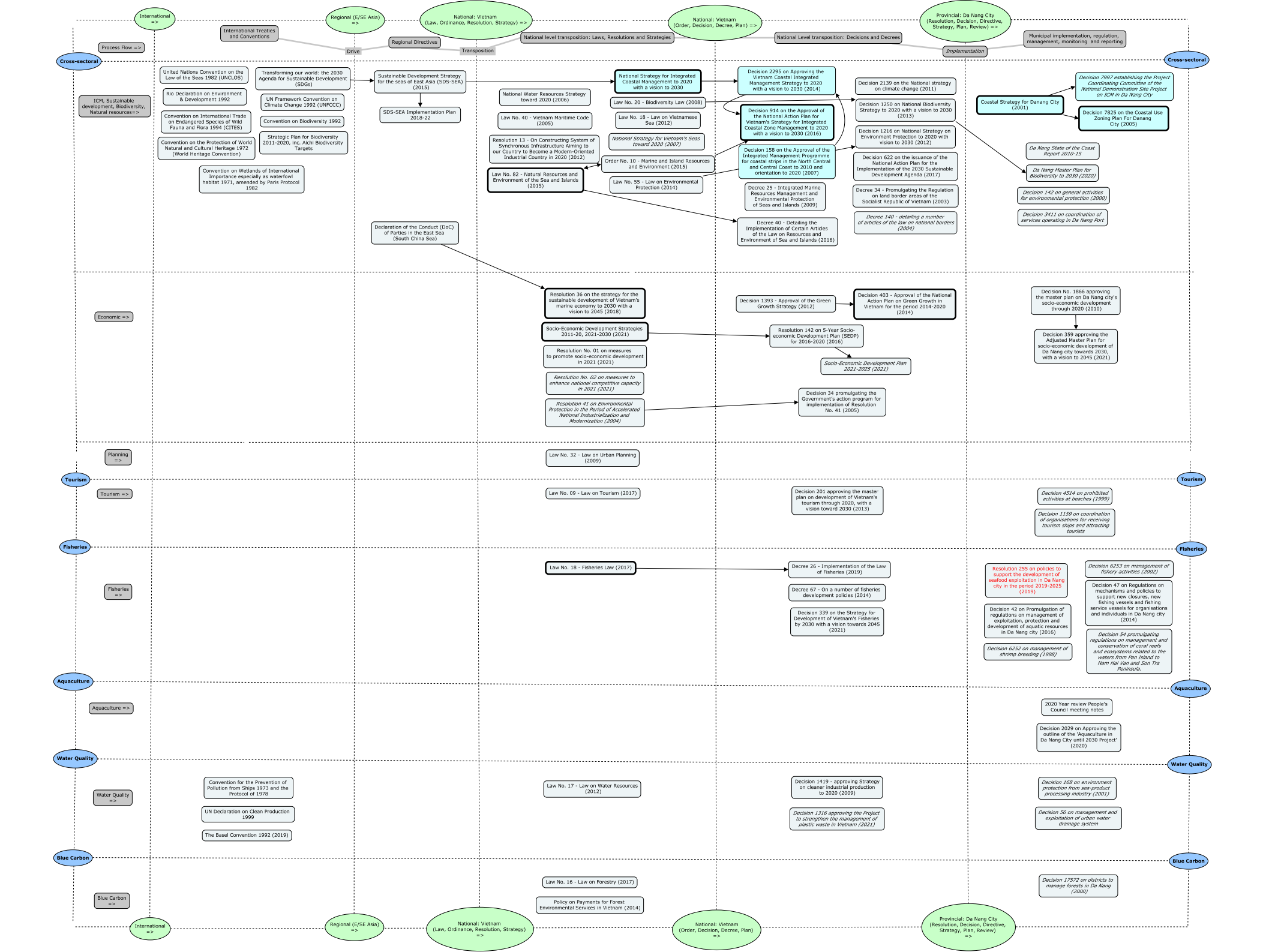
Appendix 1 - Policy Actor Concept Map


International =>
Regional =>
National: Vietnam =>
Municipal: Da Nang =>
Process Flow =>
International Agreement
Regional Interpretation and Transposition
National Transposition and Implementation
'Devolved' level transposition, implementation, regulation, management and monitoring
Reporting
Reporting
Reporting
Influencer (I)
Influencer (I)
Influencer/Owner =>
Sida Swedish International Development Agency
Royal Netherlands Embassy
United Nations (UN)
UNESCO
National Committee on Climate Change (NCCC)
National Committee for Search and Rescue of Vietnam (VINASARCOM)
National Water Resources Council
Project Coordinating Committee (PCC)
Technical Advisory Group
Da Nang Port Authority
University of Da Nang
Owner/Decision Maker (ODM)
Owner/Decision Maker (ODM)
Owner/Decision Maker =>
East Asia Seas Partnership Council
Communist Party of Vietnam (CPV)
National Assembly
Prime Minister
People's Committee of Da Nang (PC)
Zoning Implementation Sub-Committee
Influencer/Deliverer (ID)
????
Influencer/Deliverer (ID)
PEMSEA
Influencer/ Deliverer =>
Ministry of Natural Resources and Environment (MONRE)
Ministry of Agriculture and Rural Development (MARD) (inc Dept of Aquaculture, Direct. of Fisheries & Water Resources Direct.)
Ministry of National Defense
Ministry of Science & Technology
Ministry of Foreign Affairs
Ministry of Planning & Investment
Ministry of Industry & Trade
Ministry of Public Security
Ministry of Sport, Culture & Tourism
Ministry of Finance
Ministry of Transport
Ministry of Education & Training
Vietnam Fisheries Association
National ICM Coordinating Committee
Inter-Ministerial Coordinating Board for Green Growth
Department of Natural Resources and Environment (DONRE)
Department of Agriculture & Rural Development (DARD)
Department of Science and Technology (DoST)
Department of Planning and Investment
Department of Tourism (DoT)
Department of Justice (DoJ)
Department of Education & Training
Department of Finance
Thuan Phuoc Bay Urban Investment Joint Stock Co.
South Vietnam Asia Infrastructure Construction and Development Joint Stock Co.
Deliverer (D)
Deliverer (D)
Deliverer =>
Vietnam Administration of Seas and Island (VASI)
Sea Patrol and Control Forces
Da Nang Agency of Seas & Islands (DASI)
Da Nang Urban Environment Company
Marine Protected Area Management Boards
Da Nang Border Guard Command
Da Nang City Police
International =>
Europe =>
National/UK =>
England, Wales, Scotland, or Northern Ireland =>

Appendix 2 - Policy Instrument Concept Map


International =>
Regional (E/SE Asia) =>
National: Vietnam (Law, Ordinance, Resolution, Strategy) =>
National: Vietnam (Order, Decision, Decree, Plan) =>
Provincial: Da Nang City (Resolution, Decision, Directive, Strategy, Plan, Review) =>
International Treaties and Conventions
Drive
Regional Directives
Transposition
National level transposition: Laws, Resolutions and Strategies
National Level transposition: Decisions and Decrees
Implementation
Municipal implementation, regulation, management, monitoring and reporting
Process Flow =>
Cross-sectoral
United Nations Convention on the Law of the Seas 1982 (UNCLOS)
Transforming our world: the 2030 Agenda for Sustainable Development (SDGs)
Sustainable Development Strategy for the seas of East Asia (SDS-SEA) (2015)
SDS-SEA Implementation Plan 2018-22
National Strategy for Integrated Coastal Management to 2020 with a vision to 2030
Decision 2295 on Approving the Vietnam Coastal Integrated Management Strategy to 2020 with a vision to 2030 (2014)
Decision 2139 on the National strategy on climate change (2011)
Decision 7997 establishing the Project Coordinating Committee of the National Demonstration Site Project on ICM in Da Nang City
Coastal Strategy for Danang City (2001)
Decision 7825 on the Coastal Use Zoning Plan For Danang City (2005)
ICM, Sustainable development, Biodiversity, Natural resources=>
Rio Declaration on Environment & Development 1992
UN Framework Convention on Climate Change 1992 (UNFCCC)
Convention on International Trade on Endangered Species of Wild Fauna and Flora 1994 (CITES)
Convention on Biodiversity 1992
Convention on the Protection of World Natural and Cultural Heritage 1972 (World Heritage Convention)
Strategic Plan for Biodiversity 2011-2020, inc. Aichi Biodiversity Targets
Convention on Wetlands of International Importance especially as waterfowl habitat 1971, amended by Paris Protocol 1982
National Water Resources Strategy toward 2020 (2006)
Law No. 40 - Vietnam Maritime Code (2005)
Resolution 13 - On Constructing System of Synchronous Infrastructure Aiming to our Country to Become a Modern-Oriented Industrial Country in 2020 (2012)
Law No. 82 - Natural Resources and Environment of the Sea and Islands (2015)
Law No. 20 - Biodiversity Law (2008)
Law No. 18 - Law on Vietnamese Sea (2012)
National Strategy for Vietnam's Seas toward 2020 (2007)
Order No. 10 - Marine and Island Resources and Environment (2015)
Law No. 55 - Law on Environmental Protection (2014)
Decision 914 on the Approval of the National Action Plan for Vietnam's Strategy for Integrated Coastal Zone Management to 2020 with a vision to 2030 (2016)
Decision 158 on the Approval of the Integrated Management Programme for coastal strips in the North Central and Central Coast to 2010 and orientation to 2020 (2007)
Decision 1250 on National Biodiversity Strategy to 2020 with a vision to 2030 (2013)
Decision 1216 on National Strategy on Environment Protection to 2020 with vision to 2030 (2012)
Decision 622 on the issuance of the National Action Plan for the Implementation of the 2030 Sustainable Development Agenda (2017)
Decree 34 - Promulgating the Regulation on land border areas of the Socialist Republic of Vietnam (2003)
Decree 25 - Integrated Marine Resources Management and Environmental Protection of Seas and Islands (2009)
Decree 140 - detailing a number of articles of the law on national borders (2004)
Da Nang State of the Coast Report 2010-15
Da Nang Master Plan for Biodiversity to 2030 (2020)
Decision 142 on general activities for environmental protection (2000)
Decision 3411 on coordination of services operating in Da Nang Port
Declaration of the Conduct (DoC) of Parties in the East Sea (South China Sea)
Decree 40 - Detailing the Implementation of Certain Articles of the Law on Resources and Environment of Sea and Islands (2016)
Economic =>
Resolution 36 on the strategy for the sustainable development of Vietnam's marine economy to 2030 with a vision to 2045 (2018)
Socio-Economic Development Strategies 2011-20, 2021-2030 (2021)
Resolution No. 01 on measures to promote socio-economic development in 2021 (2021)
Resolution No. 02 on measures to enhance national competitive capacity in 2021 (2021)
Resolution 41 on Environmental Protection in the Period of Accelerated National Industrialization and Modernization (2004)
Decision 1393 - Approval of the Green Growth Strategy (2012)
Decision 403 - Approval of the National Action Plan on Green Growth in Vietnam for the period 2014-2020 (2014)
Resolution 142 on 5-Year Socio-economic Development Plan (SEDP) for 2016-2020 (2016)
Socio-Economic Development Plan 2021-2025 (2021)
Decision 34 promulgating the Government's action program for implementation of Resolution No. 41 (2005)
Decision No. 1866 approving the master plan on Da Nang city's socio-economic development through 2020 (2010)
Decision 359 approving the Adjusted Master Plan for socio-economic development of Da Nang city towards 2030, with a vision to 2045 (2021)
Planning =>
Law No. 32 - Law on Urban Planning (2009)
Tourism
Tourism =>
Law No. 09 - Law on Tourism (2017)
Decision 201 approving the master plan on development of Vietnam's tourism through 2020, with a vision toward 2030 (2013)
Decision 4514 on prohibited activities at beaches (1999)
Decision 1159 on coordination of organisations for receiving tourism ships and attracting tourists
Fisheries
Fisheries =>
Law No. 18 - Fisheries Law (2017)
Decree 26 - Implementation of the Law of Fisheries (2019)
Decree 67 - On a number of fisheries development policies (2014)
Decision 339 on the Strategy for Development of Vietnam's Fisheries by 2030 with a vision towards 2045 (2021)
Resolution 255 on policies to support the development of seafood exploitation in Da Nang city in the period 2019-2025 (2019)
Decision 42 on Promulgation of regulations on management of exploitation, protection and development of aquatic resources in Da Nang city (2016)
Decision 6252 on management of shrimp breeding (1998)
Decision 6253 on management of fishery activities (2002)
Decision 47 on Regulations on mechanisms and policies to support new closures, new fishing vessels and fishing service vessels for organisations and individuals in Da Nang city (2014)
Decision 54 promulgating regulations on management and conservation of coral reefs and ecosystems related to the waters from Pan Island to Nam Hai Van and Son Tra Peninsula.
Aquaculture
Aquaculture =>
2020 Year review People's Council meeting notes
Decision 2029 on Approving the outline of the 'Aquaculture in Da Nang City until 2030 Project' (2020)
Water Quality
Water Quality =>
Convention for the Prevention of Pollution from Ships 1973 and the Protocol of 1978
UN Declaration on Clean Production 1999
The Basel Convention 1992 (2019)
Law No. 17 - Law on Water Resources (2012)
Decision 1419 - approving Strategy on cleaner industrial production to 2020 (2009)
Decision 1316 approving the Project to strengthen the management of plastic waste in Vietnam (2021)
Decision 168 on environment protection from sea-product processing industry (2001)
Decision 56 on management and exploitation of urban water drainage system
Blue Carbon
Blue Carbon =>
Law No. 16 - Law on Forestry (2017)
Policy on Payments for Forest Environmental Services in Vietnam (2014)
Decision 17572 on districts to manage forests in Da Nang (2000)
International =>
Regional (E/SE Asia) =>
National: Vietnam (Law, Ordinance, Resolution, Strategy) =>
National: Vietnam (Order, Decision, Decree, Plan) =>
Provincial: Da Nang City (Resolution, Decision, Directive, Strategy, Plan, Review) =>