Department of Sociology and Public Politics

# OVERFISHING – AN EMPIRICAL STUDY OF FISHERIES AND CALL FOR ACTION

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**ABSTRACT**

ENG: Since the 1950s, the capacity of fishing fleets has increased significantly. As a result, there have been frequent cases of overfishing, particularly of some marine species that have not yet recovered. In 1982, the United Nations Convention on the Law of the Sea (UNCLOS), an international treaty, was adopted and signed. It has led to the creation of Exclusive Economic Zones (EEZs) and defined the rights and responsibilities of States with regard to the use of the seas and oceans. The Convention has become the legal framework for marine and maritime activities. However, the lack of stronger agreements leaves a wide range of problems, such as illegal, unreported and unregulated (IUU) fishing, a rapidly growing world population, the environment and human degradation. These problems are exacerbated by climate change, ocean warming, and increasing pollution of our marine spaces. One third of the world's fisheries is currently overexploited and calls for a global approach to restore once abundant ocean resources. Through case studies and analysis of the status quo in fisheries management, this thesis aims to provide the reader with an understanding of the multi-faceted anthropogenic and non-anthropogenic issues facing our oceans. Nature-based solutions are available and must be integrated. The institutional framework of Ostrom's institutions provides answers to some of the governance problems.

Keywords: overfishing, environment, degradation, human rights, fishing industry, international laws, jurisdiction, trends, challenges, policies, depletion, resources, disruption, ecosystems, biodiversity

**RESUMO**

PT: Desde a década de 1950, a capacidade das frotas de pesca aumentou significativamente. Em consequência, registaram-se casos frequentes de sobrepesca, especialmente de algumas espécies marinhas que ainda não recuperaram. Em 1982, foi adoptada e assinada a Convenção das Nações Unidas sobre o Direito do Mar (UNCLOS), um tratado internacional. Conduziu à criação de Zonas Económicas Exclusivas (ZEE) e definiu os direitos e responsabilidades dos Estados no que respeita à utilização dos mares e oceanos. No entanto, a falta de acordos mais fortes deixa uma vasta gama de problemas, como a pesca ilegal, não declarada e não regulamentada (IUU), o rápido crescimento da população mundial, o ambiente e a degradação humana. Estes problemas são exacerbados pelas alterações climáticas, pelo aquecimento dos oceanos e pela crescente poluição dos nossos espaços marinhos. Um terço da pesca mundial está actualmente sobreexplorada e exige uma abordagem global para restaurar os abundantes recursos dos oceanos. Através de estudos de caso e análise do status quo na gestão das pescas, esta tese visa proporcionar ao leitor uma compreensão das multifacetadas questões antropogénicas e não antropogénicas que os nossos oceanos enfrentam. Soluções baseadas na natureza estão disponíveis e devem ser integradas. O quadro institucional da Ostrom (1990) fornece respostas para alguns dos problemas de governança.

Palavras-chaves: sobrepesca, ambiente, degradação, direitos humanos, indústria pesqueira, legislação internacional, jurisdição, tendências, desafios, políticas, esgotamento, recursos, perturbações, ecossistemas, biodiversidade

## GLOSSARY OF ACRONYMS

### Institutions/Organizations

AFP Africa Progress Panel

EC European Commission

EJF Environmental Justice Foundation

FAO Food and Agriculture Organization

ICCAT International Commission for the Conservation of Atlantic Tuna

IATTC Inter-American Tropical Tuna Commission UNDP the United Nations Development Program

IATTC Inter-American Tropical Tuna Commission

ILO International Labor Organization

IOTC the Indian Ocean Tuna Commission

ISC International Scientific Committee

RFMO Regional Fisheries Management Organization

SPC Secretariat of the Pacific Community

UN Environment the United Nations Environment Program

UNODC United Nations Office on Drugs and Crime

WCPFC the Western and Central Pacific Fisheries Commission

### Technical terms

ALDFG abandoned, lost or otherwise discarded fishing gear

CBFM community-based approach to fisheries management

CEAFM community-based ecosystem approach to fisheries management

CPR Common Pool Resources

EAFM ecosystem approach to fisheries management

EEZ Exclusive Economic Zones

MCS Monitoring Control and Surveillance system

MSY Maximal Sustainable Yield

Mt metric tons

IPOA-IUU the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing

ITQ individual transferable quota

IUU Illegal, Unregulated and Unreported

SES social-ecological system

TAC total allowance catch

UNCLOS United Nations Convention on the Law of the Sea

WWII the Second World War

**Geographic indications**

WA West Africa

CCLME Canary Current Large Marine Ecosystem

GCLME Guinean Current Large Marine Ecosystem

# 1. INTRODUCTION

## 1.1 Introduction

The role of fisheries management is of crucial importance to manage fish stocks at sustainable levels, both to sustain human communities and to keep oceans healthy.

The need for management and regulations in the use of the oceans, seas and marine resources has recently been emphasized by the United Nations (UN) through the Agenda 2030 for sustainability and the Sustainable Development Goals (SDG). In particular, goal n°14 sets important targets to be reached worldwide, ambitiously aiming to "prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution by 2025" (UN, 2016). SDG 13: Climate Action is also to be taken into account, as it impacts fisheries and requires unprecedented action to address this global issue (UN, 2018).

The scope is also to tackle the issue of overfishing and illegal fishing which have deteriorating impacts on the natural world and, consequently, on coastal communities that rely on small-scale fisheries. Target 14.4 intends to "effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics".

The last point has caught international attention with several scholars contributing to the topic, especially over the past 50 years; there have been frequent instances of overexploitation of the oceans. The economics of fisheries has been at the forefront by stressing the importance of restoring fish stocks to sustainable levels by elaborating different models. It also considers that fishermen catch fish in stocks whose reproductive capacity, although generally high, is not unlimited. In many cases, if fishing is not controlled, it may no longer be economically viable and stocks may be depleted. Therefore, it is in everyone's interest to have fisheries management systems, to preserve stock regeneration, in order to maintain a high yield in the long term, to lay the foundations for a profitable sector, to allocate fishing opportunities fairly and preserve marine resources.[1]

## 1.2 Research objective

It seems that over the past 50 years awareness has been rising slowly as intergovernmental organizations, national governments, and nongovernmental organizations (NGOs) woke up to the fact that marine resources have been constantly depleted during that time. Regulations and attempts to manage sustainably mean that –

[1] https://ec.europa.eu/fisheries/cfp/fishing_rules_fr consulted on 20/05/19

at least to a certain degree – the decreasing trend of fish stocks that are within biologically sustainable levels seems to have stabilized since 2008, but no obvious progress has yet been made towards achieving SDG target 14.4 at a global level (FAO, 2018a).

However, the current demand for seafood in the context of a growing global population poses a serious threat to marine life and our ocean's future, exacerbated by climate change, plastic and agricultural pollution. Therefore, the aim of this work is to expose the intertwined issues that fisheries face across the world and the different forms they take, but also to find out which answers international institutions (UN, FAO, EU), as well as NGOs and national governments provide in the fight against overexploitation and destruction of crucial ecosystems.

This master thesis gives an extensive literature review of the main theories that lay the foundations and contribute to improving fisheries management practices. It addresses the main issues faced by fisheries across the world. Finally, it analyzes how the main actors react to the growing threats and how they commit to manage sustainably marine resources, for a better future.

### 1.3 Study outline and expected outcomes

First, this dissertation offers a chronological literature review. The goal is to provide a basic understanding of the main scientific theories that became important to policymakers, researchers, and civil society. Also, it helps understanding the problems that lie in managing natural resources and their complexity.

Then, the chapter on "Emerging issues" covers the most urgent problems that need a global response. It introduces the reader to four specific topics directly related to fisheries management: a growing human population and the challenges to feed it, human consumptions trends, illegal, unregulated and unreported fishing, and fishing practices. Drawing on an extensive literature, I argue why they are the ones that require action.

The following chapter "External drivers, environmental and human degradation" discusses of how our modern way of life and consumption patterns put in danger our oceans and consequently ourselves. It addresses the global footprint of industrial fishing

driven by an insatiable demand for seafood, its human degradation through modern slavery on fishing fleets. It shows how human consumptions habits can drive specific species to the brink of extinctions or threaten fragile ecosystems. I discuss then of climate change and other external drivers such as plastic pollution in the context of fisheries and the effects already seen in some regions of the world. Finally, land-based activities also damage the oceans and its inhabitants, which bring me to look at ocean dead zones.

The last chapter called “Fisheries – call for action” takes a closer look at the different initiatives led by international institutions to reverse the destructive effects of human activities on ocean’s life. Whether it is economic or legislative measures, I hope to highlight the fact that an increasing number of measures are being taken to protect our precious ocean resources. As the issues seem global and more present than ever, international institutions at the forefront of change are being studied in depth.

This master thesis aims to contribute to the status quo of fisheries management with a focus on overfishing. The expected outcomes are:

- A better understanding of the link between the various problems that, in my opinion, result from the overexploitation of fisheries resources.
- An assessment of whether the actors involved at the political and economic level implement the necessary resources to solve the multi-faceted threats that are intensifying. It is also necessary to acknowledge that resource management is subjected to conditions of uncertainty and new challenges may arise along the way.

# 2. LITERATURE REVIEW

## 2.1 Overview

Although it is a very old activity, fishing has only been recognized as an object of scientific interest for about fifty years, when the need for the management of industrial marine fisheries became apparent. This section provides a summary of the evolution in the analysis of fisheries and their management. In the remainder of the section, I will be discussing seminal works more in-depth.

Towards the beginning of the 20th century, it became clear that the effects of the considerable technological development of sea fishing were not negligible on resources (Quensière, 1993). The creation of the International Council for the Exploration of the Sea (ICES) in 1902 was a landmarking the realization of the need for management of industrial fishing. But it was only after the Second World War that the real dimension of the impact of industrial fishing was assessed: by causing a significant reduction in fishing efforts, the world conflict had led to a spectacular recovery of marine stocks. But technological advances made during the war helped state responses to immediate post-war market problems and impacted the "Great Acceleration" of fisheries between 1945 and 1975 (Holm, 2014).

The discovery of limited resources then imposes the need for regulation. In its principles, the latter will reflect the social culture and myths of the time: productivity, efficiency, control of nature. At the end of the war, the industrialization of the world's oceans otherwise known as "the blue revolution" intensifies and as such, it must be optimized. In scientific terms "optimization" means to identify a representative differentiable function and find its extremum. In the US, there is no doubt that the potential to maximize is the authorized production and the maximum sustainable yield (MSY). The ten years after WWII were the golden age of the MSY concept and all its derivations: overfishing, when harvests exceed the MSY, and under exploitation, when they are below it. Ricker (1948) produced his famous green book, the first version of his handbook (Ricker, 1958); Fry (1947) developed the virtual population idea; and Schaefer (1954) proposed a method for estimating surplus production under non-equilibrium conditions. The literature crackled with new information and new ideas. The solidification of the concept of MSY, its applications to fisheries here, there, and everywhere, was just under way (Quensière, 1993)

It is only when we see that neither oceans nor rivers or forests are inexhaustible that the concept of yield, previously developed for agriculture, is extended to the renewable resources that are harvested stocks. The first works that explicitly introduce biological and economic aspects into a logical theoretical body date back to the early 1950s. The inclusion of renewable resources (fishing more concretely) in neoclassical economic analysis really begins with the articles of H. Gordon (1953, 1954), A. Scott (1955) and M. Schaeffer (1954a and b, 1957) (J. Lopes 1985).

These economic studies show that since fishing is an activity intended to produce

wealth, the optimum for collecting it (yield maximization, the benefit to be derived from

it) does not correspond to the maximum sustainable yield defined by biologists. The management of fisheries is still ruled by the search for an optimum, although, this time, the potential representative function is no longer biologic but bio-economic. In bio-economic models, scientists are led to make a number of strong assumptions:

- First of all, we reason about balanced situations. The time of economists, like that of biologists, is stationary.
- A number of simplifications are then introduced: "the fishery consists of a single species harvested in a single occupation; producers work in perfect competition; prices (factors and landings) are assumed to be constant; the catchability coefficient is unique and constant. The rule of resource use is the maximization of rent at equilibrium". (Gilly, 1989)

In that sense, the management of fisheries became heavily standardized. The fisheries were now based on intangible laws of nature and had to be managed according to these laws, analyzing them through the filter of optimization by the nature itself of fishing.

The modernization of the fisheries models of management did not include small-scale fishing communities, which were relying on traditions and socio-cultural features. Artisanal fishing is carried out on multi-species stocks using a variety of gears that make it difficult to standardize. Moreover, they are often dispersed and particularly difficult to sample using the methods developed for port surveys (Charles-Dominique, 1989)**.** They are no more likely to fit into the economic mold. Particularly developed in the Third World, they are often the result of long tradition. Strongly integrated into the local social and economic fabric, they give rise to a wide variety of production strategies. Finally, they rarely respond to the premises of neo-classical economic models. This is evidenced by the fact that many artisanal fisheries in many countries manage or have managed the exploitation of common resources themselves without squandering them through overfishing (Berkes, Feeny, McCay, & Acheson, 1989) as Hardin predicted (1968).

The evolution of fisheries biologists and economists towards the rediscovery of a complexity of life, which deterministic models had temporarily made them forget, is gradually leading them to use the analytical tools of ecologists and anthropologists; we are therefore witnessing a rapprochement between naturalist science and social sciences. While economists are discovering that the social and cultural cannot be systematically

neglected, fisheries biologists are realizing that the influence of environmental variability on stock dynamics is not as marginal as their own simplifications suggested (Quensière, 1993).

As a result, dynamic models in bioeconomics start to develop, and mathematics modeling comes into play, especially developed by Colin W. Clark in economic terms to incorporate fisheries into a capital-theoretic framework (Clark Colin W, 1975).

As an alternative, away from economics, researchers are beginning to analyze management methods for limited resources. A special attention is given to institutions as an organizational tool. Among them, the work of Elinor Ostrom (1990) shows the way. Indeed, in her approach, she was led to build a deep institutional theory that has a more general scope. This theory is guided by a certain social and political vision, centered on the virtues of "self-governance" and "polycentric systems". This vision is illustrated by a recurring statement that is at the heart of her analyses: the market and the State are not the only possible forms of organization of economic relations. In a large number of situations, and particularly for the management of CPR, allowing individuals to organize their relationships on their own can produce better results than using public intervention, as well as the market. Furthermore, Berkes, Feeny, McCay, & Acheson, (1989), give a further definition of CPR by describing them as resources for which exclusion (or control of access) of potential users is problematic. The physical nature of the resource is such that controlling the access of potential users is costly and, in some cases, virtually impossible. Finally, common-property resources are characterized by subtractability; each user is capable of subtracting from the welfare of others. This characteristic creates a potential divergence between individual and collective economic rationality in joint use. As the number of fishing boats increases, the catch per unit of effort for each declines (Berkes et al., 1989).

Hardin’s Tragedy of the Commons (1968) demonstrates, irrational and rational behaviors play a significant part in the management of a resource. The theory of uncooperative games is elaborated, and more specifically the prisoner's dilemma. In its most general definition, which can be applied to both material resources and common knowledge, any "resource shared by a group of people" is considered a common resource (Ostrom & Hess, 2007). The prisoner’s dilemma consists in a non-cooperative game in which all the players possess complete information and are aware of the game tree and the payoffs linked to the outcome. In this game, each player has a dominant

strategy as in they are always better off choosing this strategy – to defect no matter what the other players choose (Ostrom, 1990; p.5). For Elinor Ostrom, the prisoner's dilemma is an emblematic representation of situations where "rational individual behaviors lead to collectively irrational results" (Ostrom, 1990; p.5).

We see that Ostrom and her institutional approach to managing Common Pool Resources (CPR's) have several objectives:

- Analyzing the different individual behaviors in complex and uncertain CPR situations
- Understanding the organization problems facing individuals in CPRs and how to avoid the adverse outcomes

This general problem can be solved, according to Ostrom, by two external agents through two theories: the theory of the firm and the theory of the state. These explain how institutions are supplied and how commitment is obtained and how commitment of the agents and subjects are effectively monitored using in one case the firm and the other the state as organizational device (Ostrom, 1990).

What arises from these studies is the fragility in commons. Fisheries suffer from overcrowding and rent dissipation, institutions (thereby the state) are not able to solve the multi-faceted issues considering the complexity of the different groups involved. Not only in these situations they are too many fishermen chasing too few fish but destructive methods employed severely damage their primary resource. Finally, the intervention of the state in taking a more active role can have either a positive or negative outcome.

## 2.2 The Economic Theory of a Common-Property Resource: The Fishery (1954)

In the first half of the 20th century, there was much discussion over the fishing industry and the depletion of some commercial stocks, led mostly by biologists. They produced works on the first phase of the fishing industry and eventually were forced to extend their scope into the economic sphere.

Gordon acknowledges that biology theories, which were numerous, focused mainly on environmental factors and the biology of the various commercial species, since these species represented the only data available and funds were allocated to these research programs. Nevertheless, little had been done about the economic characteristics of the fishing industry (H. Scott Gordon Press, 1954). In Gordon's view "the work of biological theory in the fishing industry is to delineate the ecological system in which a particular fish population is found (…) Despite this, however, the ecosystem of the fisheries biologist is typically one that excludes man."

Yet he argues that "the overfishing problem has its roots in the economic organization of the industry".

He illustrates by proposing an example: each fisherman has two different fishing grounds available and can either go to ground 1 or ground 2. In adding the free access and competitive nature of fishing, each of these fishermen will try to catch an average number of fish proportionate with their fishing capacity. Finally, the lack of attention given to the cost side of fishing and the attention to the production side of the problem with control measures designed solely by biologists are believed to have generated a great deal of frustration among fishermen (H. Scott Gordon Press, 1954).

He describes, in his paper that examines the economic theory of natural resources utilization regarding the fishing industry, that most of the problems of "depletion" or "overexploitation" in fisheries are, in reality, manifestations of the fact that the natural resources of the sea yield no economic rent for future periods (H. Scott Gordon Press, 1954).

## 2.3 Tragedy of the Commons (1968)

Marine fisheries conservation that involves both the biological and physical conservation of oceans habitats and ecosystems, and fisheries management that focuses on harvested species, are at a cross-road. The past fifty years have witnessed a massive expansion in fishing capacity that has overexploited many fisheries to the point that reducing fishing would increase overall profits from harvesting (Grafton, Kompas, & Hilborn, n.d.) perhaps by as much as US$50 billion per year (World Bank, 2008).

However, the level of effectiveness of conservation and fisheries management depends on a profound individual behavior. The use of a common ground by several individuals will increase as the group starts to prosper and settle down; Aristotle already observed long ago “what is common to the greatest number has the least care bestowed upon it. Everyone thinks chiefly of his own, hardly at all of the common interest; and only when he is himself concerned as an individual” (Hardin, 1968).

In 1954, before Hardin’s article, Gordon had already exposed the same dynamic in the paper discussed in the previous section: “There appears, then, to be some truth in the conservative dictum that everybody's property is nobody's property. Wealth that is free for all is valued by none because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another… the fish in the sea are valueless to the fisherman, because there is no assurance that they

will be there for him tomorrow if they are left behind today" (H. Scott Gordon Press, 1954)

The expression "Tragedy of the Commons" refers to a paper written by the biologist Garrett Hardin in 1968. He explains in it what could be the main reasons of the collapse of the commons; he uses the example of herdsmen who all have cattle grazing over a common land. Each of them will put as many cattle as possible in order to maximize individual gain (Hardin, 1968). The tragedy happens when each herdsman from a rational perspective, add one more animal after the other until the common ground has reached its maximal capacity. Hardin's model provides insight about the divergence between individual and collective rationality. But it fails to take into account the self-regulating capacity of users (F Berkes, D Feeny, BJ McCay, 1989)

Hardin's "tragedy of the Commons" is a major theoretical contribution to the study of common resources and sets the main problem arising from overpopulation and its impacts. It describes through a clear metaphor the catastrophe that may occur when rational individuals act alone in their own interests and not towards a common goal. However, Hardin's essay attempts to find principles for managing everything from parking lots to air and water on earth.

### 2.4 Bioeconomics of the ocean: The economics of fishing and modern capital theory: A simplified approach (1975)

We are living in a world with limited resources. By the 20th century it was widely recognized that ocean fisheries needed management strategies to prevent them from overexploitation and, eventually, collapsing. "Oceanic fish stocks are inexhaustible; no amount of fishing will ever destroy these stocks". This idea, strongly advocated by T.H Huxley by 1883 and reported by Gordon (H. Scott Gordon Press, 1954), has been completely denied as demand increased and technology developed.

At the beginning of the 21st century, worldwide fisheries are in a state of crisis. Extreme overfishing of many species, especially mammals and top predators, in many areas, is widely documented (e.g. Myers and Worm; 2003). Yet, there are signs of hope as new management measures are being introduced. These new strategies recognize both the biological and the economic factors of fishing.

Following the works of Gordon (1954) on the economic theory of common-property resources, bioeconomics of fisheries management intend to strengthen management of fisheries with scientific-based analysis, mathematical modeling and empirical studies.

One of the most influential economists in natural resources, specifically the management of commercial fisheries, is Colin W. Clark. While the idea of considering fish stocks as natural capital and applying a dynamic approach to fisheries management was raised by Anthony Scott in his 1955 article entitled "The fishery: the objectives of sole ownership", it is Clark and Munro's (1975) rigorous analytical methods that make the problem traceable, introducing what would become a standard approach to the dynamic problems of optimizing fisheries and other renewable natural resources. In contrast with the Gordon-Schaeffer model, which is a static model for single-species, Clark uses a dynamic approach.

When I refer to the Clark-Munro model, I consider the ability to study stock stability, which is incorporated into the optimal approach to equilibrium stock, i.e., the optimal “investment” policy. Also, I consider the ability to analyze transition from initial states to harvest equilibrium and the role of the social discount rate. In their model, Clark and Munro state that the optimal stock is the one at which the own rate of interest of the stock is equal to the social rate of discount (Clark Colin W, 1975).

## 2.5 Governing the Commons (1990)

Common-property resources have been studied thoroughly by scholars from an institutional perspective to determine successful Common Pool Resources (CPR) management strategies. In 1985, the National Academy of Sciences sponsored a conference in Annapolis, Maryland to discuss common property management. This conference was a landmark for the development of the theoretical underpinning of institutional design for CPR’s success.

As a result, an international network strong of 2,000 researchers was created and dedicated to studying CPR issues in any field it may apply. In 1989, the International Association for the Study of Common Property (IASCP) came together. Leading this intellectual movement was Elinor Ostrom with her book *Governing the Commons.* The book addresses how common pool resources may be managed successfully without falling into the trap of “the tragedy of the commons”. Here, Ostrom drops the term

common property as a starting point and uses instead “common pool resources”, which refers to a term used to describe oil and groundwater deposits.

Problems in CPRs arise when an individual decides that he is entitled to the common resource even when he does not contribute to managing it in a sustainable way. Also called as the free rider problem, Olson (1965) gives a thorough analysis of the logic in his book *Logic of Collective Action* which followed the Prisoner’s Dilemma (PD) on which an extensive literature has been dedicated to it (more than 2000, in 1975) often coming to the conclusion that the common pool resources will eventually collapse (Ostrom, 1990; p.5). Usually two solutions are given to address prisoner dilemmas in CPR: the intervention of a centralized government or resource privatization.

Ostrom offers a third alternative, which is the creation of durable cooperative institutions that are organized and governed by the resource users. She noticed that in some cases, neither the state nor the market seem to be successful in managing common natural resources in the long run whereas individuals from different communities putting their trust in institutions governed neither by the state nor the market have had better results managing some resource systems over long periods of time (Ostrom, 1990; p.13-14).

She analyzes small-scale communities, which have recently been acknowledged by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) to hold a crucial role in biodiversity management, especially when these communities are indigene ones (IPBES Chapter 1, 2019). Ostrom focuses on communities between 50-15,000 individuals who are dependent upon common pool resources for their economic welfare. In making the analysis she has narrowed down the criteria of the research by excluding non-renewable resources, resources that are plentiful and situations which create substantial externalities. These selection criteria were chosen for several reasons. First, the relatively small size of user groups allows researchers to study existing institutions in depth. Second, resource scarcity means that users will have strong incentives to manage their resources in a sustainable way. Finally, economic dependence ensures that the failures of those who appropriate resources cannot be attributed to economic indifference (Ostrom, 1990).

One of the successful examples she offers is the fishery in Alanya, Turkey. The early 1970s were considered as “the dark age” for it. Composed of about a hundred fishermen, it was threatened economically by the incessant use of available resources, leading to tensions between the various local fishermen. This growing competition led to an increase in production costs and the harvesting capacity of each boat. Then, some members of the cooperative had the idea of creating a system for allocating fishing sites to local fishermen. After a decade of errors and corrections, they finally reached a regulation allowing a better distribution of fishing effort. Local authorities took part in the process but fishermen are the ones to monitor and enforce the rules set. This case coincided with the debate happening at the time about “The Law of the Sea” for a better economic jurisdiction in coastal waters.

Exclusive Economic Zones (EEZ) play an important role in resource management. They were proclaimed by some countries before any international agreement was ever reached. This situation led to conversations between most countries in the world. As a result of this debate happening at the time, in 1982, nearly 120 countries signed the new United Nations Convention on the Law of the Sea (UNCLOS). They provide countries with a 200 nautical miles area seaward from the coast, on which they have economic rights (UN, 1982). The jurisdiction in national waters and high seas are very complex and often lead to various interpretation of the law, which undermines the effectiveness of multilateral governance rules in attempting to build a common framework and promote sustainable, legal practices. As a matter of fact, most states believe in the extension of their rights to manage all living resources within their EEZ (W. T. Burke, 1989). Tensions arise in ocean regions where high seas border EEZ’s and foreign and domestic interests enter into conflict over a similar stock since fish knows no borders. However, Regional Fisheries Management Organizations (RFMO) jurisdiction only concerns high seas and not EEZ (Agnew et al., 2009).

Ostrom agreed with Hardin (1968) that open-access resources that belonged to no one are vulnerable, but disagreed when it came to limited-access resources. In some cases, the resource had existed for centuries. This is where the concept of property rights comes into play, explaining how common usage had sustained the resource.

## 2.6 Social theory and fisheries co-management (1998)

After Ostrom (1990) many scholars have contributed to this third alternative to centralized powers or privatization. Among them, Svein Jentoft, Bonnie J. McCay and Douglas C. Wilson (1998) explore the approach of "co-management". This term refers to "a collaborative and participatory process of regulatory decision-making among representatives of user-groups, government agencies and research institutions" (Jentoft, Mccay, & Wilson, 1998)

In this paper, they address the problems that co-management policies may encounter. First, the authors present the benefits of co-management before addressing the main criticisms. In a second step, they define the framework within which they present their analysis. They are analyzing co-management from an approach of embeddedness and rational choice. Then, they explore the different perspectives offered by the institutional approach to co-management. Moreover, they explore the notion of community by defining it and argue how difficult it is to create a group dynamic with so many actors involved, especially in the fishery industry. They conclude with a social representation of a community in the collective imagination and property rights.

The theory of co-management has specifically helped in explaining the reasons why the return to a bottom-up approach, involving civil society and direct users, is appropriate at a time when governments and industrials only talk about self-interest, markets and maximization of profits. However, in the introduction of the paper, the authors acknowledge the skeptical point of view in regard of co-management which defines it as "a remnant of the past that requires a particular foundation with cooperative and communal values that has become rare in the context of an industrialized, high-tech, and increasingly globalized fishery. Thus, it seems naive to assume that co-management will transform what has become an extremely competitive and often antagonistic relationship into a cooperative and more responsible one" (Jentoft et al., 1998). They stress the fact that co-management should be seen as a "set of principles for institutional design that can assume various organizational forms depending on particular circumstances". The failure of co-management policies may be the result of external factors such as the institutional or social framework surrounding it (Jentoft et al., 1998).

Nonetheless, they argue that critics are too pessimistic and come from an overly narrow social theory about the role and nature of institutions (Jentoft et al., 1998). It is believed

that co-management eliminates what is perceived as a distant, impersonal and insensitive bureaucratic approach that now characterizes the role of government in fisheries management. Instead, responsibility for management functions is decentralized and delegated to user organizations at the national, regional and/or local level.

## 2.7 Definition of overfishing from an ecosystem perspective (2000); Ecosystem overfishing in the ocean (2008)

The ecosystem perspective as S.A Murawski (2000) presents in his paper is a complex one. It stresses the difficulty to assess when, where and how much to fish because of the lack of sufficient science to assess the full range of potential interaction among species, their physical environment and the policy choices that must be made (Murawski, 2000). Fishing has the potential to deplete fish stocks, trigger indirect effects in marine population communities, and modify the structure and the function of marine ecosystems. The cascading effects of fishing exploitation and environmental variability are often leading to failure in fisheries management (Coll, Libralato, Tudela, Palomera, & Pranovi, 2008).

Increasing harvests and growing pressure on marine ecosystems from the fishing industry, led to the creation of ecological indices. Three of them are: the Primary Production Required (PPR), the mean Trophic Levels (TL) and the Fishing in Balance index (FIB) which includes the Transfer Efficiency (TE) of energy flow in the food web and the TL of caught species. PPR is achieved by primary producers, also known as autotrophs. It is the first link in a food chain in a food web. The Trophic Level measures the position of a species in the food web. And the FIB index allows to control if sustainable ecological levels are achieved over a certain time of fishing activity (D Pauly & Christensen, 1995). Knowing how fishing affects a species and consequently the marine ecosystem in which the latter evolves, would help decision-makers to make the industry more sustainable. Scholars have been arguing that the removal of some species, which are part of secondary production, have led to a depletion of higher trophic levels (Coll et al., 2008). Cases of overfishing have been reported across the globe between 1950 and 2004 as the result of vast expansion in global fishing and technological advances allowing vessels to fish more and deeper (Coll et al., 2008).

Fish catches represent the first source of food from the ocean and the fact that large predators, such as Tuna or Codfish, are targeted for human consumption, it eventually

led to the depletion of their population. In the North Atlantic, populations have shrunk of 2/3 in the past 50 years. The intensification of fishing efforts in this area is responsible for this decline. As a result, there is a relative increase in populations of small fish and invertebrates lower down the food chain. This increase has led to a decline in the average position of fish caught in the food chain (average trophic level) since the 1970s. The Marine Trophic Index, which measures changes in the mean trophic level, can be calculated from existing fish catch data and is therefore a very reliable indicator of the health of an ecosystem and the sustainable use of its biological resources.

According to the FAO guidelines, the key features of the ecosystem approach to fisheries and aquaculture are based on a participatory risk-based management process adapted to these sectors. Some of the features include:

- Wide stakeholder participation at all levels of planning and implementations
- Key components of a fishery or aquaculture system (ecological, social, economic and governance) as well as external drivers (e.g. climate change)
- Reconciliation of environmental/conservation and social/economic management objectives including explicit consideration of trade-offs between them (FAO, 2018a)

## 3. EMERGING ISSUES

There are increased concerns about whether fish stocks will be able to feed human populations while maintaining them at sustainable levels. Overfishing, Illegal Unreported and Unregulated (IUU) fishing, poor management practices, global food trends such as the sushi market, have put our marine resources under great pressure. In addition, external drivers like climate change, ocean dead zones and plastic pollution are growing global issues that threaten the livelihood of millions of people. The FAO estimates that fisheries and aquaculture support the livelihoods of 10-12% of the world population (FAO, 2014).

### 3.1 Feeding a growing world population

#### a) An increasing population that needs to be fed

A growing human population and growing per capita demand for food, nutrition and other goods and services means an expansion of fisheries and aquaculture activities in the oceans and inland water bodies and along the coasts, and increased pressure on the environment and on the use of other resources. Pressure on aquatic and coastal ecosystems is increasing even faster than the number of people on the planet (NOAA, 2013; Neumann et al., 2015).

To keep pace with population growth, it is estimated that in the next 40 years food production must increase greatly with the limited availability of arable land, water, and fossil fuels, exacerbated by climate change (ISF 2011). 815 million people in the world face starvation and two billion people suffer one or more micronutrient deficiencies, especially vitamin A, iodine and iron, often lumped as hidden hunger (FAO, 2018b)

Several factors of population growth require a global attention. While, in general, world population growth is slowing down, some regions population will continue to grow well beyond 2050 (especially in Asia and Africa) and even into the next century with more people living in urban areas than in rural area. Urbanization has been accompanied by a transition in dietary patterns and has had great impact on our food systems (FAO, 2017). Ageing, as a trend, is projected to increase both in urban and rural areas, which will lead to a more populous and demographically older world. The share of young children is likely to drop by 5.8%, while the proportion of older people is expected to rise to 22.7% (UN, 2015).

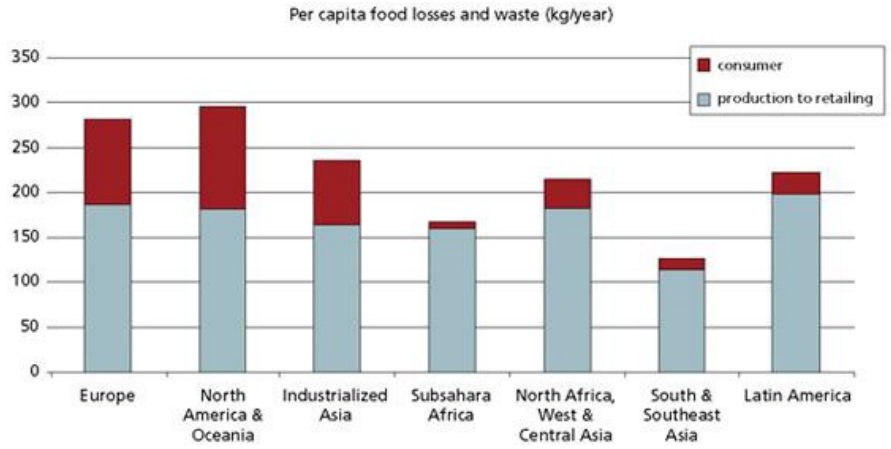
As a result of this growth, demand for food is projected to increase by 50 percent between 2012 and 2050 (FAO, 2017). But soon, the world might face an intensified competition for natural resources as overexploitation; destructive methods and unsustainable use drive them to dangerous levels of scarcity (Alexandratos & Bruinsma, 2012). Pressures on coastal and marine biodiversity continue to increase, as an estimated 40 percent of the world's population lives within 100km of the coast. Therefore, seafood security and sustainable development of coastal areas are vital for the generations to come (FAO, 2018a).

### b) Food waste in the global food chain

As the world population is expected to grow to 9 billion people by 2050 and 11 billion people by the end of the century (FAO, 2017), the inequalities are worsening and food

security is one of them. This is of urgent concern as 80% of the world's undernourished children live in just 20 countries (Darnton-hill & Pelletier, 2008). As awful as it may sounds 10 children die of hunger every minute in the world and this staggering rate adds to the fact that worldwide 1.3 billion tons of food gets wasted or thrown away. According to the FAO, Food losses and waste amounts to roughly US$ 680 billion in industrialized countries and US$ 310 billion in developing countries. Industrialized and developing countries dissipate roughly the same quantities of food — respectively 670 and 630 million tons.[2]

Chart 3.1 (source: FAO)




For example, food losses in low-income countries occur throughout food value chains, owing to managerial and technical limitations in harvesting, storage, transportation, processing, packaging and marketing. While food waste in middle and high-income countries is caused mainly by consumer behavior and by policies and regulations that address other sectoral priorities (FAO, 2017).

Nutrition should be a priority at national and sub-national levels because it sits at the heart of human development, social and economic development (Darnton-hill & Pelletier, 2008). Unsustainable agriculture systems and change in dietary habits are threatening global biodiversity and consequently the livelihood of billion of people in the world (FAO, 2018b).

### c) Food waste in the fishing industry: overexploitation and fish discards

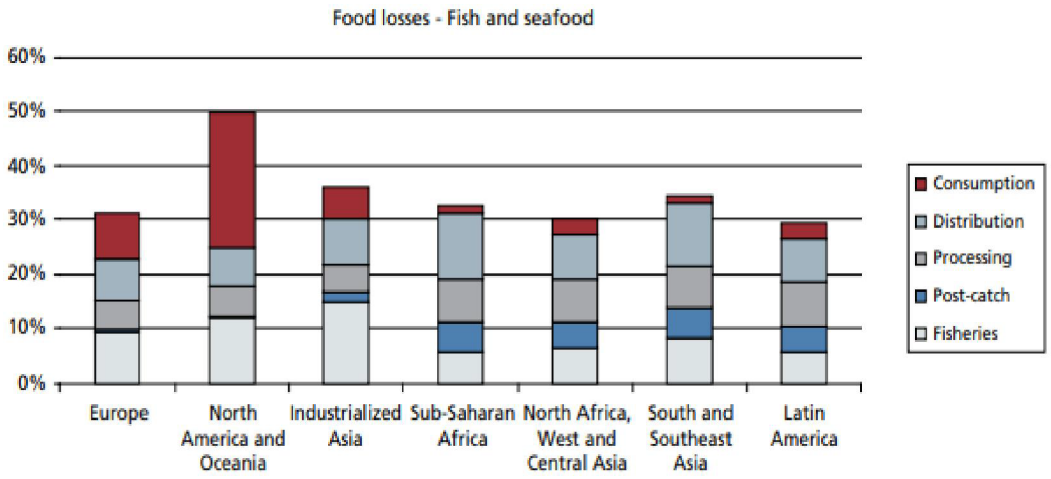
[2] FAO key information on food losses and waste: http://www.fao.org/save-food/resources/keyfindings/en/ consulted on 10/03/19

As far as fishing is concerned, the industry wastes or throws back into the sea, on average, 35% of the catches (Jenny Gustavsson, Christel Cederberg, 2011), the equivalent of 3 billion Atlantic salmon. Fish that are thrown into the sea are, most of the time, dead, dying or seriously injured. The FAO identifies for the fishing industry that fish discards represent currently 8% of total catches, which has significantly improved since the first report published in 1994 estimated the discards at 27 million ton (Jenny Gustavsson, Christel Cederberg, 2011).

Chart 3.2 (source: FAO)


The part of fish discarded, lost or wasted is much higher in industrialized regions, especially in Europe, North America and Oceania, followed by Asia. The highest rate of loss being at consumption stage in those regions, better consuming practices should be advocated. For example, Supermarket policies, such as consumption deadlines, which often lead to excessive amounts of food being wasted in combination with the careless attitude of consumers who can afford to waste food, need to be revised (Jenny Gustavsson, Christel Cederberg, 2011).

Chart 3.3: Part of the initial catching (fish and seafood harvested) discarded, lost and wasted in different regions and at different stages in the FSC (source: FAO)




It is widely accepted that there is a severe problem with future global food security. Driven by substantial world population growth, demand for fish protein continues to increase, but a large number of fish species are already overexploited and therefore are not able to produce their maximum sustainable yield (FAO, 2018a). Fish losses contribute to food insecurity, especially post-harvest loss and waste, which typically occur in countries that can least afford to waste a valuable source of food and nutrition. Removal of fish contributes to reduced availability of a given population. Both types of loss result in negative impacts on consumers whom have access to less fish or fish of lower quality (FAO, 2018a).

## 3.2 Human consumption trends

People have never consumed as much fish as they do today, with per capita global fish consumption having doubled since the 1960s. In per capita terms, food fish consumption grew from 9.0 kg in 1961 to 20.2 kg in 2015, at an average rate of about 1.5 percent per year. Preliminary estimates for 2016 and 2017 point to further growth to about 20.3 and 20.5 kg, respectively (FAO, 2018a).

### a) Sushi trend: a symbol of a global established trade

The study of the sushi market today is of particular interest to scientists, from a sociological and commercial point of view. Not only does this allow us to appreciate the creation of a highly complex global network, but also to focus on the scale of human activity such as fishing linked to a trend. Bestor (2000) gives us a rigorous analysis of how sushi went global in his paper and this section highlights how deeply rooted and quickly the sushi trend established itself.

Japan's most refined culinary tradition, sushi, went global in a matter of a few decades. The global integrations between the west and non-west through the boom of sushi started forming first, around the 1960s and 1970s in North America, and then quickly spread to the rest of the world (Katarzyna J Cwiertka, 2001). Nowadays sushi bars can be found everywhere in Europe, Asia, Latin America and some parts of Oceania, symbols of a modern process of capitalist globalization in the food industry, which is impacting fishing communities throughout the world.

Due to advances in technology and increasing efficiency within transatlantic trade in respect to food, sushi has become a dietary staple in most parts of the Western world. This transition has had a dramatic effect on the fishing industries as sushi has increased in demand. In fact, the success of sushi has come to influence how fishing around the world is done. Its rise as a status symbol and its overwhelming demand has even shifted the American fishery towards tuna, a species that was barely suitable for cat food a few decades earlier. Although the Japanese economy and demand for sushi stagnated at the height of sushi exports, the Americans took over and adopted it as a status symbol (Bestor, 2000).

Simultaneously, Bestor documents that Japanese trade firms and large scale Spanish fishing companies have set up farms using the latest in Japanese fishing technology. The workers may be locals but the techniques employed are part of a global flow backed by major foreign capital. Highly organized fisheries structures have emerged as a result of a more organized industry that revolves around tuna with at its center, the Tsukiji market in Tokyo. This command post for global seafood trade deploys enormous amounts of Japanese capital around the world to make sure operations keep running smoothly. These global food networks have not only transformed food consumption patterns and food culture in places like North America and Europe but they have changed people's livelihood. Indeed, because of the globalization of trade and a sushi rush to the four corners of the world, fishermen and their families now rely on unfamiliar tastes and distant markets to sustain themselves. But they are also vulnerable to disasters halfway across the world (Bestor, 2000)

Many scholars have drawn conclusions on the formidable expansion of the sushi trade. While Issenberg (2007) argues that the sushi trade reveals itself as "a virtuous global commerce (…)" and a proof that a "(…) food culture exists", Bestor (2000) draws on

the knowledge of economic anthropology and sociology, which emphasize the cultural and social anchoring of economic processes and institutions, rather than considering the global sushi trade as the inevitable result of market forces (Carroll, 2009).

**b) Tuna management**

This section provides an overview of how management of the different tuna stocks is organized, why they are targeted, and a case study regarding one of them; the Atlantic bluefin tuna. The current state of this species is contested, but the International Union of the Conservation of Nature (IUCN) continues to put them on their Red List of Threatened Species[3].

It makes no doubts that world tuna fisheries are under threat of overexploitation and require better management practices. For a few stocks (albacore, southern bluefin, Pacific bluefin and Atlantic bluefin), fishing mortality is above maximum sustainable yield (MSY) as shown in formal assessments by each of the tuna Regional Fisheries Management Organizations (RFMOs) (FAO, 2010).

All the world's tuna and tuna-like species are the subject of research and management by RFMO's. Among them, the major ones are the International Commission for the Conservation of Atlantic Tunas (ICCAT) for the Atlantic Ocean; the Indian Ocean Tuna Commission (IOTC) for the Indian Ocean; and the Western and Central Pacific Fisheries Commission (WCPFC) and Inter-American Tropical Tuna Commission (IATTC) for the Pacific Ocean. In the Pacific Ocean, another international organization, the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) is responsible for the provision of conservation and management advice for North Pacific stocks, whose distributions cross the border of IATTC and WCPFC.

These stocks are mainly fueling three global markets:

- Sashimi market
- Fresh and frozen tuna (non-sashimi)
- Canned goods

[3] https://www.iucnredlist.org/species/21860/9331546 consulted on 7/04/19

**Box 1:**

**Atlantic bluefin Tuna: an emblematic case of overfishing**

In 2013, Kiyoshi Kimura, the owner of a Japanese restaurant chain, paid $1.78 million for the first tuna, which weighed 489 pounds. Each year, on the first Saturday of January, Japan opens an auction to put an exorbitant price on the head of a single bluefin tuna. This tuna auction takes place at the famous Tsukiji fish market in Tokyo and represents many different things: a growing consumer demand for bluefin sashimi, the exploitation of natural resources and the collapse of an entire species. Behind this popular event hides a terrible reality: shortsightedness of preventing a greater danger, the collapse of the oceans.

Bluefin catches are managed –the word is used here loosely –by the ICCAT based in Madrid, which includes the European Union (EU), Japan, Canada and Brazil. In 2008, ICCAT scientists recommended that the bluefin catch in the Eastern Atlantic and the Mediterranean be limited to 15,000 tons. Instead of that the catch limit adopted was of 22,000 tons. As a result, overfishing and poor management have caused collapse of tuna stocks, such as the western Atlantic bluefin tuna and failing catches indicate a fishery running out of time (Safina Carl, 2008).

Tuna in the ocean are an open access resource, because there are no property rights to fish in the ocean and no one can be prevented or prosecuted from fishing in there. Several factors have made this fish very popular. Indeed, bluefin tuna is the most commonly used for sushi, and its growing demand does not seem to be stopping. Its increasing value induced a sharp increase in the fishing efficiency and capacity of various fleets during the 1990s and 2000s, especially in the Mediterranean Sea. Since 1960 tuna catches have decreased by 75%, well below maximal sustainable yield (MSY). Adding new storage technologies and farming practices introduced in the late 1990s have led to a severe depletion of tuna (Fromentin, Jean-marc; Ravier, 2014).

**Box 1 (continued):**

**Historical background**

Atlantic bluefin Tuna has been constantly fished since antiquity, and was once considered as low quality fish and grounded up into cat food. But it has become highly profitable with the development of the sushi-sashimi market in Japan, expanding later on throughout the world (Fromentin, Jean-marc; Ravier, 2014). Tuna is a pelagic predator and highly-migratory fish of large size spawning in warm waters and feeding in cold waters. The International Commission for the Conservation of Atlantic Tuna (ICCAT) considers tuna as two different stocks. This delimitation was based on several information such as spawning sites (western Mediterranean, Gulf of Mexico), traditional fishing grounds and age-at-maturity (ICCAT, 2014). Its dramatic decline was covered by the media as much as it can possibly be and was described as the archetype of overfishing and mis-management.

**Stateless fish**

The high Japanese demand for bluefin tuna has created a "gold-rush mentality" on fishing ground across the globe. Tuna travels long distance at a fast pace across the Atlantic. The species range from equatorial waters to the Mediterranean Sea and therefore swims across multiple national jurisdictions which require regulations for a stateless fish (Bestor, 2000)

## 3.3 Illegal, unregulated and unreported fishing

Illegal, unregulated and unreported (IUU) fishing can lead to severe depletion of fish stocks and eventually drive an entire system to the brink of collapse. It contributes to overexploitation and is a hindrance to the recovery of fish populations and ecosystems. In 1999, the FAO acknowledged in its 23rd session that IUU should be treated as a high priority matter. As a result, two years later, the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU) was adopted within the framework of the Code of Conduct for Responsible Fisheries (FAO, 2001). This section introduces the main problems that IUU fishing poses, the economics

and environmental impacts, and the difficulties to monitor and estimate it. Two case studies are used to show the scale of IUU fishing across the planet and how it threatens people's livelihood.

### a) What is IUU?

IUU fishing is found in all types and dimensions of fisheries; it occurs both on the high seas and in areas within national jurisdiction. IUU fishing is a very complex issue. The largest component of it will be discarded bycatch of non-target species but still important for local communities and ecosystems. Illegal catch refers to catch deliberately concealed, or misreported as other species to contravene regulatory limitations. It also includes unreported harvests landed in foreign ports or trans-shipped to foreign vessels at sea. It is the most difficult component of IUU to quantify as an accurate record may be hard to obtain (Ainsworth & Pitcher, 2005).

The FAO broadens the definition of IUU fishing with some additional elements:

- Fishing by "Stateless" vessels.
- Fishing in convention areas of Regional Fisheries Management Organizations (RFMOs) by non-party vessels.
- Fishing activities which are not regulated by States and cannot be easily monitored and accounted for (FAO(b), 2016)

### b) Economics and environmental impacts

According to estimations, current illegal unreported fishing losses worldwide account between $10bn and $23.5bn annually, representing between 11 and 26 million tons (of landed fish, discards and artisanal catches are not included in these figures) (Agnew et al., 2009).

**Box 2:**

**IUU in West Africa: Serious concerns**

Fish is a highly nutritious source of essential fatty acids, contributing to nearly 50% of animal protein intake in many countries of the South: Bangladesh, Gambia, Senegal, Somalia, and Sierra Leone, to cite a few... In Africa, during periods of drought, seafood has long been a relief food resource, as in Somalia in 1974 and 1975, when the pastoral economy had been devastated (J. Mora, 2012). But since the major players in the sector - Europe, Russia, South Korea, Japan and now China - have been moving in tropical waters off the African coast, they have been competing with small-scale fishing and directly endangering the countries' food self-sufficiency. They also threaten some of the most diverse marine ecosystems in the world.

Today, there is a major governance crisis playing out on the Western African coastline (from Mauritania to Nigeria), which is experiencing some of the worst IUU fishing, losing overall $1.3 billion to illegal fishing (Africa Progress Panel, 2014). Some 50% of fisheries resources have already been overfished (FAO, 2011). This is affecting greatly the livelihood of small-scale fishing communities in WA and seriously damages these African countries' economies.

Although the 2009 Port State Measures Agreement to tackle IUU fishing was introduced by the UN, most of the vessels fishing illegally nowadays are unregistered. This fact is due to weak governance in the affected countries, which fail to implement it. According to the AFP illicit outflows in African fisheries account for $50 billion a year which equals 5.7% of Africa's GDP and exceeds regional public spending on health (Africa Progress Panel, 2014).

Industrial trawlers fishing in WA compete against and contribute drastically to the collapse of artisanal fisheries – an activity that supports millions of people in coastal areas. Not only it plunders the oceans ecosystems but seriously put at risks people working in the fishing sector and threatens a vital source of food. Fisheries are estimated to employ, directly or indirectly, 600,000 people in Senegal (Africa Progress Panel, 2014) and more than 160,000 people in the Democratic Republic of Congo – not including the thousands of jobs in fish processing plant in which most workers are women (FAO, 2014). In countries like Ghana, Gambia and Sierra Leone, fish provide 60% of the animal protein required for a healthy growth and in some rural coastal areas; people entirely depend on fish to sustain themselves (M. Gutierrez, 2016).

### c) Assessing and Monitoring IUU

Poor quality management of fisheries often leads to increased IUU fishing activity. The political institutions and fishing communities usually play an important regulatory role, but they can be overrun by a wide range of issues. IUU fishing is more likely to happen in countries whose monitoring is particularly limited or where governance is weak due to political instability or lack thereof (FAO, 2018a).

Assessing illegal and unreported fishing represents a challenge because of its complexity. There are good reasons for that. While we have tools to analyze spatial and temporal patterns of global fishing effort (the Automatic Identification System, for instance), we now know that fishing fleets have expanded to all world's oceans with increased power capacity (R. A. Watson et al., 2013), making it difficult to assess the actual degree of IUU fishing. As of 2010, around 1900 Chinese fishing vessels operated in the waters of 32 countries, some as far away as West Africa, generating an annual catch worth $1.8 billion (Moore, 2016) and symbolizing the difficulty to determine who is illegally fishing or not. Vessels are highly mobile and tracking them is difficult.

**Box 3:**

**The Chinese case**

China is the world's biggest producer in terms of fish production, yet its fisheries management is paradoxically unknown (FAO, 2012). In its 2016 report, the FAO highlights that in 2014, China accounted for just over 18% of global catch; by 2030 China is projected to account for 38% of global marine catch more than double any other region (the FAO consider China as a region) (FAO, 2016).

The growth of the Chinese middle class over the past 40 years or so has driven up demands for all sorts of luxury goods in the country. There has been a higher demand for high-quality seafood, which comes at the most inopportune time.

In order to sate its population's raising desire for fish; the People's Republic of China has been expanding its fishing fleets throughout the high seas (i.e., international waters) and, most likely is involved in illegal fishing practices in other countries domains. Distant-waters fleets have been encouraged to fish more and bigger fish, mainly through unsustainable fishing practices damaging the environment such as trawling.

Many clashes have recently occurred throughout the world involving China. In 2016, a number of Chinese vessels were fired at for fishing in other nation's exclusive economic zones, areas of waters off countries' coastlines where those nations have sovereignty over marine resources and their exploitation for economic purposes. In March 2016, according to Reuters, the Argentinean coast guards chased and sank the Lu Yan Yuan Yu 010, which attempted to flee into international waters after allegedly trawling illegally off the coast of the Argentinean city Puerto Madryn, an area known for squids; a blatant case of illegal fishing. These extreme measures highlight the growing tension between nations over natural resources.

The lack of data covering some regions leads to inaccurate figures and unaccounted species in global landings reports. In their paper, (R. A. Watson et al., 2013) have highlighted the lack of data regarding global fishing efforts. Fishing effort statistics, unlike global fisheries catch statistics, are not provided by reporting areas, so initially nothing is known about where the fleets fished. This had to be deduced from what is

known about catch. Global catch has been mapped (R. Watson, Kitchingman, Gelchu, & Pauly, 2004) but to do the same for fishing effort was more difficult because of the poor data quality generally.

After the mid 1970s, Exclusive Economic Zones (EEZ) were declared. This restricted access forced fleets from developed countries to negotiate access agreements with developing countries (R. A. Watson et al., 2013). However, these arrangements were considered more as business transactions. When reviewing global catch data, it seemed foreign fleets had disappeared, but an increased number of vessels under the resource provider flag followed. This "flag-hopping" is common practice, especially in West Africa, and it seriously undermines the anti-IUU effort (Agnew et al., 2009).

Recent years have seen renewed momentum regarding IUU fishing. The emphasis has been particularly on improving monitoring practices and reporting on catches through Port State Measures (2009). Retailers and processors have adopted a wide range of voluntary sustainable seafood standards, including a requirement that vessels have operational Automatic Information Systems (AIS) and IMO registration (Daniels, A., Gutierrez, M., Fanjul, G., Guerena, A., Matheson, I., and Watkins, 2016). Despite these tools and increased efforts, IUU has been flourishing around the world – stressed by the fact that illegal fleets always switch off the AIS or avoid registration to go unnoticed. On top of that, there is a widespread use of convenience flags, especially from states – such as Panama, Liberia, and the Bahamas – that are unable or unwilling to enforce existing regulations (Daniels, A., Gutierrez, M., Fanjul, G., Guerena, A., Matheson, I., and Watkins, 2016). Additionally, foreign companies set up joint ventures with local fishing companies to legally obtain licenses in order to fish in their waters.

Nowhere are the costs of unsustainable fishing practices more visible than in the world's poorest countries. According to the Environmental Justice Foundation (EJF), data collected in Guinea-Conakry's waters show that 53 out of 104 identified vessels were either connected to, or involved in, IUU fishing (EJF, 2009), some of which, after investigations, appear on the Directorate-General for Health and Food Safety's List (DG SANTE) to export their fish to the EU. Previously known as Directorate-General for Health and Consumers (DG SANCO) until 2014, this list contains all the information about countries importing goods into the EU, what they are importing and how much they are allowed to.

## 3.4 Fishing practices

The scale on which global fleets operate on the world's oceans today has increasingly negative consequences for the environment and marine ecosystems. Technological development in the 20th century improved fishing methods and capacity, on-board and on land storage, but also led to the destruction of breeding grounds for some fish species due to dangerous fishing practices. For example, midwater and bottom trawling are extremely destructive methods that not only catch many (unwanted) fish but also destroy a very fragile habitat that is struggling to recover.

This section provides an overview of a particular case of fishing practices in Europe: deep-sea trawling. It is a method used in high sea on various fishing grounds. In the Baltic Sea, fisheries are dominated by otter trawlers targeting roundfish or Norway lobster in soft sediment habitats. The main fishery of western Baltic cod is by trawlers. In the North Sea, the flatfish fishery is a fishery in transition. The persistent criticism of the environmental impact of fishing through seabed impacts, discards, by-catch of marine mammals and impacts on seabirds has been an important driver. The flatfish fishery in the North Sea is dominated, in terms of landings and fishing effort, by large vessels which deploy beam trawls. Three beam-trawl categories operate in the North Sea, i.e. the larger meshed flatfish beam trawl with plaice as the main target species, the smaller meshed flatfish beam trawl with sole as the main target species and the shrimp beam trawl. In the North East Atlantic, fisheries are managed by the North East Atlantic Fisheries Commission (NEAFC), one of the most abundant fishing areas in the world. Deep-sea fishing practices are mainly composed of trawls, longlines and gillnet in mixed species areas.

The remainder of this section highlights the direct or indirect effects of fishing practices, including environmental and economic ones through a case study: Indonesia.

### a) Deep sea trawling

In the European Union, deep sea trawling was banned in 2016 after four years of long and tough negotiations. This agreement aims at protecting deep-sea ecosystems well below 800m deep and up to 1500m. This comes after many years in which studies showed how damaging this method is. Indeed, in the Northeast Atlantic area, from Ireland, Scotland and Norway, where unique coral reefs have grown over centuries to

millennia, there have been signs of trawl marks thanks to photographic and acoustic surveys (Hall-spencer, Allain, Fossa, & Copernic, 2002). These scars are sometimes up to 4km long and characterized by parallel trenches where otter doors, rock hopper gear and nets have damaged epi-fauna, dragged rocks and turned-over sediments. These coral structures remain poorly known around the world and are an ongoing field of research. Therefore, there is growing concern over potential damage to deep-water coral reefs as they are built up over millennia, which could eventually affect the distribution of marine life (Freiwald & Henrich, 1999).

**Box 4:**

**The EU ban on deep-sea trawling: efforts diminished by lobbying**

It took four years of intense negotiations from the European Commission's initial proposal in July 2012 to be ratified, which was surprisingly rejected at first by the European Parliament in December 2013.

Despite this text bans trawling at depths greater than 800 meters in all European waters the final version was significantly watered down after intense lobbying effort from Spain, which was denounced by NGO groups such as Bloom. This ban largely resulted from NGO's campaigns like Bloom or Pew, which spent eight years advocating against the dangers of deep sea fishing, especially gill netting and trawling.

The area covered by the ban includes EU waters and the Eastern Central Atlantic Ocean, but does not cover the Northeast Atlantic, as the European Parliament had hoped. In the Northeast Atlantic, the catches – and related jobs – have been declining for years due to depleted stocks. The poor state of key deep sea stocks and the lack of scientific data clearly show the need for a better management framework for deep sea fisheries.

As of 2014, Spain's fleet was the largest in Europe, with 9,895 boats and a gross capacity of 379,209 tons. Its fleet is mainly fishing outside and therefore is effectively exempt from this ban.

Fishing efforts in the Northeast Atlantic have been declining drastically and have put fishermen out of business. This fishery went on largely unregulated until 2003 when the EU started imposing limits on the amount of fish that can be taken, on the numbers of vessels authorized and on the days that can be spent at sea to fish for those species[4]

According to a NEAFC report on deep-sea fishing in the North East Atlantic between 1973 and 2016, landings and effort in the Regulatory Area declined significantly in the most recent years in the period. Some Contracting Parties that previously fished deep-sea species in the Regulatory Area have barely fished there in the recent years (Russian Federation, after 2010) or in the entire period since 2003 (Iceland, DFG Greenland). The combined Regulatory Area landings of Deep-sea Species for all Contracting Parties for the period 2003-2015 suggest a declining trend after around 2008 to less than 2000 t in 2011-2012. The increase in 2014 and 2015 reflects enhanced fishing for grenadiers on the mid-Atlantic Ridge. The EU was the dominant party throughout the period 2003-2015 (NEAFC, 2018).

Chart 3.4 (Source NEAFC)

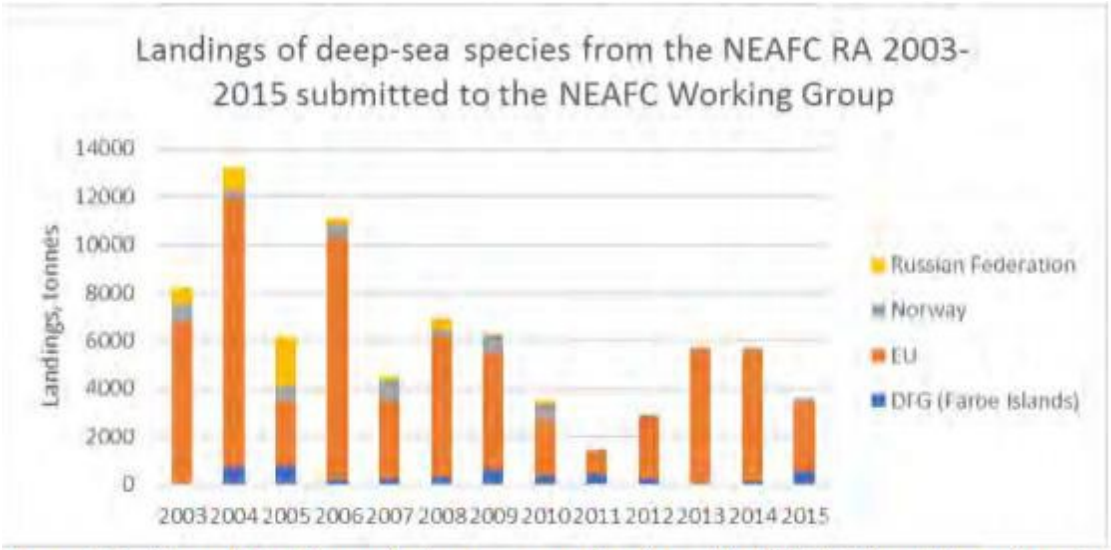



*Figure 6.1. Annual landings of deep-sea species from the NEAFC Regulatory Area in the years 2003-2015 as recorded by the WG in 2017.*

[4] Press release: Fisheries: the Commission tables new measures for better protection for deep-sea stocks and their habitats http://europa.eu/rapid/press-release_IP-12-813_en.html consulted on 3/05/2019

### b) Effects of fishing practices

The destructive effects of fishing practices are numerous and many books and studies have been devoted to documenting and raising awareness, particularly in developing countries and poor communities.

Considered as traditional practices, blast fishing and poisoning are widely spread across Indonesia, yet extremely damaging for coral reefs. Both activities are prohibited, but still widely used in remote, poor communities across Indonesia, a country where enforcing marine laws can be difficult (Heber, 2014). In her study about destructive fishing practices in Ende, Flores, Indonesia, Ramenzoni (2018) analyzes through a survey what local people think are the most important factors for environmental degradation; bombs and potassium cyanide ranked consistently as second and first cause (Ramenzoni, 2018).

The effects may be directly visible and affect the surrounding environment. One of the first effects of blast fishing is the death of fish and invertebrates that inhabit the reef. Commercial sizes and preferred species are killed but also unattractive living organisms, species and juvenile fall victim to the explosion as well. Secondly, reefs can no longer provide food and shelter to marine life and can take decades to recover, if at all. Moreover, protection of coastlines cannot be sustained against wave-action or storms and seriously expose coastal communities to natural disaster. Finally reef-related tourism, which holds great promise for alternative income generation on reefs that are not too remote, cannot be developed in areas which are being blasted. Even sporadic blast fishing can destroy the reputation of a scuba-diving area (Cesar & Pet, 1999)

The indirect effects related to destructive fishing practices include different aspects, as the impact is transferred through the ecosystem to its point of emergence or accumulates to the point that it becomes visible (FAO, 2009). Endangering larval or juveniles' survival by: damaging their living habitat; releasing fatal contaminants trapped in the sediments; increasing natural mortality by reducing structural protection in complex habitats (e.g. removing large boulders or crushing corals) is an example. The second example is related to economic losses as it may impact greatly local, regional and national economies in the long run. Reef at Risk in South East Asia (SEA) estimated in 2002 (L. Burke, Selig, & Spalding, 2002) that the net economic loss in Indonesia from blast fishing over the next 20 years will be at least US$570 million. The economic loss

from cyanide fishing is estimated to be US$46 million annually. As a result, the search for an effective solution to harmful fishing practices has become not only an ecological problem, but also an economic one (Heber, 2014).

# 4. EXTERNAL DRIVERS, ENVIRONMENTAL AND HUMAN DEGRADATION

## 4.1 Industrial fishing and artisanal fishing

Fishing has always been a traditional activity carried out by human populations to feed themselves. Long established fishing communities that rely on the ocean and its resources to support their lifestyle have been at risk for the past two decades as the considerable pressure exerted by the world's industrial fisheries on marine resources has increased. This section stresses how industrial fishing increases the pressure on marine resources and may be a hindrance to coastal communities' development and their fishing activity, but also acknowledges the importance and the weight of artisanal fishing. Then, the human impact of industrial fishing is considered, using the example of West Africa.

### a) The footprint of industrial fishing

Artisanal fisheries play an important role in sustaining coastal communities and alleviating poverty and have caught attention marked with the proliferation of scientific publications. However, small-scale fisheries are underreported. Millions of metric tons of fish from the small-scale fisheries sector are hidden (unreported). This was shown in the study Hidden Harvest: The Global Contribution of Capture Fisheries synthesized in 2012 by the FAO, the World Bank and WorldFish. The study looked at livelihood and economic contributions of capture fisheries globally and presented the following key quantitative findings:

- Approximately 120 million full-time and part-time workers are directly dependent on commercial capture fisheries value chains for their livelihoods.

- Ninety-seven percent (116 million) of these people live in developing countries. Among them,
    - more than 90 percent (including almost 32 million fishers) work in the small-scale fisheries subsector,
    - 47 percent of the total workforce is women, which in developing countries equates to 56 million jobs,
    - over half (60 million) of those employed in fisheries value chains in developing countries work in small-scale inland fisheries, and
    - 73 percent (approximately 23 million) of developing country fishers and fish workers live in Asia.
- An estimated 5.8 million fishers in the world earn less than $1 per day (FAO, World Bank, & WorldFish, 2012).

In addition, Brinson, Die, Bannerman, & Diatta, 2009 highlighted the socioeconomic performance of West African fishing fleets that target Atlantic billfish. The findings show that fishermen from fishing communities live in poverty, depend upon fish for their livelihood and often have little access to education or infrastructure such as running water and sewer systems (FAO(d), 2016).

On the other hand, industrial fishing deploys a high level of technology and investment, but it also brings huge socio economic impacts to fisheries. Based on a hyper-productivist model, industrial fishing companies do not represent what fishing is supposed to be; a lever for local development capable of making the most out of the resource. D. Pauly describes the social and geopolitical paradox of industrial fishing: “Those who do not need the fish, people living in rich countries, consume over 80% of the global catch”. Furthermore, the overcapitalization of the world’s fisheries encourages the fishing industry to compete and expand always further out on the world’s oceans and several reasons include: the open-access nature of many fisheries; common-pool fisheries that are managed non-cooperatively; sole-ownership fisheries with high discount rates and/or high price-to-cost ratios; the increasing replacement of small-scale fishing vessels with larger ones; and the payment of subsidies by governments to fishers, which generate ‘profits’ even when resources are overfished (Daniel Pauly et al., 2002). Therefore, industrial fishing exerts market and resource

controls that are not favorable to small-scale fisheries and coastal communities and landings are intended for export (Céline Yolande, 2010).

Today, industrial fishing exploits more than half of the ocean's surface area. According to satellite observations, these fleets are known to operate over 200 million square km, an area four times larger than that used by agriculture. These figures were obtained as part of a study commissioned by several organizations (Global Fishing Watch, National Geographic Society, and Sky Truth). Observing 40 million hours of fishing for 20 billion kWh of energy, the study concludes that these boats have covered more than 460 million km, or 600 times the round trip distance between the Earth and the Moon. The regions that are the most affected are the North-East Atlantic (Europe), the Northwest Pacific (China, Japan, Russia) and some regions off South America and West Africa.[5]

The university-based project "Sea around us" compiled a report of satellite data to track seafood print around the globe since 1950 and found that global trends were dominated by the heavily subsidized fleets of a small number of countries, increasing the total area fished from 60 per cent to 90 per cent of the world's oceans leaving only a few untouched places on earth (mainly in polar areas) (Tickler, Meeuwig, Palomares, Pauly, & Zeller, 2018). The main author of this study, David Tickler, researcher at the Biology Center of the University of Western Australia says that only China, Taiwan, Spain and South Korea have a fleet big enough to exploit further out at sea. He also points out that "While most countries continue to focus their fishing efforts on local waters, Taiwan, South Korea, Spain and China have aggressively subsidized vessel and fuel costs to encourage their fleets to operate thousands of kilometers from their home ports". Although not included in the study, Japan is one of the most important fishing countries both in Asia and globally. It is responsible for the fifth largest fisheries production volume in the world and three of the 16 largest seafood companies are based in Japan (Ichinokawa, Okamura, & Kurota, 2017). As of 2016, the fisheries production sector employed 160,000 people and the production value of marine capture fisheries amounted to over 962 billion Japanese yen[6].

Government subsidies for industrial fishing are believed to be responsible for the constant deterioration of ocean ecosystem health. They are one of the key drivers behind

[5] http://www.rfi.fr/science/20181221-le-pillage-oceans-desastre-ecologique-surpeche-poisson-industrie
[6] http://www.maff.go.jp/j/tokei/sihyo/data/18.html and http://www.maff.go.jp/j/tokei/kouhyou/gyogyou_seigaku/ consulted on 10/05/2019

the decline in fish stocks. Governments pay around $20 billion each year in damaging fishing subsidies, primarily to industrial fishers, to offset costs such as fuel, gear, and vessel construction[7]. According to a PEW research, global fishing capacity - the total capability of the world's fleets - is estimated at 250 percent of the level that would bring in the maximum sustainable catch.[8]

**b) Human degradation driven by industrial fishing in West Africa**

Nowhere are the effects of industrial fishing on coastal population more visible than in West African countries. For the 22 West African countries, it has been estimated that 6.7 million people directly depend on fishing activities for their food and/or livelihood (Belhabib, Sumaila, & Pauly, 2015).

The area covered by six countries (Mauritania, Senegal, The Gambia, Guinea-Bissau, Guinea and Sierra Leone) lay within the Canary Current Large Marine Ecosystem (CCLME) in the North and the Guinean Current Large Marine Ecosystem (GCLME) in the South. This represents a particularly productive region. The coastal zone of West Africa is an area of strategic interest for the socio-economic development and livelihoods of 1.4 million people living along the coast, but fisheries contribution to GDP in WA is highly variable. Indeed, the lowest contribution to GDP was observed for Gabon, Namibia, Equatorial Guinea, Congo (less than 1%) and the highest contribution to GDP was estimated for Sierra Leone with almost 40%, Cape Verde with 24% and the Gambia with 20% (Belhabib et al., 2015).

Unfortunately, over-exploitation, overcapacity and illegal fishing have severely damaged both fish stocks and the economy of these vulnerable countries (Daniels, A., Gutierrez, M., Fanjul, G., Guerena, A., Matheson, I., and Watkins, 2016). The likely culprits are industrial fishing fleets sailing around West African countries' waters. Such fleets are, most of the time, affiliated to European countries, Russia, China or South Korea and can even be found in unauthorized areas. However, some of these West African countries sell official licenses, legally allowing foreign vessels to fish in their waters. The problem lies in transparency; information regarding the number of licenses

[7] https://www.pewtrusts.org/en/research-and-analysis/articles/2019/06/07/subsidizing-the-decline-in-ocean-health?sc_camp=4B79EF1A5C5D4421ACB82E992700AEB4&utm_campaign=atf58&utm_source=linkedin&utm_medium=paid

[8] https://www.pewtrusts.org/en/research-and-analysis/articles/2018/07/19/fishing-subsidies-are-speeding-the-decline-of-ocean-health consulted on 12/05/19

granted by governments and sold to foreign or nationally flagged commercial fishing boats is very difficult to obtain, even for other parts of the government, as it is confidential information (Interpol, 2014). Several drivers can be identified for these crimes: the lure of profit (Le Gallic & Cox, 2006) as well as the ability to simply doing so motivate foreign fleets, especially in these six countries' waters whose Monitoring Control and Surveillance (MCS) systems are relatively weak.

Monitoring systems are bound to governance and corruption (André Standing, 2008). Poor governance and high corruption combined with high monitoring costs pose a serious concern on the sustainability of West African countries' efforts to combat illegal fishing (Doumbouya, Camara, Mamie, & Intchama, 2017).

The Ebola crisis in 2015 in Sierra Leone along with governance issues related to the cancellation of the World Bank project, a major contributor to MCS between 2012 and 2013, prompted low to virtually no surveillance after 2014, which led to an increase of vessels fishing illegally and depleting stocks (NOAA, 2017), from 7 in 2014 to over 80 in 2015 (Doumbouya et al., 2017).

All these issues have seriously compromised food security and economic development for coastal communities in West Africa. The footprint in terms of catch and value on the small-scale sector is heavily felt, and for foreign fleets, their impacts and catches are still unaccounted for, like in Guinea-Bissau (Intchama, Belhabib, Joaquim, & Jumpe, 2018). Furthermore, West Africa shows an increasing reliance on fisheries for their food and income despite decreasing total salaries and increasing fishing costs (Belhabib et al., 2015), which is disrupting more and more coastal communities in the region. People perceive fisheries as a way to alleviate poverty as more and more people are depending on them, but their current profitability is decreasing (although still attractive) (FAO(c), 2016). The perception of artisanal fishing as an activity of last resort is justified, probably more so than as a source of sustainable livelihoods (Belhabib et al., 2015).

**Box 5:**

**Traditional fishing communities in Senegal**

Overfishing, industrial fishing, the effects of climate change, Senegal's once abundant fisheries resources are drying up at an alarming rate. To find out more, Salwa Jaafari, from VOAA Africa, went to meet the traditional fishermen of the village of Yoff Tonghor, a few kilometers from the city of Dakar. When asked, local fishermen say that huge foreign vessels are depleting their resources and their methods have been devastating for small-scale fisheries. Nowadays, these people are forced to spend more time at sea and to travel further out to get their catch.

Fish, the main source of protein for Senegalese people, is caught on a massive scale. This exploitation was not a problem until two decades ago. The advent of industrialized fishing and illegal fishing are a danger to the fishery resources of a country that employs more than 600,000 people (Daniels, A., Gutierrez, M., Fanjul, G., Guerena, A., Matheson, I., and Watkins, 2016). These people are highly dependent on these resources for their economic and nutritional well-being. More than 17% of the active population is employed in the fishing industry. 20,000 pirogues and some 160 industrial ships compete for 718 km of coastline (Belhabib et al., 2014). A rate that does not allow fish stocks to regenerate. Fish arrive on the Senegalese markets in droves and as a result, prices have risen sharply. Foreign illegal fishing in Senegalese waters is estimated at 260,000 tons between 2010 and 2015 (Doumbouya et al., 2017). The Senegalese government stresses the importance of respecting the rules established for fishermen so that commercial species can reach commercial size or reproduce and rebuild the stock. However, foreign vessels sail through Senegal's territorial waters and are not limited to the area for which they have obtained an authorization. A situation that is likely to drag on in the absence of clearer agreements between the countries concerned.

## 4.2 The live reef fish trade and human trafficking

The future of commercial fish stocks across the globe is being discussed widely by scientists, governments, civil society and conservationists as we have entered an unprecedented wildlife crisis. Not only the future of entire ecosystems is at stake, but also the fishing communities whose livelihoods depend upon healthy fish populations.
Many unsuccessful systems have put in jeopardy entire areas through overfishing, illegal fishing, mismanagement of open access resources, attempts at top-down control, poor ability to monitor and implement regulations, or reliance or consensus. An emerging issue in the fishing industry involves human trafficking. As fish stocks are depleted and commercial fishing operations toiling under tighter and tighter budgets, the need for slave labor grows. Threats and punishments do too.

This section highlights the status quo of illegal trafficking of both fish species and humans. The fishing industry expanding across all oceans leads to new forms of violence towards humans. The second half of this section introduces the reader to a fairly new discussion: modern slavery on fishing fleets using the example of the latest documentary on slavery in Thai fleets: Ghost Fleet.

### a) The live reef fish trade

Some fish populations, such as reef fish across the Indo-Pacific are undergoing intense fishing pressure. While being largely unspoken, these colorful fish are being targeted for their consumption or enter the aquarium trade, which is very lucrative. However, in 2007 Scales, Balmford, & Manica, (2007) have compiled a report based on data retrieved over a course of 8 years off Northern Borneo. They concluded that many reef populations are in steep decline in the area, including the most important species, the Napoleon Wrasse. Researchers have estimated changes of – 98% and – 78% over 8 years in catch and relative abundance (Scales et al., 2007). According to the study, these declines are directly linked to the live reef fish trade (LRFT).

Award-winning photojournalist and conservationist Paul Hilton has been investigating the LRFT for years in the Coral Triangle[9], working closely with regional authorities on some cases such as Indonesia. He has also been working on conservation issues, the illegal wildlife trade and will release a short documentary called "ILosingColor" about the LRFT. He is calling on tighter monitoring and control from governments in the region and across international borders[10].

**Colorful reef fish for sale in Jimbaran fish market in Bali, Indonesia.**

**Photograph: Paul Hilton/WCS**

This complex trade, with many links in the chain from fisher to retailer, has been going on largely unregulated since its beginning even in the major trading center, Hong Kong, where there was a lack of data as per estimations of total catches. Its development and expansion have occurred in the 1990s in response to an increasing demand for luxury fish consumption (Graham, Phillips, & Yeeting, 2003). The characteristic of this fishery is that it is nomadic and shifts to other grounds across countries in Southeast Asia and in the western Pacific until fish targets become hard to find (Scales et al., 2007). Still nowadays, the industry remains largely unregulated and threatens important tropical ecosystems.

### b) Human trafficking in the fishing industry

[9] The **Coral Triangle** is a roughly triangular area of the tropical marine waters of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste that contain at least 500 species of reef-building corals in each eco-region.[1] This region encompasses portions of two bio-geographic regions: the Indonesian-Philippines Region, and the Far Southwestern Pacific Region. It is recognized as the global center of marine biodiversity and a global priority for conservation, often called as "the Amazon" of the oceans

[10] https://www.theguardian.com/global-development/gallery/2017/jul/26/fishing-communities-asia-bali-summit-in-pictures consulted on 23/05/19

Human trafficking is a term widely used to describe trafficking in persons and is considered as a grave violation of basic human rights and involves: recruitment through promises of getting a good job, harboring or transporting people into a situation of exploitation through the use of violence, deception, or coercion and forced to work against their will (UNODC, 2016).

In the context of fishing, forced labor and human trafficking are part of an emerging debate. There are only a few contributions to the topic and the awareness had been low until fairly recently. A study led by Stringer, Whittaker and Simmons (2016) has drawn the attention onto the use of forced labor in the fishing industry in New Zealand and stressed the fact that there is a need to extend the International Labor Organization (ILO) and European Commission (EC) operational indicators of human trafficking for forced labor. They have found insufficient recognition of deception, exploitation and coercion at the point of exit, which can prevent trafficked victim from exiting their job and call on tighter rules and acknowledgement of all stages from recruitment to exit (Stringer, Whittaker, & Simmons, 2016).

Falling productivity and financial returns in commercial fisheries can pressure vessels to cut operating costs, at the extreme by fishing illegally, circumventing licensing costs and catch limits, and by reducing expenditure on crew pay, safety and living conditions (Tickler, Meeuwig, Bryant, et al., 2018).

The UNODC has recently identified South East Asia as an area where such practices are frequently detected with cases involving Indonesia and Thailand (UNODC, 2016). Modern slavery does exist and as of 2019, over 10% of commercial fishermen work under conditions that classify them as slaves. These shing slaves are recruited from small rural villages, mostly in countries like Cambodia or Myanmar. The courageous work of the Thai activist Pati Tungpuchayakul recently helped uncover the vast injustice of slavery in the Thai fishing industry. Thailand supplies a large portion of America’s seafood, but Thailand’s giant fishing fleet is chronically short tens of thousands of fishermen per year. Human traffickers have stepped in, selling captives from the region to the captains for a few hundred dollars each.

The documentary called The Ghost Fleet explores escape stories from people who worked on Thai trawlers to denounce these practices, which are spreading in the fishing industry. In 2014, Kate Hodal, Chris Kelly and Felicity Lawrence from The Guardian,

led a six-month investigation on human trafficking on fishing boats in Thailand. Their work established that large numbers of men bought and sold like animals and held against their will on fishing fleets off Thailand are part of the production of prawns sold in leading supermarket around the world, including the top four global retailers: Walmart, Carrefour, Costco and Tesco[11].

In fact, findings on the Thai fishing industry indicate that men work an average of 18–22 h/day under the harshest, most punishing conditions, which has recently led to Thailand being relegated to the worst tier of the US State Department's human trafficking (Zimmerman & Schenker, 2014).

### 4.3 Climate change, plastic and land-based pollution

After WWII our global footprint on natural resources has increased as society developed. Today, climate change is a topic widely spoken in the world. Achieving global net zero emission by 2050 and reversing the current trend require unprecedented transitions in all aspects of society.

Climate change has a warming effect on the ocean and affect fish distribution as they move towards the poles (Perry, Low, Ellis, & Reynolds, 2005). In addition to that, a growing global issue catches everyone's attention; plastic pollution in the oceans. Indeed, these two threats are adding up to human pressure already existing on fisheries. This section looks at these two global threats.

#### a) Fish distribution and climate change

The ocean absorbed more than 90 percent of the additional energy generated between 1971 and 2010 and 30 percent of emissions of carbon dioxide. The surface water (from 0 to 700 m deep) has warmed on average by 0.7°C per century on a global scale between 1900 and 2016 (HUANG et al., 2016). Therefore, significant changes in aquatic communities have been strongly associated with global warming (Perry et al., 2005).

Perry, Low, Ellis and Reynolds' study (2005) points out that recent increases in sea temperatures in the North Sea have triggered responses from fish, with nearly two-thirds

[11] https://www.theguardian.com/global-development/2014/jun/10/supermarket-prawns-thailand-produced-slave-labour consulted on 29/05/19

of species shifting in mean latitude or depth or both over 25 years. For species with a range north or south of the North Sea, half of them have seen their limits shift with warming, and all but one have changed their range to the north. Species with changing distributions have faster life cycles and smaller bodies than species that do not change distributions. Further temperature increases are likely to have a significant impact on commercial fisheries through continuous changes in distribution and changes in community interactions (Perry et al., 2005). Their study shows that climate change is having detectable impacts on marine fish distributions, and observed rates of boundary movement with warming indicate that future distribution shifts could be pronounced. Mean annual surface temperatures in the North Sea are predicted to increase by 0.5 to 1.0-C by 2020, 1.0 to 2.5-C by 2050, and 1.5 to 4.0-C by 2080 (15). They used the midpoints of these temperature ranges as the basis for a rough approximation, which suggested that two types of commercial fishes, blue whiting and redfishes (Sebastes spp.), may retract completely from the North Sea by 2050.

This study only focused on the impacts of climate change on commercial and non commercial species in the North Sea and not on the causes of climate change. However, they point out that any climate-driven changes could have devastating effects on these fragile ecosystems already under heavy anthropogenic pressure.

According to the FAO (2018) report on climate change, fisheries and aquaculture, ocean warming is already visible in most regions of the world and is arguably more obvious in higher latitudes. The projections in marine capture fisheries between now and the end of the twenty-first century show that the total Maximum Catch Potential in the world's EEZs is likely to decrease under two different scenarios of greenhouse gas emissions:

- Representative concentration pathways 2.6 (RPC2.6)
- Representative concentration pathways 8.5 (RPC8.5)

The total maximum catch potential in the world's exclusive economic zones (EEZs) is likely to decrease by 2.8 percent to 5.3 percent by 2050 (relative to 2000) under RCP2.6 (low emissions) or by 7.0 percent to 12.1 percent under RCP8.5 (high emissions) (FAO(b), 2018).

These possible scenarios require unprecedented actions and a transition to build more climate-resilient fishing communities in order to avoid the collapse of some fisheries.

There are several reasons to believe that ending overfishing could mitigate impacts of climate change. In fact, U.R Sumaila and Travis C. Tai (2019) link climate change effects to overfished stocks as they become more vulnerable to all sort of stressors including climate change. Drawing on the concept of fishing down marine food webs by Christensen, Pauly, Dalsgaard, Froese, & JR, (1998) that is, fishing at lower trophic levels, the authors' findings suggest that eliminating overfishing would allow marine ecosystems to recover as well as the balance predator-prey. Furthermore, they identify that some strategies could benefit greatly our oceans such as dynamic fishing rules based on measured changes in biomass; designating marine reserves or reducing catch rates of some commercial stocks, improving ocean health and subsequently increasing resilience to climate change (Sumaila & Tai, 2019).

**b) Plastic pollution in the ocean**

Society has benefitted enormously from the development of plastics. They have become indispensable in our economy and social development, and have offered many benefits to mankind across all sectors, from health and food preservation, to transportation and enhancing the digital era (UNEP, 2016). However, our increased reliance on plastics is now taking a toll on our ocean health and threatens marine life, human health, and food safety.

Our throwaway society is sending 4.8 to 12.7 million tons of plastic waste towards oceans every year, due to inadequate waste management (UNEA, 2017). Moreover, plastic production reached 335 metric tons (Mt) in 2017, and this number is projected to increase almost fourfold to 1.100 Mt by 2050 (Simon, Knoblauch, Mederake, & Mcglade, 2018). We know that 8.300 Mt has been produced up until this point, of which only 9% have been recycled and 12% have been incinerated. The remaining 79% was dumped in landfill or ended up in the environment uncontrolled.

An estimated 5.25 trillion pieces of plastic are drifting on the ocean surface weighting over 250.000 tons (Eriksen et al., 2014). Initially, researchers were lacking data on plastic debris and could not really assess the impact of what has already been found in the ocean. Nowadays, we know that over 2000 species are affected by large chunks,

small particles, or macro – and microplastics. They are mainly victims of ingestion (as they confuse it for food) and entanglement, resulting in injuries or death.[12]

Plastic debris finds its way into the oceans through various sources. Plastic often ends up in the ocean and originates from land-based and sea-based activities

- **Plastic in wastewater:** Wastewater provides a pathway for dissolved chemicals as well as solid particles to be transported into aquatic habitats (UNEP, 2016). This includes macroplastics and microplastics. Theoretically these should be removed by primary sewage treatment but in case of heavy rain, or snowfall it can be overwhelmed and particles may pass through. In addition, in developing countries it is estimated that approximately 90% of all wastewater generated is discharged without primary treatment (Corcoran, E., C. Nellemann, E. Baker, R. Bos & Savelli, 2010)
- **Plastic in solid waste:** Solid waste coming from municipalities around the world can find their way into the ocean when waste management and facilities are not adequate (UNEP, 2016).
- **Maritime waste:** Losses in the fisheries sector include loss of fishing gear (e.g. nets, ropes, floats, fishing line). loss of ancillary items (e.g. gloves, fish boxes, strapping bands), galley waste and release of fibers and other fragments due to normal wear and tear (e.g. use of ground ropes). Fishing gear may be lost at sea by accident, abandonment or deliberate disposal. This is commonly referred to as abandoned, lost or otherwise discarded fishing gear (ALDFG), and probably represents the largest category in terms of volume and potential impact out of all the sea-based sources (UNEP, 2016). Other sources of plastic pollution come from aquaculture, maritime-based tourism, recreational activities at sea, commercial shipping and offshore industries.

There are several human health concerns associated with poorly managed waste collection and treatment. First of all, littering can block wastewater drains, leading to sewage contamination of communities and areas of stagnant water. Plastic pollution in the ocean leads marine species to ingest small pieces of plastic. Human are now exposed to microplastics and nanoplastics as they consume seafood that may have ingested them. Entering the food chain in the ocean, they finally end up in people's

[12] https://litterbase.awi.de/interaction_graph consulted on 2/06/19

plates. Although the effects are relatively unknown and constitute a major knowledge gap (Alexandre et al., 2016), it poses a great risk for food safety and human health if it further developed.

**Box 6:**

**Cigarette butts: example of plastic pollution**

Cigarette butts are the most common plastic waste found on European beaches, just after the plastic bottle according to the French ministry of ecological and solidarity transition (law's proposal anti-waste; 2019). Already identified as a hazardous waste for the environment for decades, cigarette butts are found everywhere as people throw them away. They contaminate water and are hard to dissolve.

It is a plague for our planet for two reasons: a lack of awareness on the smoker's part, and the lack of availability of waste receptacles at transition locations, such as outside stores and buildings, and at public transportation public spots

The core of most cigarette filters is actually a form of plastic called cellulose acetate. By itself, cellulose acetate is very slow to degrade in the environment. Depending on the condition of the area the cigarette butt is discarded in, it can take 18 months to 10 years for a cigarette filter to decompose. On top of that, used cigarette filters are full of toxins, which may be released into the ground and waterways, damaging living organisms. For example, nicotine may leak and is highly poisonous.

A new study suggests that the overall projected figures for the accumulation of plastic debris in the ocean surface layer, representing only a few percent of estimated annual emissions to the marine environment and explaining that the degradation of this mass to microplastics would have occurred below the surface, cannot explain the occurrence of decades-old objects collected by oceanic expeditions. They show that the dynamics of debris circulation in coastal environments can be a better explanation for this difference. The results presented in their study suggest that there is a significant time interval, in the order of several years to several decades, between terrestrial emissions and representative accumulation in coastal waters. Importantly, their results also indicate

that the current generation of secondary microplastics in the global ocean is mainly the result of the degradation of objects produced in the 1990s and earlier (Lebreton, Egger, & Slat, 2019).

**c) Ocean dead zones**

Oxygen concentrations in both the ocean and coastal waters have been declining since at least the middle of the 20th century. Global warming leads to deoxygenation as it disturbs the regulation of global cycles of major nutrients and carbon. Since 1950, the anthropogenic pressure intensified greatly, with human-induced greenhouse gas emissions and nutrients discharged to coastal waters, leading to a reduction in the rate of oxygen resupply from the atmosphere to the ocean (Breitburg et al., 2018).

Areas starved with oxygen in the open ocean and by coasts have soared in recent decades, risking dire consequences for marine life and humanity. Although ocean dead zones have quadruple since 1950 and the number of very low oxygen sites in coastal waters has multiplied tenfold, there are actions that can be undertaken to avoid them or restore those already existing.

Declining oxygen levels in open ocean have been associated with climate change and the global warming of the oceans since the 1980s. Ocean warming reduces the solubility of oxygen, which is estimated to account for ~15% of current total global oxygen loss and >50% of the oxygen loss in the upper 1000 m of the ocean (Schmidtko, Stramma, & Visbeck, 2017) (Helm, Bindoff, & Church, 2011). In addition, another phenomenon will be likely to occur; water column stratification. Warmer air temperatures associated with climate change will enhance stratification by heating the surface waters, which will lead to hypoxia by preventing oxygenated surface waters from mixing to the bottom (Altieri & Gedan, 2014). Therefore, seasonal summer hypoxia in dead zones can be linked to this change in oxygen distribution and harm marine life.

Finally, estuaries and coastal waters are more vulnerable to climate change as they are often shallow and have limited exchange with the open ocean. Therefore, their water temperatures are closely linked to air temperatures (Altieri & Gedan, 2014).

Dead zones are found mostly in coastal waters and are often the results of human activity. Dead zones created by the depletion of dissolved oxygen in coastal waters are one of the most widespread and detrimental anthropogenic threats to marine ecosystems

worldwide. They have significant consequences for the biodiversity and functioning of marine ecosystems and the services they provide to society, including fisheries production, water column filtration and nutrient cycling and as such deserve a better attention in humanity's interest.

## 5. FISHERIES – CALL FOR ACTION

"Resource systems are best thought of stock variables that are capable, under favorable conditions, of producing a maximum quantity of a flow variable without harming the stock of resource unit itself" (Ostrom, 1990). A resource system can be illustrated by fishing grounds. Resource units are what individuals seek to appropriate. In the case of a fishing ground, we are talking about tons of fish that are extracted from it.

Despite the legal advances of recent decades, the oceans are a clear example of a common, which if unregulated can only end in tragedy, as Hardin describes it. Bio-economic models have drawn scientists' attention to the dynamic aspects of stock management, but institutional frameworks have not been sufficiently strengthened. In addition, the problems go beyond the overexploitation of resources and new threats to fisheries have emerged, as mentioned in the previous section. In this chapter, the potential contribution of Ostrom's polycentric approach is described. The objective is to identify a set of measures that could be taken to achieve sustainable management of CPR in the fisheries sector.

### 5.1 The role of the FAO and NGO initiatives

#### a) The FAO's community-based approach

In recent years leading organizations such as the FAO have adopted community-based fisheries management (CBFM) programs by bringing scientific, financial and technological support to local communities. The FAO defends this approach, which uses some of the key components that Ostrom (1990) developed in her analytical framework of collective action and institutional design. For example, the FAO has been working with Pacific Islands States to help them protect their coastal fisheries.

The need to empower local communities and to protect natural resources from overfishing and other human activities led to the combination of the CBFM and the ecosystem approach to fisheries management (EAFM). The ecosystem approach to fisheries and aquaculture includes a number of principles that recognize the interactive nature of sustainable development:

- **Wider effects:** Taking into account the effect of fisheries on the environment, as well as the effects of other human activities on fisheries;
- **Appropriate scale:** Management of the resources taking into account the movement, the distribution of the targeted resource and other elements affecting or being affected by fisheries.
- **Participation and cooperation:** Management decisions and their implementation must involve the full participation of all stakeholders and cooperation with the necessary institutions and user groups (FAO, 2018a)

A community-based ecosystem approach to fisheries management (CEAFM) can encompass and foster cooperation between local communities, which hold the knowledge about the fishing area, and various key actors and stakeholders. Working with a promoting agency, whether it is a NGO, an international organization or a state agency, and adopting these approaches can bring benefits to the communities and the ecosystem as a whole (FAO(b), 2010). CEAFM are voluntary-based programs designed to avoid wasting time looking for communities to partner with. Only those who are expressing the need of assistance are then provided with the program services (FAO(b), 2010). However, further exploration could be encouraged in areas where scientific evidence of resource depletion or other types of anthropogenic pressures have been established, even if local communities have not expressed a desire to be involved in this program.

Islands are a good place for implementing a community-based approach as they are relatively small-scale communities, the limited availability of the resource and the economic dependence upon the latter incentivize the population and the existing institutions. Communities are encouraged to get in touch with a promoting agency (fisheries agency, other governmental agency or NGO) and design community-owned plans of their fishery with its main components (FAO(b), 2010). In Pacific islands countries, coastal fishing is one of the main drivers and therefore represents a key

element of social, cultural and economic welfare. The Pacific Island fisheries that are based on coastal resources provide most of the non-imported fish supplies to the region. Coastal fisheries harvest a very diverse range of finfish, invertebrates and algae. Unlike the tuna fishery, virtually all the coastal catch is undertaken by Pacific Islanders themselves, with very little access by foreign fishing vessels (FAO, 2011).

The FAO works with local partners such as the Pacific Community (SPC) and has its regional headquarters in Bangkok, Thailand. They work with small-island communities to enhance their capacity (human and financial) to preserve both the natural resources intact and their harvest from overfishing and other human activities that may occur. In those areas, community rules of access and management of all resources are required if people want to continue their fishing activity in the long-term.

One way to reach a bigger audience, as Ostrom (1990) describes it, is the norms of behavior. It affects the way alternatives are perceived and weighted. When an individual has strongly internalized a norm related to keeping promises, for example, the individual suffers shame and guilt when a personal promise is broken. If the norm is shared with others, the individual is also subject to considerable social censure for taking an action considered to be wrong by others (Ostrom, 1990). These norms of behavior may be the key that could unlock a stronger cooperation in fisheries management in small, remote communities. If sustainability and management of a fishery become the norm, overfishing or the temptation of free-riding may be seen as abnormal and thus rejected as whole by the user group. The FAO can play an active role in empowering local-communities and providing education tools to reach that goal of changing the norm.

**b) NGO initiatives**

Several NGOs advocate against overfishing and policy measures considered unsustainable. I look at the way they organize their advocacy activities and analyze whether their actions (lobbying, education, advocacy campaigns) have an impact on decision-making process regarding fisheries management.

In April 2019, the International Council for the Exploration of the Sea (ICES) found that the eastern Baltic cod population has reached such a critically low level that it is unable to reproduce itself sufficiently to maintain a future healthy stock (ICES, 2019).

In reaction to this news, **Coalition Clean Baltic, Deutsche Umwelthilfe, Oceana, Our Fish, and WWF**'s are calling on the fisheries ministers of all EU Baltic member states to immediately close the fishery. As a result and after press releases from Baltic member states showing reactions of all sorts, on July 23rd 2019, the EU Commission approved emergency measures to protect eastern Baltic cod, banning commercial fishing with immediate effects until December, 31st 2019[13].

Total allowable catches for eastern Baltic cod have already been reduced every year since 2014, from 65 934t down to 24 112t in 2019. Even so, in the last years fishermen only used up between 40-60% of the total allowable catch, probably due to a lack of fish of commercial size (ICES, 2019). Indeed, according to scientists, the volume of commercial sized cod (>= 35 cm) is currently at the lowest level observed since the 1950s. This year, fishermen have so far used around 21% of their available quota.

The NGOs provide a number of elements to be addressed in the implementation of emergency measures. They note that "spawning for eastern Baltic cod takes place right now, from May to 31st August. If action is taken quickly, i.e. measures in place by 1st July, it can have a beneficial effect on spawning and therefore on the future stock recovery."

What roles have the abovementioned NGOs played? In this current crisis that concerns Eastern Baltic cod, Baltic and European NGOs have written an open letter to all Baltic state fisheries ministers and to the EU Commission calling on them to implement national emergency measures. The EU Common Fishery Policy (CFP) provides the solutions - it includes provisions for dealing with this form of serious threat to the marine environment. Articles 12 and 13 of the CFP empower the Commission and Members States to take emergency measures (European Union, 2018).

Commitment was obtained for a single CPR, when scientific evidence combined with advocacy groups, hereby, NGOs, expressed their concerned and called on member states to act. The "dual governance" has worked well, NGO activists – whistleblowers have been witnesses to the relevance of the actions undertaken - heads of state and international agencies, have guided public policies in a sustainable way to take urgent action.

[13] https://europa.eu/rapid/press-release_IP-19-4149_en.htm consulted on 8/08/19

In the context of this event, it is useful to provide again the definition of institutions according to S. Jentoft, B.J McCay and C. Wilson (1998), as a reminder of why they are necessary in a crisis situation like this one: "Institutions can be defined as the sets of working rules that are used to determine who is eligible to make decisions in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must or must not be provided, and what payoffs will be assigned to individuals dependent on their actions."

## 5.2 Aquaculture in the fishing industry

In 2016, fish production reached a record level of 171 million tons, of which 88 percent was used for direct human consumption, thanks to a relatively stable production of capture fisheries, reduced waste and continued growth in aquaculture. While annual growth in aquaculture has declined in the last few years, some countries, notably Africa and Asia, have continued to record significant two-figure growth. The sector's contribution to economic growth and poverty reduction is increasing. Increased demand and prices increased the value of global fish exports to USD 152 billion in 2017, with 54 percent coming from developing countries (FAO, 2018a).

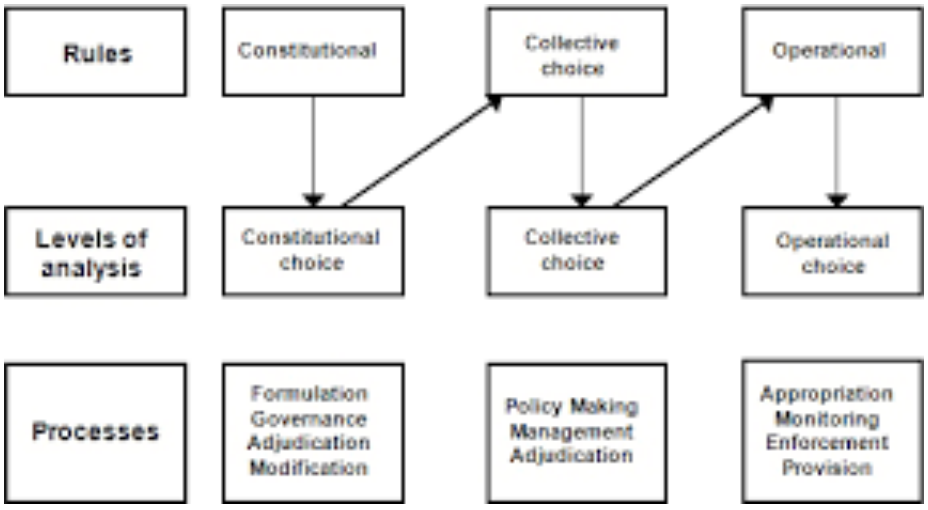
Global aquaculture production (including aquatic plants) in 2016 was 110.2 million tons (FAO, 2018a). While wild capture fisheries have remained relatively static since the 1980s, the aquaculture's supply contributions have been growing constantly over the past decades. Aquaculture operations were responsible for contributing more fish for human consumption than their wild capture counterparts in 2014, harvesting 73.8 million metric tons (MT) of seafood that year with an estimated first-sale value of USD 160.2 billion (EUR 131.3 billion) (FAO(a), 2016). The increasingly reliance on aquaculture for seafood calls for strengthened regulations and a better management of fish farms to reduce their environmental impact.

The role of ecosystems has been widely discussed in marine science and management for decades and authors like Folke & Kautsky (1989) have argued about the importance of incorporating an ecosystem-based approach to aquaculture. They looked at cage culturing of salmonids and mussels in Scandinavian marine aquaculture, advocating that a combined harvest of these species would be one way to achieve sustainable use of the ecosystems without overloading them with nutrient inputs (Folke & Kautsky, 1989).

Today, the ecosystem approach to aquaculture is developed and promoted by FAO in recognition of the need for wider frameworks for the planning, development and management of sustainable aquaculture, taking into consideration the effects of other sectors on aquaculture and the effects of aquaculture on the ecosystem (FAO, 2018a).

Ostrom's (1990) institutional framework gives potential answers to regulating and managing the aquaculture sector. Based on unique set of characteristics of each ecosystem in which sea farms are set up and fish species harvested, companies, governments and civil society have the unique opportunity to organize set of rules at different levels to manage effectively the resource unit and accordingly to the ecosystem's attributes. Three levels of rules may be the key. Operational rules that directly affect day-to-day decisions. The processes of appropriation, provision, monitoring, and enforcement occur at the operational level. Collective-choice rules indirectly affect operational choices. The processes of policy-making, management, and adjudication of policy decisions occur at the collective-choice level. Constitutional-choice rules affect operational activities and results. Formulation, governance, adjudication, and modification of constitutional decisions occur at the constitutional level (Ostrom, 1990).

Image 5.1: Source: Governing the Commons, Linkages among rules and levels of analysis, E.Ostrom (1990).



**Box 7:**

**Vertical Aquaculture in Singapore**

Vertical Aquaculture in Singapore emerged as a response to food security and population growth in a space-scarce island nation. Urban farming may be an alternative to traditional farming which takes up more land or uses more resources in the wild. This initiative aims at boosting food production, providing consumption transparency and traceability while being sustainable. Altogether, this method allow farmers to harvest almost six times the amount of produce compared to traditional aquaculture methods, while using less energy per fish produced. The land-based model can fit into any unused urban space including parks, rooftops, and community spaces.

Naturally, Singapore's eyes have now turned to Agri-tech, urban farming and aquaculture. It is a relatively small island and according to the Population White Paper19, Singapore will have a population of between 6.5 and 6.9 million people by 2030 (Strategy Group Singapore, 2013). This means a major challenge to Singapore's government, to create additional agricultural land, develop land reserves and old industrial areas. Such a population growth also implies higher imports of food and drinking water since land for agricultural use cannot be augmented.

At present, Singapore imports almost 90 percent of its food and less than 1 percent of its land is used for agriculture. The responsible national authority, AVA, introduced on October 2013 a "Food Security Roadmap" for a resilient supply of safe food which is based on supporting and enabling strategies.[1] AVA uses contract farming in foreign countries (Indonesia, Philippines, Poland, Denmark and China) in order to have a better control of the supply and quality of the food and at the same time, to diversify its food sources. In the future, if there is not enough space within the city borders, vertical farms could also be established on ships or on off-shore landfill areas like Pulau Semakau.

Vertical farms are the key solution for sustainable land management in Singapore. They can make Singapore less vulnerable, less dependent on food imports and, ultimately, ensure its survival, even in times of crisis.

**Sources:**

www.ava.gov.sg/files/avavision/issues3-4_2013/food-security-roadmap.html, consulted on 26.08.2019

http://www.nea.gov.sg/energy-waste/waste-management/semakau-landfill ibid.

**Note:** Singapore's vertical aquaculture is a very specific case applied to a space-scarce country and might not be replicable to other cases. Singapore's vertical farms cultivate fish species that can be fed with a vegetarian diet in a controlled environment as opposed to open ocean aquaculture species that are carnivorous. In fact, the harvesting of carnivorous species (e.g. salmon, cod and tuna) in aquaculture operations leads the industry to target small forage fish (e.g. sardines, anchovies, mackerel, herring) and crustaceans (mainly krill) to feed them, which has detrimental effects on fish populations and contribute even more to the plundering of the oceans. The development of fishmeal factories in West Africa poses a threat to wild-fish stocks, the marine food web, and to food security in some of the most vulnerable communities in Morocco, Senegal and Mauritania (Changing Markets Foundation & Compassion in World Farming, 2019), which are ranked among the top ten fishmeal-producing countries in Africa (Barange, M. et al., 2018).

## 5.3 Policy measures in the fishing industry

First, this section explores the different measures available to limit abuses in the fishing industry, namely overfishing of a given stock, illegal fishing in restricted areas or in a country's national waters without authorization, pollution and ecosystem deterioration. From existing institutional tools to innovative technologies, effective management practices can be implemented. Ostrom's institutional framework provides some of the answers. Second, ITQs or catch shares are known to prevent fisheries to collapse but how should they be implemented? Third, traceability and transparency lie at the heart of the problem, since knowledge about fish provenance (where it was caught, by whom and how) would allow better regulation of the flow of seafood across markets. Thus it is important to discuss which tools can help achieve more transparency and traceability? Finally, monitoring and surveillance are essential in the fight against overfishing and illegal fishing. How can existing surveillance systems be improved and international cooperation reinforced?

### a) Property rights

In economics, property rights form the basis for all market exchange, and the allocation of property rights in society affects the efficiency of resource use.

Property rights constitute an important set of institutions influencing the nature of a resource regime. Property rights institutions are often strongly embedded in fishing communities. They can be very complex, with both formal and informal elements involving both social and ecological dimensions (Jentoft et al., 1998). In the rudimentary "the tragedy of the commons" model, open access is the root problem. The solutions to avoid the destruction of the resource is to set some institutional leverages, which can link individuals, groups, communities or even the state that restrict open access.

Svein Jentoft, Bonnie J. McCay and Douglas C. Wilson (1998) argue that most resource economists are in favor of private-property solutions, but denounce the "disembedding" of the resource from its social and cultural context, reducing the social capital and ecological flexibility needed for effective management. Co-management systems have been found to build larger sets of property options for managing natural resources (Jentoft et al., 1998). For example, in Norway, co-management works within the principle that fish and waters are no one's property, while in Japan property rights are exclusive to the fishing community, and in parts of Canada and New Zealand, co-management may be found in systems where rights to shares in quotas are privatized. For instance, New Zealand adopted ITQS as part of its national policy in 1986.

Additionally, Ostrom and Schlager (1992) previously defined collective-choice property rights to be powerful when the authority to devise future operational-level rights is embedded in those systems (Schlager & Ostrom, 1992). In regard to common-pool resources, collective-choice property rights include management, exclusion and alienation. Management systems can include the right to regulate internal use patterns and transform the resource by making improvements. Exclusion refers to the right to determine who will have an access right, and how that right may be transferred. Finally, alienation is the right to sell or lease either or both of the above collective choice rights (Schlager & Ostrom, 1992). Resource-users may be granted access but not withdrawal or withdrawal rights without management rights, rights of exclusion but without the rights of alienation. So, institutional sets may vary depending on the resource situation, communities and type of institutions that emit those rights.

**b) Individual transferable quotas (ITQs)**

The introduction of individual transferable quotas (ITQs) in fisheries is an attempt to correct the economic inefficiency in the fisheries sector, the so-called common ownership problem. However, ITQs are not property rights to relevant natural resources, i.e. fish stocks and their habitat. These are only harvesting rights and are therefore far from ideal as property rights. Nevertheless, ITQs have been introduced in many fisheries around the world, apparently with good economic results (Arnason, 2006).

Institutional change has the potential for greatly altering the future of global fisheries (Costello, Gaines, & Lynham, 2008). As Ostrom points it out, within relationships of formal and informal collective-choice arenas and CPR operational rules, changing the rules at any level of analysis may increase the uncertainty that individuals face. However, strategies adopted within the rules are changed more frequently after regular analysis to enable improvements (Ostrom, 1990). Thus, ITQs can be used, with different basis, and in a certain extent, to limit outputs over a number of seasons.

Individual transferable quotas (ITQs) have proven to be effective remedies against overcapitalization and fish racing in many single-species fisheries, but they are more problematic in multi-species fisheries. The underlying problem is that each of the many species in a multi-species fishery can support different maximum catch rates, but species that are unproductive may be as sensitive to fishing gear as species that are relatively more productive (Copes, 1986).

Under ITQs, quotas for each species are allocated as shares of the total allowable catches (TACs) of these species, which are usually based on the productivity of each species and not on their relative catchability. Individual vessels generally catch their quota share for some species before catching their share of other species. This leads to misreporting, discarding higher quality catches or discarding additional catches of some species in order to continue fishing for other species (e. g. Copes, 1986).

In existing multi-species fisheries, several approaches have been adopted to address this problem, including renting additional quotas, carrying over surpluses and under-harvests to the following year and confiscating catches. These approaches are based on

the assumption that it would be too difficult or costly for fishers to modify their fishing practices so that their catches closely match their quotas and that it would be too costly to require full coverage by observers on board to report discards.

**c) Seafood traceability system, transparency and technology**

Consumption patterns in developed countries have changed over the past decade. As a result, food safety issues, particularly health and ethics, are becoming increasingly important (FAO, 2014). End users are more aware and concerned about what they are buying, how, where and when their seafood was harvested and produced. These concerns have been the main drivers for the adoption of laws and the development of reliable procedures to assess quality and safety requirements throughout the seafood supply chain (Ricardo, Rosa, Leal, & Calado, 2015).

Biotechnology, seafood traceability data through technologies and data-sharing between authorities may assist in the fight against fraud and unregulated fisheries thus addressing underlying issues such as overfishing (FAO, 2018a).

The use of biotechnological tools for authentication or origin certification of food products is becoming increasingly important in the food sector. Different methods have been adopted, among them, three particular ones have emerged: The analysis of trace elements (TEF), the analysis of fatty acids (FA) and DNA-based analysis.

**Box 8:**

**Interview with Alexis Fossi**

For 25 years Alexis Fossi has been photographing artisanal fishing communities and their know-how. His images, technical diagrams and maps are used to initiate exchanges on topics related to the sector, to illustrate the particularities of a fishery or as a training tool.

Alexis lived 5 years in Sesimbra/Lisbon, Portugal where he gave trainings (EU regulations on health and security practices) in processing factories in the fishing industry.

Our interview took place on September 19th, 2019. The discussion revolved around a wide range of topics that have been discussed in this dissertation. These topics are: Fishing practices, industrial fishing/artisanal fishing, and violence in the fishing industry, dead zones, aquaculture, and traceability/transparence in the fishing industry, transshipment, the concept of Ocean Grabbing and the Mediterranean Sea.

**Fishing practices:** The different fishing gears can potentially harm the ecosystem, bycatch species that can be found swimming alongside the target species, and severely deplete a stock. Although, fishermen are aware that some fishing practices are unsustainable and dangerous but they use them anyway due to the lack of money and other sustainable options.

**Industrial/artisanal fishing:** As far as industrial fishing fleets and artisanal ones, the competition is thought to happen when targeted migratory species are found in coastal areas during spawning season or in specific feeding grounds.

**Human degradation:** Regarding human violence, Alexis describes that conditions on longliners are deplorable as people aren't fed enough and sleep in terrible condition. When a storm comes in, these boats have to stay put in the harbor. Once a storm hit Mauritius Island and the boat crews disembarked and stayed in town for a few days. Five crew members were killed during their stay. Alexis says that they mostly fight each other for alcohol and people ended up being stabbed. He then argues that China is also known to have abandoned its own vessels and crews on board as far out as West Africa. These boats are no longer profitable so they abandon them, with no supply to survive.

**Box 8 (continued):**

**Aquaculture:** The example of Singapore that I used is only applicable to the realities of the island. Other forms of aquaculture have been destructive for the ecosystems. Species harvested are mainly carnivores and thus need to be fed with other fish. Alexis argues that an ecological catastrophe is looming in West Africa where there are an increasing number of fish meal factories. Sardines are historically the fish of the poor in African coastal communities and contribute to food security and poverty alleviation. However, the development of these factories has shifted the attention of fishing fleets that target sardines to sell them to the sardine factories. The fish meal is then used to feed aquaculture species that are harvested for external markets (EU, USA mainly). According to the FAO, inland aquaculture and ocean aquaculture are accounted for. But these factories may soon disturb the aquaculture industry.

**Traceability/Transparence in the fishing industry:** It is a work in progress, FAO and UN regulations combined with technologies have contributed to improving the traceability of fish species. The market requires a certain control. In the EU market, traceability, transparency and product quality are required. The EU processes to import seafood in the internal market are often really complex and expensive; some countries are not able to afford the cost of monitoring, or setting up quality control teams. In addition, the country exporting must have the same regulations as the ones in force in the EU. Legal teams, inspectors and sanitary teams need to be provided by the exporting country (to prevent IUU). Alexis says that Madagascar was closed to export into the EU, and companies involved in the seafood trade were impacted. They exerted pressure on governments to open the trade routes again. However, the EU only allows it if the requirements (legal, health-related and economic) are met.

**Mediterranean Sea:** The development of the Aswan dam between 1960 and 1970 in Egypt led to a depletion of nutrients into the Mediterranean Sea. Consequently, some fisheries disappeared as the biodiversity decreased in the region. Nowadays, rivers in Europe are carrying pollution, including chemicals, into the sea. Coastal areas are fragile ecosystems, when they are affected by pollution, both marine life and human communities suffer from it.

**Box 8 (continued):**

**Ocean Grabbing:** The term "ocean grabbing" has been used to describe actions, policies or initiatives that deprive small-scale fishers of resources, dispossess vulnerable populations of coastal lands, and/or undermine historical access to areas of the sea. Rights and access to marine resources and spaces are frequently reallocated through government or private sector initiatives to achieve conservation, management or development objectives with a variety of outcomes for different sectors of society.

Table 5.2: Pros and cons of biotechnological tools (analysis of trace elements, FA, and DNA) for seafood geographical traceability (origin and/or production method) (Ricardo et al., 2015).

| Tool | Pros | Cons |
|---|---|---|
| Analysis of trace elements (e.g., TEF) | • Low cost | • Cannot be applied in processed products or those with no mineral structures |
| | • Fast | |
| | • No post-harvesting shift and/or degradation | |
| | • Relatively simple methodology | |
| Analysis of FA | • Low cost | • Cannot be applied in all processed products |
| | • Fast | • Lipids are susceptible to oxidation |
| | • Relatively simple methodology | |
| Analysis of DNA (e.g., PCR-specific primers, real-time PCR, PCR-DGGE, barcoding, or microarrays) | • Highly sensitive and accurate | • Complex methodologies |
| | • Species specific | • DNA susceptible to degradation |
| | | • Time consuming |
| | | • Cannot be applied to all processed products |
| | | • Does not distinguish specimens from geographically close populations |

There have been successful cases of traceability systems, with information stored electronically and where traceability implementation is a positive experience for employees on board. From catch to landing, a quality control system and the traceability system allow better flow of information about seafood. This is highlighted by the study of the Norwegian white fish sector by P. Olsen and K A.-M Donnelly (2012). Using methods of process mapping, interviews and structured questionnaires, the authors

investigated a trawler named CodTrawl, targeting white fish in the North Sea, the Norwegian Sea, the Barents Sea and the fishing grounds around Spitsbergen. The results showed that excellent traceability software systems on board of the boat and transparency from the company's CEO and responsible of operations allowed to retrieve accurate information about quantity landed, catch area, date of extraction, number of trips, storage capacity and transformation (Donnelly & Olsen, 2012).

**Box 9:**

**E-fish – Fish market management system in Italy**

The Council of Europe adopted a specific legislation on compulsory labeling of seafood (Regulation EC No 104/2000 and Regulation EC No 2065/20011), requiring that seafood can be sold to the consumers only if the label displays species, production method and catch area (wild fish) or country of origin (for farmed fish).

E-fish allows traceability and management in a simple way. It helps consumers verify the whole seafood labeling and traceability as follows:

- Auction line, daily sequence number of the sale;
- CE approval mark of the market;
- Sale date and time;
- Catch species, alpha-3 FAO code, commercial name, quality, scientific name;
- Buyer code;
- Lot number, made up of EU number of the vessel, catch date, sequence number for the same species;
- 13-EAN barcode of the transaction;
- Information on the fish market, e.g.: name and website;
- International identification code of the harbor;
- Name of the vessel, EU code of the vessel;
- Company information of the producer;
- Catch date;
- Catch method and tool used;
- FAO catch area and sub-area;
- Presentation, freshness, destination and condition of the fish;
- Net weight, gross weight;
- Package and tare;
- Condition of storage and use.

**Box 9 (continued):**

The characteristics of e-fish also include the analysis of risk management processes with the identification and control of all safety measures in order to:

- Prevent fraud attempts on seafood products, such as ration fraud (sale of frozen fish, refrigerated instead of fresh), fraud on farmed fish sold as wild and change of species fraud;
- Prevent any type of health risk, by adopting the concept of total quality in compliance with national and international laws on fisheries and trade, also referring to the main case studies of health and trade non-compliance in the fisheries sector. Among the issues examined are: laws on the fishing industry and trade related to health and hygiene legislation - documentary controls - inspection methods at landing sites, wholesale markets, distribution centers, retailers and importers and exporters - national and Community legislation on mandatory minimum sizes for marketed fish species - sanctions regime - main legal and illegal additives used in the fishing sector - main cases of non-compliance and RASFF on imported fish - main offences on packaging and labels.

**Source:**http://www.efish.it/auction-management-system-for-fish-markets/traceability.html

**d) Monitoring technology and data collection**

What benefits can technology possibly offer to fisheries management organizations? Under strict regulations, maritime data and analytics is now playing a major role in tracking fishing vessels, with zero latency, assessing whether they are committing offenses and tracking the flow of seafood across supply chains.

Artificial Intelligence (AI) can help prevent illegal fishing; Moroccan technology startup ATLAN Space is developing AI to guide autonomous drones to scan large areas in search of "environmental crimes" such as illegal fishing, poaching or deforestation. In June 2018, ATLAN Space won the National Geographic Society's $150,000 Marine Environment Protection Award to implement a pilot project to combat illegal fishing in the Seychelles. As soon as a drone detects a boat, AI allows it to check whether it is a cruise ship, an oil tanker or a fishing boat. The drone will then determine whether the vessel is operating in a Marine Protected Area and whether it is an authorized fishing

vessel. If it concludes that the activity is illegal, the drone will record the location of the vessel, its identification number and the number of people on board and transmit this information to the authorities by satellite.

Some startups have been working towards providing better tools to monitor fishing fleets and bring more accurate data, helping in the fight against IUU fishing and overfishing. San Francisco-based Spire has one of the largest satellite constellations in the world. They build, launch and write the software for those satellites. Spire Sense Cloud enables access to this industry-leading AIS data.

Despite increased innovation in technology, the efficiency of monitoring vessels at sea has been limited. For instance, the management of transshipment has been found to be compromised by a lack of reported information in transshipment activities. In absence of data-sharing agreements the likelihood that unreported transshipments occur in overlap area, between two jurisdictions, is increased (PEW, 2019).

Governments must enable individuals to achieve productive outcomes in situations where temptations to free-ride are ever present. Ostrom (1990) offers an alternative solution for solving commons dilemmas; Game 5. Indeed, just as farmers can enter into a contract to engage in a cooperation strategy that they will develop with the information they have at hand (Game 5; Ostrom 1990), participants in a CPR have the opportunity to set themselves objectives to be achieved. Contracts and technologies would be designed and chosen by themselves as the resource-users have detailed and more accurate information about the output capacity of the resource. On the state and institution side, an entire ecosystem of new technologies that complement and communicate with each other will be able to determine how policies can influence their development and vice versa. It will help governments examine how they can adapt and improve policies, regulations, enforcement and compliance.

New technologies, including Big Data, the internet of things (IoT), sensors, robotics, data storage and transmission will become more compact and cheaper thus encouraging their use. However, the wider use of these technologies is still limited by their cost, increasingly complex data requirements, difficulties in sharing this data between fisheries management authorities and the limited number of people trained to use these tools (OECD, 2017). There is a growing need to contribute to technological capacity

building of developing economies that do not have the tools to monitor their EEZ properly (OECD, 2017).

## 6. CONCLUSION

Fishing is a long traditional activity embedded in human history. The relationship man has with the sea has always been source of nutrition and sustainable livelihood. However, since the 1950s, the advent of industrial fishing backed by government subsidies, favorable policies and loans to increase fishing capacity have led to frequent instances of overexploitation. Ocean overfishing is simply the fishing of one or more species at rates too high for the targeted fish population to replace itself. The earliest case of overfishing occurred in the early 1800s, when humans seeking blubber for lamp oil decimated the whale population.

While Gordon (1954) explored the economic theory of natural resources utilization and opened up the debate around the economic aspects of overfishing, Hardin's tragedy of the commons (1968) linked individual choices to overexploitation based on collective rationality. Then, bioeconomics models allowed scientists to draw attention on dynamic problems of fisheries optimization. Clark and Munro's (1975) rigorous analytical model has contributed to a better traceability of multi-species stock management. Consequently, biological and economic theories have proliferated with scientific publications whereas institutions received little attention until Elinor Ostrom's (1990) polycentric approach proposed an alternative to state control or privatization of natural resources, highlighting various levels of active oversight by local, regional, and national stakeholders. Following the successful approach of Ostrom, works led by Jentoft et al. (1998) have contributed to fostering collaborative and participatory process of regulatory decision-making among representatives of user-groups, government agencies and research institutions. Finally, ecosystem overfishing has been widely integrated into fisheries management through the works of organizations like FAO. Ecological indicators have contributed to a better understanding of the effects of fishing in the ocean and its ecosystems. The ecosystem perspective on overfishing study of S.A Murawski (2000) and works from Coll et al., (2008) are to be acknowledged for these developments.

In this dissertation, I attempted to expose and give a better understanding of the increasingly complex issues that fisheries are facing around the world, driven by a growing demand for seafood in a context of climate crisis. The emerging issues are a consequence of a more globalized world, with a growing population, changing consumption patterns; illegal fishing fleets, and enhanced fishing practices resulting from the industrialization of fishing. The external drivers such as climate change, land-based and plastic pollution as well as human trafficking and fish trade are a consequence of the failure in policy-making processes regarding fisheries management.

Cross sectoral solutions are available and Ostrom's polycentric approach provides an institutional framework that could strengthen fisheries management practices, depending on the type of fishing, the ecosystem features, the market for which the resources is intended. Local, regional, and national authorities have the potential to unlock cooperative and sustainable management programs based on a set of institutional tools.

**Recommendations**

**Artisanal fisheries**

In regards to small-scale fisheries, the Voluntary Guidelines by FAO (2015) in the context of food security and poverty eradication is a stepping stone for advancing sustainable development in artisanal fisheries. It recognizes the fact that these fishing communities are seldom remote, with difficult access to markets, infrastructure, education, and supplies, thus making them highly dependent upon the resource unit (FAO, 2015). Improving their infrastructure and facilitating their access to the market could unlock a better human, social, and economic development of these communities in developing countries.

**Policymakers**

Implementing stricter regulations on due diligence and transparency in global fisheries supply chains is needed to prevent IUU, slave labor, prevent overfishing and enhance transparency and reporting on fish landings.

**Aquaculture**

A shift towards vegetarian-based diet is vital to make aquaculture operations more sustainable and stop the overfishing of small forage fish that are vital for predators in the ocean.

**Monitoring and surveillance**

Technologies allow a better control and traceability of seafood flows. Strengthening institutional frameworks regarding the use of technology in fisheries management is required for improving data-sharing and transparency between RFMO, national governments and civil society, which is still not achieved.

**Future research ideas**

Further research could be carried out on Ostrom's ecosystem approach. Indeed, the social-ecological system (SES) framework offers an opportunity to strengthen the relationship between social systems and an ecological system made of several dynamic natural processes that interact directly with the choices made in those systems.

Finally, another research should focus on the growing violence on fishing fleets, exacerbated by an increased competition for marine resources. The New York Times journalist Ian Urbina recently released his book: "The Outlaw Ocean". It is a four-year project, built on a series of reported features for the New York Times that brought the author from Antarctica to Somalia. In the context of the fishing industry, this book highlights how the ocean has become a space for corruption, violence and lawlessness. This book would be a starting point towards understanding the crimes that are committed on high seas and how to stop them. These issues are intimately linked to sustainably improving the state of our oceans and require more attention.

**Final statement**

Fisheries contribute significantly to global food security, livelihoods and economy. Although there are signs of improvements, discussions and pledges made towards ending overfishing and restoring the ocean health, the proportion of fish stocks within biologically sustainable levels still shows that one third of the world's marine fish

stocks are overfished, as highlighted by the FAO SDG 14 Progress Report.[14] The world's leading organizations need to move faster and take bold, unprecedented actions to avoid breaking the cycle of life in the ocean. Nature-based solutions need to be fostered such as respecting spawning seasons, feeding periods.

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