How Does Coral Reefs Degradation Impact upon Marine Capture Fisheries, and How Can the Tragedy of the Commons Be Solved? A Case Study of the Philippines 1997-2015

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Coral reefs and fisheries ecosystems have become increasingly important for the Philippines' population. This paper explores the ecological indicators of these ecosystems to identify possible degradation and overfishing. Moreover, economic and social indicators will show the impact of the degradation of these ecosystems on the economy and the society. This dissertation looks at the tragedy of the commons literature and follows the appropriate frameworks to recognise the nature of the problem looking at governance indicators. Findings show that if the institutions of the Philippines had been more robust over the past decades, the coral reefs and the fisheries would be in better conditions.

1. Introduction

1.1. Importance of Coral Reefs and Fisheries

The Coral Triangle has been recognised as the global centre of marine biological diversity. About 76% of all coral species and 37% of all coral reef fish of the world live in its waters. Coral reefs are a critical habitat for many species as they provide essential ecosystem services. The Philippines, with 27000 sq. km., has the second largest number of hard coral species with 464 after Indonesia with 590 (Wilkinson, 2004). The physical structures built by the actions of many minuscule coral animals provide a home to 4000 species of fish along with other life forms such as molluscs, crustaceans, starfish and sponges (Burke *et al*, 2012).

Fisheries are important contributors to nutrition, employment, income and foreign exchange earnings. More than 40 million people live on the coast within 30 km of a coral reef, representing 45% of the total national population (Wilkinson, 2008; Burke *et al*, 2012). A great part of the fish production is consumed locally, with a per capita fish consumption of 32.7 kg in 2011 (Fisheries and Aquaculture Department, 2009). Moreover, about 2 million people in the Philippines are dependent on fisheries for employment and 1 million small scale fishers directly depend on reef fisheries (Burke *et al*, 2012).

The Philippines was ranked among the major fish producing countries in the world in 2012, with a total production of 3.1 million tonnes of fish and other aquatic animals (Fisheries and Aquaculture Department, 2014). Its marine capture production accounts for an average of 2.2 million tonnes of marine fish between 2003-2012 (Fisheries and Aquaculture Department, 2016). The industry contributes 1.8 percent to the Philippines' Gross Domestic Product (GDP) at prices in 2012 and the value of fish and fishery products in 2013 was estimated to be US$264 million (Fisheries and Aquaculture Department, 2014). Furthermore, the country exported at least 1,370 tonnes of coral trout which raised an estimated retail value of around $140 million in 2007. Also, 1,000 tonnes of other species of live reef fish with a retail value of more than $35 million were exported by the Philippines, attracting a growing number of small-scale fishers over the past decade but at the expense of the increase in overharvesting of these species (Burke *et al*, 2012).

In addition, coral reefs are vital to tourism as they attract divers, snorkelers and recreational fishers and tourists fascinated by their white sand beaches (Burke *et al*, 2012). The share of tourism to GDP was 8.2 percent in 2015 compared to 6.8 percent in 2011 (Philippine Statistics Authority, 2016b). Furthermore, coral reefs help to dissipate wave energy, reducing erosion and decreasing inundation

and wave damage during storms. Consequently, human settlements, infrastructure and valuable ecosystems such as seagrass meadows and mangrove forests are protected. Data from 2000 estimates that the economic benefits of shoreline protection from reefs in the Philippines was $400 million (converted to US$ 2010) (Burke *et al*, 2012).

1.2. Threats to Coral Reefs and Coral Reef Fish

Surveys in the Philippines show a progressive decline in coral reefs condition in recent decades due to different types of threats (Burke *et al*, 2012). Firstly, overfishing, destructive fishing methods and sedimentation damage have destroyed many reef areas (White, 2000). Secondly, coastal expansion along crowded shorelines threat around 60% of the reefs. Thirdly, watershed-based pollution from agricultural overflow and erosion of deforested slopes present 60% of the coral reefs threat. Lastly, if one was to add to these local threats the effects of thermal stress and coral bleaching, about 80% of reefs are in high or very high risk (Burke *et al*, 2012). Socioeconomic monitoring has occurred in the Philippines through surveys in 27 communities. These households communicated a decline in resource conditions due to over-fishing and damaging fishing such as cyanide fishing, dynamite fishing and usage of fine mesh nets. However, the response to larger scale threats such as climate change and pollution were low, demonstrating a disconnection in local perceptions of the most harmful threats facing coral reefs and fisheries in these regions (Wilkinson, 2008).

Moreover, even though catch rates in fisheries production have been falling since the 1980s, the fishing effort has been continuously raising (Anticamara and Go, 2016). The rate of utilisation of coastal resources has been influenced by the Philippines' government economic policies that inadvertently pressured the marine environment. Economic policies, such as subsidies, incentives, tax exemptions and lower tariff rates resulted in increased fishing intensity and reduced wild stock resources (Aliño *et al*, 2004).

1.3. Losses and Consequences

The incidence of destructive fishing methods, targeting spawning aggregations and capture of immature fish, are causing signs of overfishing in the main target reef fishery species. In the Philippines, the harvest rate is around 30% higher than the maximum sustainable yield which causes stock collapses in the absence of increased management (Burke *et al*, 2012). Evidence shows a decline of fish catch around the country making fish for food out of reach for the population in the region. Lobster and large tunas are icons in export-oriented markets. With the diminishing fish catch rate, the ones that are caught are exported, leaving the local markets or baskets of fishers out of reach.

Moreover, scads, sardines and anchovies that are demanded for food security by Filipinos, have greatly decreased in quantity and their prices have risen sharply due to poor management. The country holds an increasing trend of losses of about US$120 million every year which implies that fishers are losing their vital source of protein and income (Green *et al*, 2003).

Refer to Appendix A for a glossary of various terms.

2. Methodology

2.1. Why a Case Study?

A case study attempts to study and understand the particularity and difficulty of a single case. Case studies are used when a case itself is of very special interest and when one is seeking to understand them (Stake, 1995). In economics, a case study may be used to investigate the structure of a given industry or the economy of a region as this dissertation will do with the Philippine fishery industry. Moreover, case studies are used to increase the knowledge of the reader about a related phenomenon (Yin, 2009).

It is appropriate to use a case study when asking 'How' or 'Why' questions and when it is required to study some social phenomenon extensively and in-depth (Yin, 2009). This dissertation attempts to clarify how the event of coral reef degradation impacts upon declining production in marine capture fisheries and other social and economic indicators in the Philippines, and see how the tragedy of the commons can be solved. In the current investigation, a contemporary event such as the degradation of the coral reefs and the state of fisheries is being analysed and the relevant circumstances cannot be manipulated as they are determined by external factors. This paper will directly observe the event but will not be able to manipulate the behaviour of the variables being analysed (Yin, 2009).

It is argued that case study research lacks rigor as too many times it does not follow systematic procedures and influences the direction of the results and conclusions (Yin, 2009). Campbell and others argue the opposite because the case study has its own rigor which is different but it is not less thorough than the rigor of quantitative approaches. Moreover, subjectivism and bias applies to all methods, not just to the case study as for example, the selection of categories and variables for a quantitative investigation has an element of arbitrary subjectivism (Flyvbjerg, 2006).

Critics of case study research also argue that it provides little basis for scientific generalisation. However, if one was to consider the same question for an experiment it is found that scientific facts are rarely based on single experiments and they are usually based on multiple set of experiments (Yin, 2009). Moreover, Flyvbjerg (2006) claims that it would be incorrect to declare that the only way to work is generalising or that one cannot generalise from a single case. This will depend on the case and how it is selected. Popper used the example 'all swans are white' and suggests that only one observation of a single black swan would be meaningful for further investigations. The positive aspect of the case study is that due to its in-depth method it is convenient for identifying 'black swans'

(Flyvbjerg, 2006). This dissertation will use the work of Ostrom (1990) and its general framework for robust institutions to identify solutions for this specific case.

2.2. Data

To analyse the impact of coral reefs degradation on fisheries and the nature of the common source situation, this dissertation will follow the Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries in order to choose the relevant indicators for sustainable development of marine capture. This is the major initiative related to the use of ecosystem indicators for sustainable fisheries (Cury, 2005). This paper will look at the main dimensions provided in the guidelines which are: ecological, economic, social, and governance (Garcia *et al*, 2000). There is a large number of potential indicators that could be used. To assess all of them, a significant amount of time and resources will be needed. For this reason, some of the indicators will not be presented in this study.
Chapter 4 will focus on a significant number of these indicators. Firstly, ecological indicators of fisheries such as the catch structure and pressure to fishing using qualitative data, mostly provided by the FAO, the Bureau of Fisheries and Aquatic Resources of the Department of Agriculture and the Marine Resource Institute of the University of the Philippines.

Secondly, ecological indicators of the coral reefs condition will be assessed using both qualitative and quantitative. Evidence will show coral reefs status between 1997 and 1998 and then from 2003 to 2008. Local reef threat data from 2002 to 2011 which will be shown. Due to unavailability of coral reefs status quantitative data after 2008, qualitative data will be presented in the form of maps showing coral reef bleaching alert area in key dates in 2010 and 2013. This will make possible to demonstrate the degradation of coral reefs in those years and compare it to the fish indicators from 1997 to 2015.

Thirdly, economic and social indicators will be analysed using quantitative fisheries data from the Philippine government and the FAO. The indicators that are evaluated are: harvest volume and value, average fish consumption, GDP per capita, demographic indicators, employment, fisheries contribution to GDP and fisheries exports' volume and value.

Due to unavailability of data some of the economic and social indicators will not show full trend data from 1997 to 2015. Those indicators are as follows. Firstly, the value of the total production of marine municipal fisheries which is shown between 2004 and 2015. Secondly, average fish consumption per capita (kg/year) shows data from 1997 to 2013 as years 2014 and 2015 are unavailable. Thirdly, the

percent distribution of fisheries to GDP will show data from 1998 to 2015 where 1997 data is missing. Lastly, fisheries employment data will show between 2011 and 2015.

Lastly, governance indicators such as capacity to manage, property rights and compliance regime will be analysed following the framework provided by Ostrom (1990) in chapter 3 (Garcia *et al*, 2000). Governance indicators are provided by The Philippine Fisheries Code of 1998 and various authors.

The use of both qualitative and quantitative data and the unavailability of some of it makes the study more complex and increases the amount of limitations in the analysis. This is another indication that a case study is the appropriate method for this dissertation (Yin, 2009). This investigation would not be able to be studied properly using econometrics due to the limited availability of quantitative data as it will not be possible to compare a long set of series.

3. Theory

This chapter will firstly, look at the tragedy of the commons theory presented by Hardin (1968), formalised as the prisoner's dilemma. Secondly, Ostrom's (1990) alternative theory and framework will be examined.

Hardin's exposition of The Tragedy of the Commons in 1968 claims that freedom in a common brings destruction to all, by illustrating the example of an open pasture where each farmer will try to have as many cattle as possible as they try to maximise their gains (Hardin, 1968). To make the case more relevant to this paper, the parable will be adapted to fisheries.

Imagine a body of water which has finite capacity for fish production. The first few fishers find fishing profitable, which will end in more boats entering in the fishery. Some of the boats belong to the existing fishers who want to increase their capabilities and others from the new fisher folks who are attracted by profitable fishing. The higher the fishers' individual catches per unit the lower the fishing effort needed. This will affect utility positively, but the negative aspect is that overfishing will occur at some point. Overfishing will mean that the fish population's natural ability to renew themselves in a sustainable basis will be damaged (Berkes, 1985).

This adjustment can be less damaging to the ecosystem while there is low population growth due to wars and diseases. However, when these factors diminish considerably, social stability brings an increment of population growth which ends the logic of the adjustment and it causes tragedy. Hardin argues that this occurs when the individual benefits from his/her ability to deny the truth even though society deteriorates (Hardin, 1968).

But furthermore, Hardin (1968) explains that there are several options to solve the tragedy depending on the nature of the commons. In the case of commons as a food basket, it might be sold as private property or kept as public property but having a limit to enter them with coercive laws or taxing devices. As the population grows significantly, these laws become more important (Hardin, 1968).

Every new inclusion of the commons leads to the violation of somebody's personal liberty which it is usually accepted because no one complains about this loss. The most important solution that Hardin finds in preserving these freedoms is by renouncing to the freedom to breed which would mean a

lower growth of the population. This is the only way to end with the tragedy of the commons (Hardin, 1968).

Ostrom (1990) argues that Hardin was not the first to realise about the tragedy of the commons. Aristotle said that everyone thinks of themselves more than they do of the common interest. Therefore, what it is common to all will not be treated with sufficient care. Ostrom indicates that Hardin uses the grazing commons as a metaphor for the problematic of overpopulation.

Ostrom (1990) considers Hardin's model formalised as a prisoner's dilemma game, where two fisher folks can be thought of as players in a game using a common fishery. There is a limit to the volume of fish that can be caught in the fishery and it is referred to as volume Y. The cooperative strategy would be that each fisherman will catch Y/2. If the fishers do not cooperate, then they will defect and both will catch as many fish as they think they can sell at a profit. If both of them limit their catching to Y/2 they will gain 10 units of profit. On the contrary, if both choose to defect, they will obtain zero unit of profit. If one limits the number of catches but the other fishes as he wants, the defector obtains 11 units of profit and the cooperative fisher folk obtains -1. This results in both selecting the dominant strategy which is to defect obtaining zero profit (Ostrom, 1990).

In the prisoner's dilemma, the players have complete information but they decide not to cooperate. If communication is possible and there are agreements between the players, it implies that all of them know the complete structure of the game and payoff the outcomes. But the dominant strategy is to defect no matter what the other player decides. The equilibrium outcome from this strategy is not Pareto-optimal because there are other outcomes preferred by at least one player and it is as good for the others. The prisoner's dilemma then shows how separately rational strategies ends in collectively irrational outcomes which challenges a fundamental belief that rational human being can achieve rational outcomes (Ostrom, 1990).

Ostrom (1990) proposed a different game in which the fishers themselves can make an agreement to work out a cooperative strategy. Now, the fishers must negotiate a strategy for sharing the carrying capacity of the fishery and the costs of applying this contract. The agreement would not be enforceable unless agreed unanimously by the fishers. And any unfair sharing of the capacity or the enforcement costs would be vetoed by the rest of the fisher folks during the negotiations. The result of the pact is to share equally the sustainable yield levels of the fishery and the costs of enforcing the contract. Furthermore, there is an enforcer, for example a government official that will enforce the

contract in case one of the fishers do not comply with it. But the fishers are not dependent on this measure, because they ask the enforcer to enforce only what they agreed on the contract. If the enforcer tries to charge too much for his or her services, neither will agree to the contract and the worst they could do is to defect. This is only one way to solve the commons dilemma.

Moreover, Ostrom (1990) analysed different examples of Common Pool Resources (CPR) such as Alicante, Spain or Bacarra-Vintar, the Philippines with very complex, uncertain and interdependent environments. However, individuals recognise the importance of maintaining their reputation as reliable members of their communities. These resource systems clearly meet the criterion of sustainability and robustness of their institutions; therefore, they have remained stable over long periods of time.

These settings have had different rules and they cannot provide the basis for an explanation for sustainability and institutional robustness. However, eight design principles characterise all these solid CPR institutions: clearly defined boundaries; congruence between appropriation and provision of rules and local conditions; collective-choice arrangements; monitoring; graduated sanctions; conflict-resolution mechanisms; minimal recognition of rights to organise and nested enterprises (Ostrom, 1990). Section 4.4 of this paper will identify the design principles of this case and section 5.1 will suggest a solution for this case.

4. Data and Findings

This section will examine ecological, economic, social and governance indicators of the situation of coral reefs and fisheries in the Philippines.

4.1. Ecological Indicators of Fisheries.

The structure of the Philippines' fishing industry is composed of marine capture fisheries, inland capture fisheries, and aquaculture. Marine capture fisheries can be divided into municipal fisheries and commercial fisheries. Marine capture fisheries are the most important sector of the country's fisheries. The production associated with coastal ecosystems is around 65% of the total production in the Philippines (Aliño *et al*, 2004). The Philippines' catch profile shows that 51% of reported marine fisheries production was from municipal fisheries while 49% was from commercial fisheries. Although commercial and municipal fishers work in different sectors of the fishing industry, they are direct competitors (Fisheries and Aquaculture Department, 2014).

The Philippines has 2.2 million km^2 of highly productive seas with extensive fishery resources at its disposal. Evidence from 1988 collected in Cape Bolinao reef fishery in Lingayen Gulf suggests that such fisheries are capable of maintaining a high production despite heavy fishing pressure. However, yield comparisons with other reef fisheries on the characteristics of the catch and the use of gear types, recommended not to increase the extraction rate (Campos *et al*, 1993).

Nevertheless, studies indicate that the Philippines have reached the maximum economic yield from its demersal fish stocks as early as the late 1960s. Pelagic fisheries showed signs of overfishing and declining catch per unit effort. Further data collected in 2002 from the Lingayen Gulf shows that the fishing ground reached its maximum sustainable yield more than 20 years ago. The WorldFish Center in 1998-2001 advised that the level of fishing in the Philippines was 30% higher than the fish were capable to produce (Green *et al*, 2003).

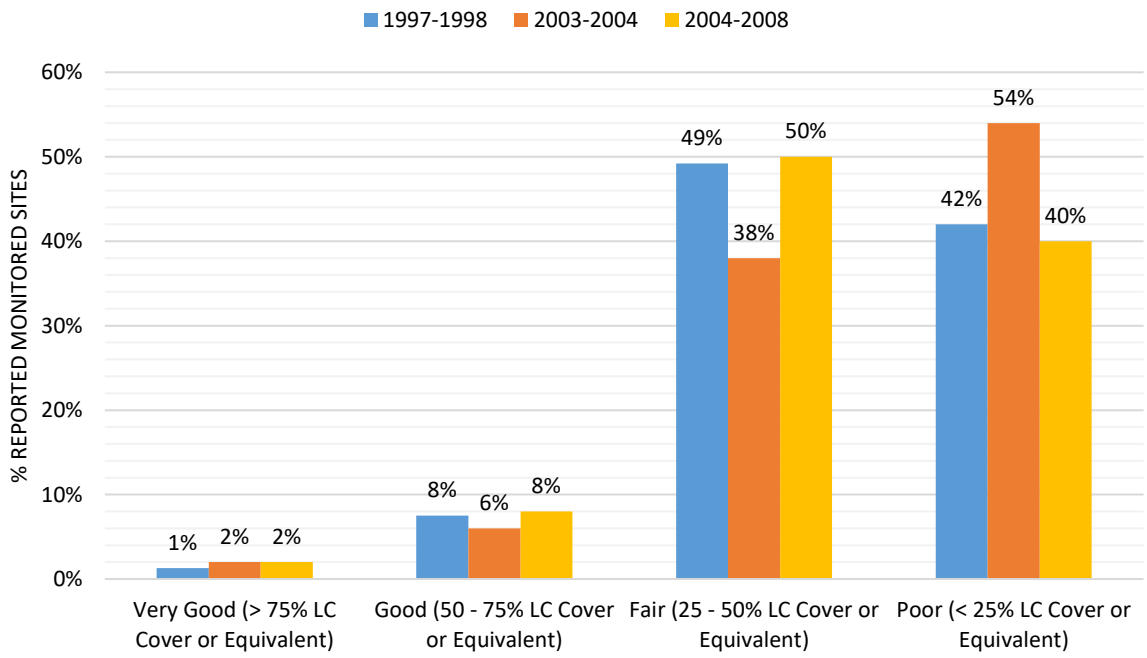
Although there were exceptions in lightly fished areas such as in waters of Palawan and Mindanao, there was still an observed change in species composition (Fisheries and Aquaculture Department. 2014). For instance, in Central Visayas, the volume of catch has been reduced, but in addition, the catch compositions have changed from coastal pelagic to oceanic pelagic species and away from demersal to pelagic species due to fishing pressure (Green *et al*, 2004).

4.2. Ecological Indicators of Coral Reefs

In the Philippines, coral reefs have been studied extensively compared to other countries in Southeast Asia with surveys from the late 1970s. The result of the surveys is a progressive decline in coral reef condition over the past decades (Burke *et al*, 2012).

During the mid-1997 to late-1998 there was an unprecedented bleaching of hard and soft corals in the world. This bleaching coincided with the El Niño event and switching to La Niña (Wilkinson, 1998). Each El Niño event causes thermal stress that results in severe coral bleaching. La Niña events cause bleaching by warming areas that were not affected during El Niño. The 1997-1999 period was exceptional as both parts of the El Niño-Southern Oscillation (ENSO) system arose consecutively without any time gap in between (Eakin *et al*, 2014).

Figure 1. Status of Coral Reefs during 1997-2008



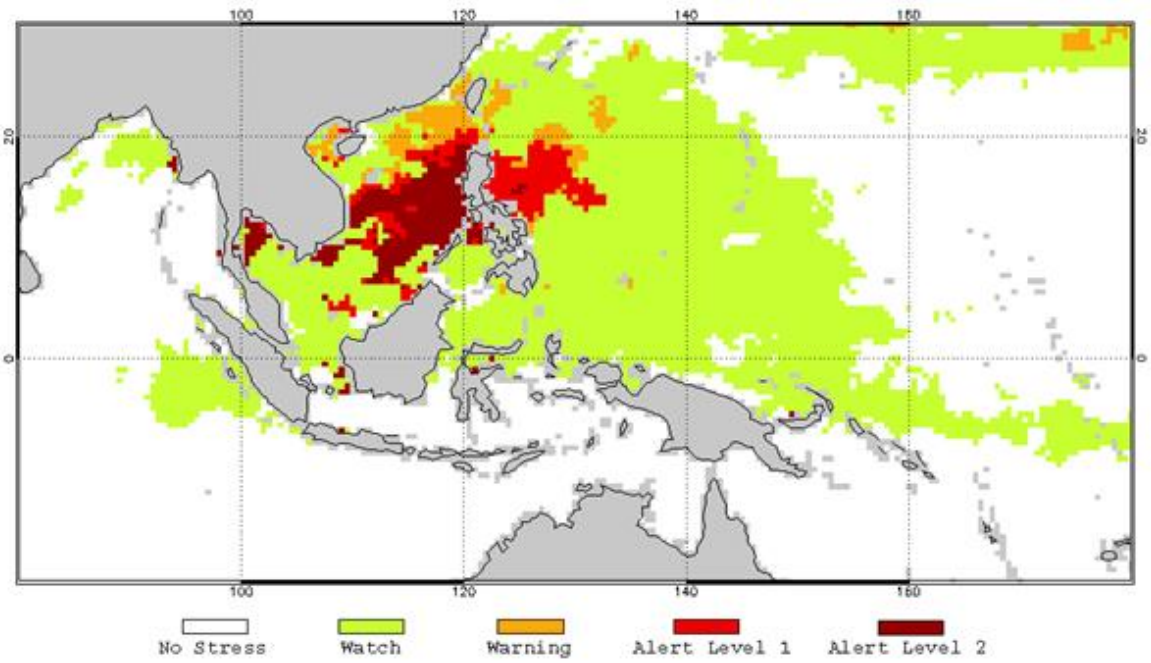
Source: Wilkinson, 1998; 2008.

The bleaching was particularly severe in western regions of the Philippines where temperatures of 33-34 ºC degrees were reported, and bleaching went as deep as 28m entirely impacting soft corals and anemones. Up to 75% of the community of hard corals were bleached in some areas. However, mortality appeared to be low. As demonstrated in Figure 1, during 1997 and 1998, only 1% of the reported monitored sites were in very good conditions, 8% were in good conditions, 49% were in fair conditions, and 42% were in poor conditions (Wilkinson, 1998). The most severe influence arose at Bolinao, Pangasinan where 80% of the corals were bleached (Wilkinson, 2000).

After the mass bleaching from 1998 there was documented recovery. The live coral cover decreased by 19% after bleaching, but it was constant from 1999 to 2001 (Wilkinson, 2002).

During 2003-2004, the reported monitored sites in very good conditions increased by 1%, the ones in good conditions decreased by 2%, coral reefs in fair state decreased by 11% and coral reefs in poor state increased by 12% as presented in Figure 1. There is a shift from the coral reefs in fair conditions to the ones in poor conditions. After this negative impact, between 2004 and 2008 conditions slightly improved (Wilkinson, 2008). The reported monitored sites in very good conditions stayed stable in 2%, the ones in good conditions increased back to 8%, the ones in fair conditions increased up to 50% and the ones in poor conditions decreased down to 40% as seen in Figure 1.

Figure 2. NOAA Coral Reef Watch Satellite Bleaching Alert Area 19 July 2010

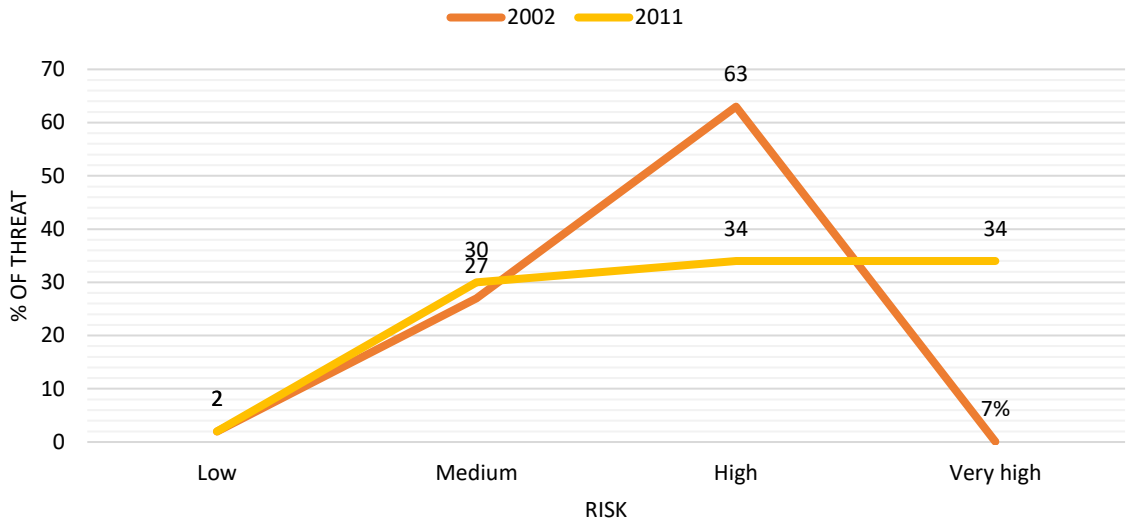


Source: NOAA Coral Reef Watch, 2010.

During the weak 2009-2010 El Niño, bleaching patterns were like those in 1997-1998, however, less severe (Eakin *et al*, 2014). Figure 2 shows the potential risk level of bleaching thermal stress for corals in the Philippines on the 19th of July 2010. In the areas where stress level is "Warning", possible bleaching might occur. "Alert Level 1" areas show the likelihood of bleaching while in "Alert Level 2" areas mortality is likely to happen (National Oceanic and Atmosphere Administration, 2013). "Alert level 2" occurs in the South China Sea close to the Philippines' areas of Palawan and Luzon and at the

same time “Alert Level 1” is happening in the Philippine Sea. This demonstrates further degradation of coral reefs in the area with likely mortality.

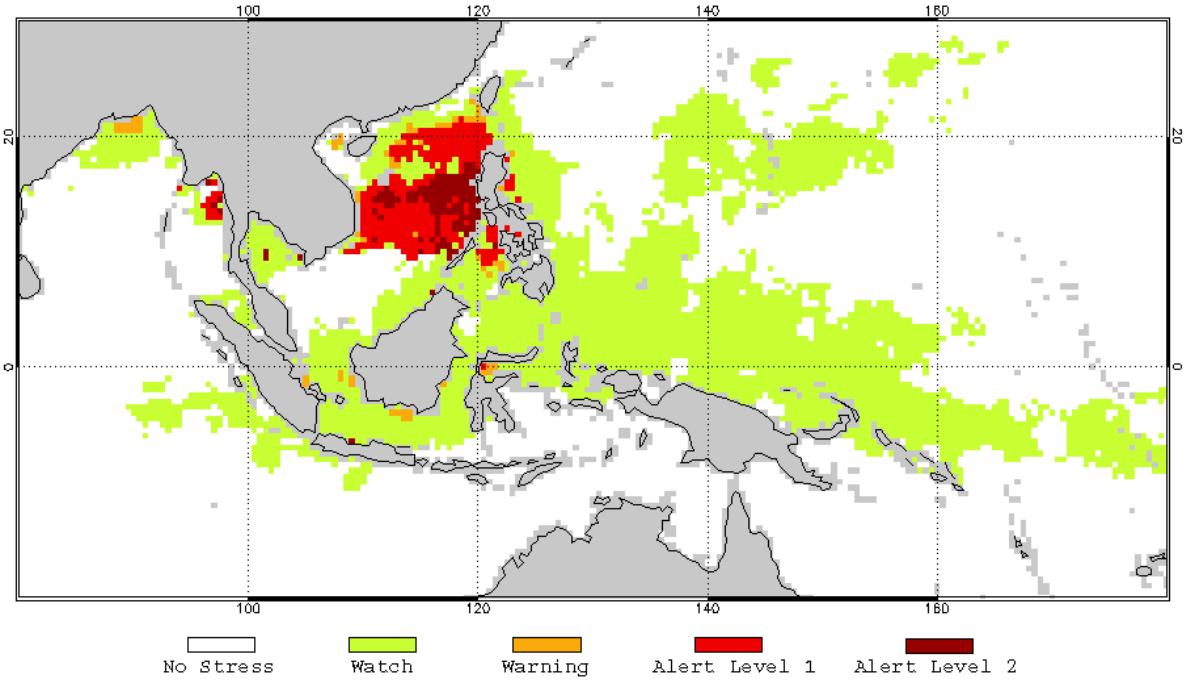
Figure 3. Local Reef Threat in 2002 and 2011



Source: Burke *et al*, 2002; Burke *et al*, 2011.

Regarding local reef threat, Figure 3 shows data from 2002 and 2011. In 2002, coral reefs at low risk were 2%, 27% at medium risk, 63% at high risk and 7% at very high risk. In 2011, coral reefs at low risk stayed constant with no difference and coral reefs at medium risk increased by 3%. Coral reefs at high risk decreased by 29% while the ones at very high risk increased by 27%. There is a significant shift from the coral reefs that were highly threatened in 2002 to the ones that were very highly threatened in 2011. Consequently, the coral reefs considered threatened (medium, high and high threatened) were 98% (Burke *et al*, 2011). This figure indicates that most of the coral reefs are threatened by effects of recent thermal stress and coral bleaching. If these effects combine with local threats such as destructive fishing, it would lead to severe degradation of the coral reefs (Burke *et al*, 2012).

Figure 4. NOAA Coral Reef Watch Satellite Bleaching Alert Area 24 June 2013.



Source: NOAA Coral Reef Watch, 2013.

Further considering NOAA Coral Reef Watch Satellite, it is found that as of 24th of June 2013, there is another event of potential risk of bleaching thermal stress in the Philippines. Figure 4 reflects how the west coast of the Philippines is in "Alert Level 2" and the Sulu Sea is in "Alert Level 1". Quantitative data is missing in this respect and there is no evidence as to what extent this bleaching affected the status of the coral reefs, however, Figure 4 demonstrates that if coral reefs were in risk by several threats, this coral bleaching event might have worsened their status.

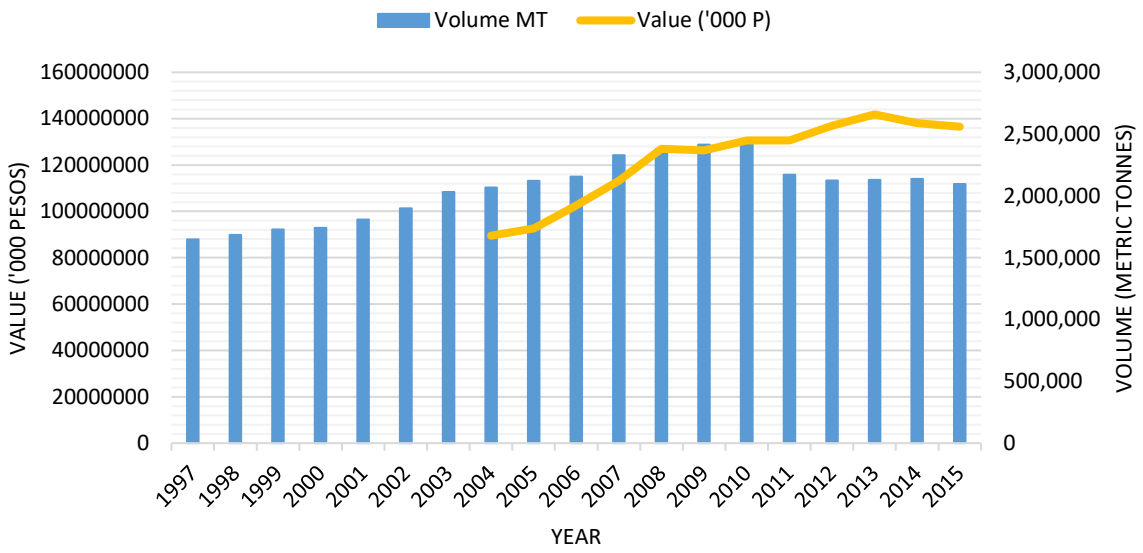
As of June 2014, the US National oceanic and Atmosphere Administration's (NOAA) predicted that there was 70% chance that El Niño and La Niña would develop early in 2015 (Eakin *et al*, 2014) Although, El Niño was never fully formed, it facilitated to trigger coral bleaching around the world (Eakin *et al*, 2016). During the period 2015-2016 a strong El Niño was formed, spreading and making the bleaching worse. Unfortunately, the current global coral bleaching event is the longest ever recorded causing thermal stress leading to mass bleaching in several reefs that never bleached before (Eakin *et al*, 2016).

To summarise, the coral reefs of the Philippines are in critical conditions because of global climate change and other threats as one can see above.

4.3. Social and Economic Indicators of Fisheries

To analyse the link between coral reefs and volume and value of production, this paper will use marine capture fisheries data. To analyse the other indicators, the total fishing industry data will be used due to unavailability of marine capture data. This will be considered when analysing the data as it is a limitation to the study.

Figure 5. Volume (metric tonnes) and Value ('000 pesos) of Total Production of Commercial and Marine Municipal Fisheries.

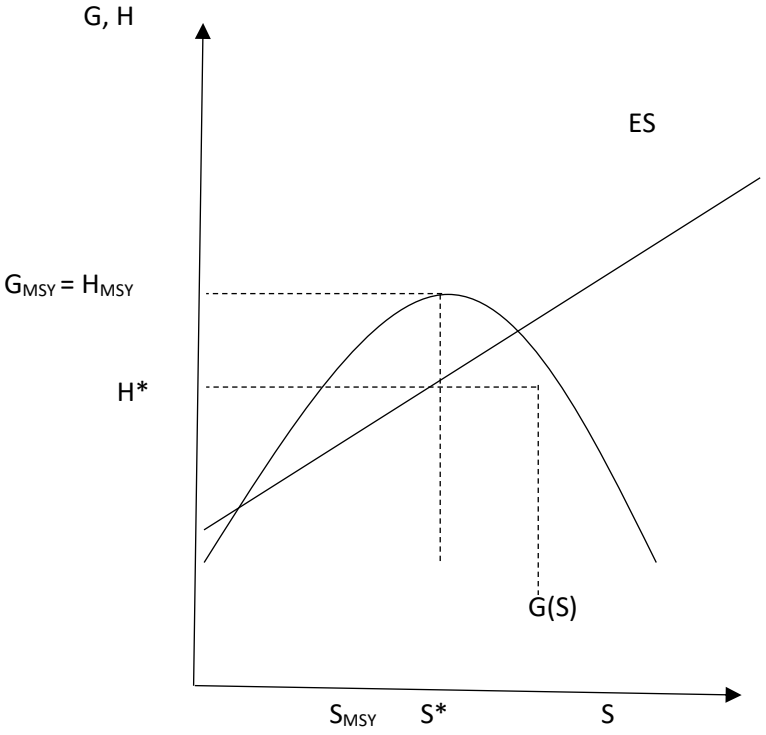


Source: Department of Agriculture, 2002; 2004; 2007; 2010; 2013 and 2015.

In Figure 5, the volume and value of the total production of commercial and marine municipal fisheries are represented. Regarding the production volume, there has been an increasing trend from 1997 to 2011, when there is a reduction of the fish capture of around 260,000 metric tonnes compared to 2010. Following 2011, the production volume overall keeps decreasing until reaching 2,096,417 metric tonnes. This is a difference of about 330,000 metric tonnes compared to the highest volume production in 2010.

The Philippines has enjoyed an increase in the size of the fish catch over time (Asian Development Bank, 2014) even since 1997, when the degradation of coral reefs was occurring. However, as seen above, the results of several studies demonstrate that the country has exceeded the carrying capacity and this could be related to the degree of loss of coral cover in their coral reef ecosystems (Asian Development Bank, 2014). This could explain why after 2010 the production volume decreases significantly (Philippine Statistics Authority, 2016a).

Figure 6. Steady-state Equilibrium Fish Harvest and Stock at Effort Level.

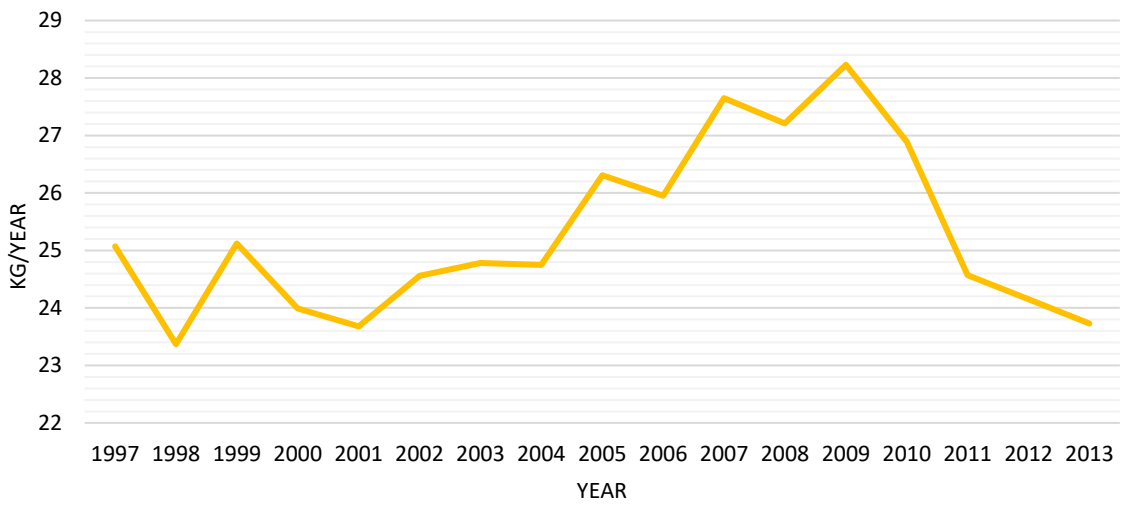


Source: Perman *et al*, 2011.

In Figure 6, vertical axis show the rate of growth (G) and harvest (H) and horizontal axis present the level of stock (S). Harvesting activity can be aggregated into one magnitude called effort (E). At stock size S_{MSY}, the quantity of net natural growth is at a maximum (G_{MSY}). A maximum sustainable yield (MSY) steady state can be achieved if a stock of S_{MSY} harvest is set at the constant rate $H_{MSY.}$ MSY allows the stock to renew itself, therefore, it is the maximum sustainable use. The yields that might be achieved depend on the amount of effort applied. Biological equilibrium occurs when the resource stock is constant through time and it is achieved when the amount being harvested equals the amount of net natural growth. At G(S) = ES the maximum harvest is achieved without depletion of stock. If H is bigger than the sustainable yield, S will fall and if H is smaller than the sustainable yield, S will grow (Perman *et al*, 2011). In this case, it might be possible that the decrease in volume of catch during 2011-2015 is due to H being bigger than G(S) during the period 1997-2010.

Moreover, Figure 5 also shows an increasing trend in the value of commercial and marine municipal fisheries production from 2004 to 2015. This increase is clearly seen from 2004 to 2008. During 2008-2011 production values, do not increase significantly. Then, the graph depicts a greater increase reaching its highest peak in 2013. Afterwards, production values start to slowly decrease.

Figure 7. Average Fish Consumption per Capita (kg/year)



Source: FAO, 2016.

Literature suggests that the own-price elasticity of the demand for fish is high, showing elastic demand with rising values as income rises (Garcia *et al*, 2005). The Philippines' annual GDP per capita in current US$ has been increasing from 1,127 in 1997 to 2,904 in 2015. Moreover, Figure 7 illustrates that the average fish consumption per year has overall increased between 1997 and 2009. The increase in income and in average fish consumption could explain why there has been an increase in production values between 2004 and 2009.

However, from 2010 to 2013 there was a great decrease in the average fish consumption, as Figure 7 represents, even though income continued to increase during these years. This could be because supply shortage from the marine capture fisheries from 2011 onwards as one can see above in Figure 5. Following the market equilibrium theory, if supply of fish decreases, the equilibrium price should have to rise to reduce the quantity demanded (Goolsbee *et al*, 2013). This would explain both the rise in values and the decrease in quantity consumed between 2010 and 2013.

Moreover, the Philippines has had an increase in population. Data shows that in 2000 the population was formed by 76.51 million people and in 2015, it rose to 100.98 million people in the country. Due to population growth, one of the main challenges of the fisheries sector is how it will be able to compensate for the deficits in fish supply given the increasing demand. There is an increase in the annual population growth rate of the Philippines which continues to raise at 1.72% (Philippine Statistics Authority, 2016d). Consequently, a considerable deficit in fisheries yield relative to per capita consumption is expected (Aliño *et al*, 2004).

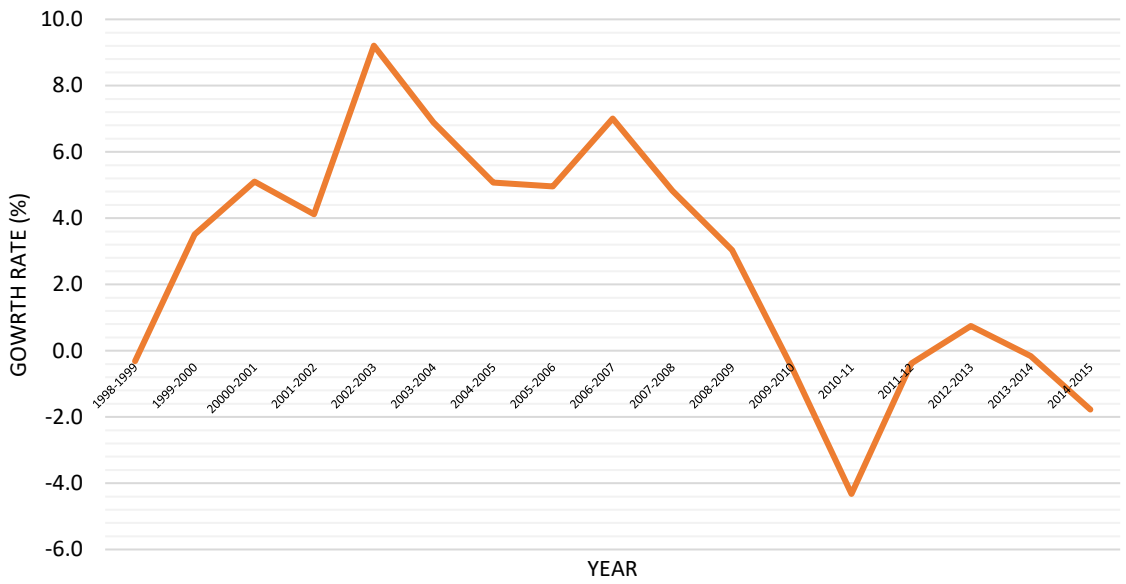
Table 1. Employed People by the Fishing Industry from 2012 to 2015 (in thousands).

Year	2012	2013	2014	2015
Employed people	1,432	1,407	1,396	1,321

Source: Philippine Statistics Authority, 2016e.

Table 1 reflects the number of people employed by the fishing industry in the Philippines. Unemployment increased in the fishing industry during the four years represented in the table. In 2012, the industry employed 1,432 thousand people while three years later this figure was reduced by 111,000 people. This increase in unemployment might be the result of less capacity in the sector during 2012-2015 or it might be the consequence of other reasons related to aquaculture and inland capture fisheries that are not being analysed in this paper.

Figure 8. Growth rate of fishing industry to GDP (Constant 2000 prices)



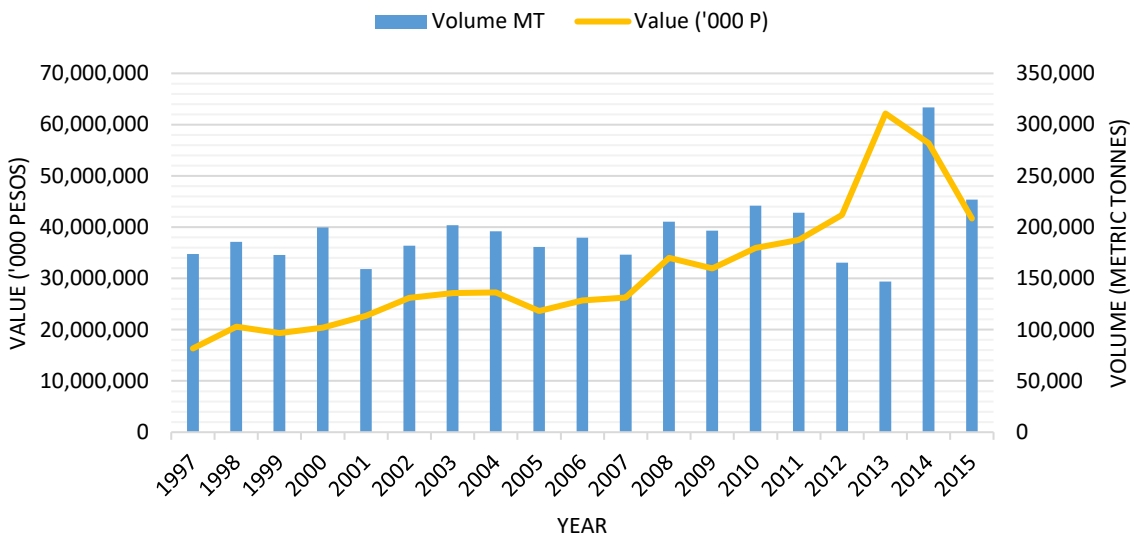
Source: Philippine Statistics Authority, 2016c.

Figure 8 illustrates the growth rate of the fishing industry to GDP. From 1998 to 2003 the fishing industry grew significantly reaching 9.2 growth rate in 2003. In subsequent years, the industry contribution to GDP slumped 4.2% in 2006, and grew up to 7% in 2007. Afterwards, the growth rate fell dramatically, reaching its lowest point of -4.3% in 2011. Lately, the growth rate increased up to 0.7% in 2013 and decreased again down to -1.8% in 2015.

The low contribution of the fishing industry in the recent years could be affected by the degradation that the marine capture fisheries are facing as explained above. The overall production volume has

decreased while the production value increased, this could have had consequences for the average fish consumption per capita and for employment in the fishing industry.

Figure 9. Volume (metric tonnes) and Value ('000 pesos) of Total Fishery Exports



Source: Department of Agriculture, 2002; 2004; 2007; 2010; 2013 and 2015.

Figure 9 indicates the volume and value of total fishery exports in the Philippines from 1997 to 2015. The total fishery exports show a stable trend in volume and value during years 1997-2011. However, in 2012 and 2013 exports suffered a substantial fall in their volume and a significant rise on their value, especially in 2013. This coincides with very low average fish consumption and low production of marine capture fisheries. It might be possible that marine capture fisheries had an important effect on exports during these two years due to supply shortage. Moreover, in 2014 exports volume rise dramatically which could be the result of an increase in the production volume from other types of fisheries. In 2015, volume and value get closer to their average values and show a more stabilised figure. Nevertheless, exports' performance might be affected not only by the Philippines' fishing industry capacity but also by the international demand.

4.4. Governance Indicators

This section discusses the eight design principles mentioned in section 3 to find out if the Philippine fisheries system is sufficiently robust.

Firstly, this dissertation will examine if the boundaries are clearly defined. The compliance regime of the Philippines' fisheries is set by The Philippine Fisheries Code (PFC) of 1998. The PFC indicates that the use and exploitation of Philippine waters is exclusively reserved to Filipinos. The Department of

Agriculture issues a limited number of licenses and permits the conduct of fishery activities depending on the limits of the MSY of the resource. This will be subject to scientific studies and available evidence and preference will be given to resource users in local communities close to the municipal waters. These limitations are set by special agencies and the Local Government Units (LGUs) in municipal waters (The Philippine Fisheries Code of 1998). LGUs are responsible for enforcing fisheries laws, rules and regulations; delineate municipal waters and ordinances in municipal waters and local chief executives guarantee that they are applied (Green *et al*, 2003).

The PFC prioritises municipal fishers in its objectives, however, the PFC does not state clearly who may use and control municipal waters for fishing activities as other provisions within the PFC reported that municipal waters between 10.1 and 15 kiliometers from the shoreline may be utilised by small and medium sized commercial fishers. There are concerns that this provision will intensify resource reduction in municipal waters and allow local officials who own commercial fishing firms to jeopardise local policy. In addition, this will affect food security as it permits commercial fishing in a greater area of municipal waters than was allowed prior to the PFC (Shannon, 2002).

Although, the PFC tries to emulate international standards, its ambiguous language in some areas increases the concerns for small-scale fisherfolk regarding commercial sector access to municipal waters (Shannon, 2002). Therefore, this paper will assume that the first design principle is not clearly met.

Secondly, looking at <u>the congruence between appropriation and provision of rules and local conditions</u> it is found that limitations are established on the total quantity of fish captured and the type of vessels and fishing gear that should be used for specific periods and areas. The Department might also declare closed seasons to take conservation of threatened and endangered species (The Philippine Fisheries Code of 1998).

Different laws promoting foreign investment by the Philippines government led foreign corporations the right to extract resources and repatriate profits without taxation. These corporations have helped to increase the total annual marine fish production to over one million metric tonnes bringing large-scale trawlers and purse-seiners. This has shaped export-oriented trade patterns that have created a dual economy. The intensified harvesting has lowered the productivity of the traditional coastal fishing grounds on which small-scale fishers rely (Blitz, 1987).

Moreover, commercial fishers can continue to increase their capacity to fish in municipal waters because of poor law enforcement (Green *et al*, 2003). Coastal fishers have to venture farther out to sea which is more costly than traditional methods. In addition to longer hours of work the costs of engines, fuel and machinery increase. In some areas where fishers were not able to cover the costs, they turned to use explosives as an alternative method as it brings the greatest inmediate return in the short-term (Blitz, 1987). Fishers say they have no other option when competing with trawlers and overcome smaller supply of fish because of preceding overfishing (International Coral Reef Initiative. 2017). Concerning the second design principle, it will be assumed that it is not met either.

Thirdly, looking at collective-choice arrangements, the Coastal Resource Management Project (CRMP) was created after the realisation that fisheries cannot be managed effectively if there is no cooperation of stakeholders to make the laws and regulations work (Eder, 2005). The PFC recognises the need to devolve control over resource access to local levels and gives LGUs the task of coordinating services, efforts and resources with people's organisations (PO) and non-governmental organisations (NGOs) to engage in commonly beneficial projects (Wilson *et al*, 2003). However, the CRMP was less participatory than many of the NGO coastal resource management projects that emphasise community empowerment (Eder, 2005). Although, the need for public involvement is recognised there is no clear evidence that most individuals affected by this law did participate or will be able to participate in modifying the operational rules as it is suggested by the third design principle (Shannon, 2002; Ostrom, 1990). Therefore, it is assumed that the former is not fully satisfied.

Fourthly, regarding monitoring, it is argued that LGUs might be more capable of enforcing the law because of the lack of national resources to regulate fishing activity. The lack of staff and absence of training in national agencies makes it difficult to give fines, confiscate vessels and catch and monitor compliance (Shannon, 2002).

Studies show that the capacity for law enforcement to stop illegal fishing in the Philippines is growing at the villages level. At the municipal and national governement level, capacity is also growing, however, financing is limited and laws are enforced irregularly (Christie *et al*, 2005). This is affecting municipal fishers that are not enjoying their legal preferential rights to municipal waters. Consequently, the fourth design principle which suggests that there should be monitors auditing the CPR conditions and fisherfolk behaviour, seems to be inappropriate in the case of the Philippine fisheries (Green, 2003).

Fifthly, looking at the graduated sanctions imposed by the CRMP it is found that the governement relies on a variety of interventions from 'soft' measures such as education and training to 'hard' sanctions imposed by prosecution and conviction. In some municipalities there have been significant improvements in local governance and in the conditions of coastal resources by applying both soft and hard law enforcement approaches as part of the CRMP.

However, the LGUs that were determined to impose the law were challenged by logistical constraints and the fragmented state of the Philippine law enforcement system. In 2000, only 15% of the LGUs had law enforcement budgets and of these, only 7% had operational patrol boats which makes it significantly hard to enforce the sanctions (CRMP, 2004). Although there are rules set by the institutions, they have not been applied due to lack of resources in most of the cases. Consequently, graduated sanctions imposed by the Philippine institutions appear to be weak.

Moreover, the sixth design principle suggests that appropriators and their officials should have rapid access to low-cost local arenas and resolve conflicts among the fisher folks (Ostrom, 1990). Poorly managed conflict can marginalise user groups and provoke cynicism regarding resource management which will aggravate environmental conditions. Studies show that in the Philippines, conflict resolution mechanisms are: informal in the villages; depend on the mayor and staff commitment at the municipal government level and at the national government level, these mechanisms are not in place as they do not facilitate at lower levels. This is the consequence of systemic weaknesses in legal systems, chronic fiscal crises, weak faith in the rule of law and high incidence of poverty (Christie *et al*, 2005). Thus, the resolution of conflicts also seems to be weak in this case.

The seventh design principle argues that there should be minimal recognition of rights to organise. Sometimes, local fishers devise extensive rules defining who can use a fishing ground and the kind of equipment that they can use. Government officials should give legitimacy to these rules and fishers may be able to enforce them themselves (Ostrom, 1990). The Indigenous Peoples' Rights Act of 1997 recognises the vital role of Indigenous Peoples Organizations (IPOs) as autonomous partners in progress and it fully supports these associations to pursue and protect their legitimate and collective interests. Therefore, it is assumed that the seventh design principle is met.

The last principle suggests that all governance activities should be organised in multiple layer of nested enterprises in the case of complex and enduring CPRs (Ostrom, 1990). In the Philippines, the national government and LGUs are responsible for fisheries management as it is said above. The municipal

legislative councils together with their respective municipal Fisheries and Aquatic Resource Management Councils (FARMCs), create the laws, and the local chief executives safeguard that they are implemented. Moreover, the Bureau of Fisheries and Aquatic Resources (BFAR) is the primary national government agency that ensures protection for the country's fishery resources (Green *et al*, 2003). The last design principle is met as there is clearly a multiple layer of nested enterprises.

A summary of the conclusions reached in the analysis of governance indicators can be found below in Table 2.

Table 2. Criteria for Robust Institutions

Design principle	**Meet criteria?**
Boundaries are clearly defined	No
Congruence between appropriation and provision of rules	No
Collective-choice arrangements	No
Monitoring	No
Graduated sanctions	Weak
Resolution of conflicts	Weak
Minimal recognition of rights to organise	Yes
Nested enterprises	Yes

Source: Ostrom (1990).

Further empirical and theoretical work is needed before having a high degree of confidence that these principles are the best way to analyse the strength of these institutions (Ostrom, 1990). However, this paper will assume that the Philippine fisheries institutional performance is fragile. Although, the institutions are pointing in the right direction, there are many aspects that could be improved. Section 5.1. will give suggestions as to how solve the issues presented above.

In summary, this chapter has shown that the set of design principles investigated in section 4.4 demonstrate the institutional issues of the Philippines' fishery industry. This has had significant consequences on the ecological, economic and social indicators explained in sections 4.1, 4.2 and 4.3. If the institutions of the Philippines had been more robust over the last 18 years, it is likely that the conditions of the coral reefs and fisheries would have been more appropriate.

5. Conclusions

5.1. Recommendations

There are several reasons why the Philippine fisheries system is fragile and consequently, it results in lower fish stock and the degradation of the surrounding ecosystems as is noted in chapter 4. This paper believes that the two main issues that are preventing the fishery industry from having an optimum performance are: the low participation of the different stakeholders in making the laws and regulations (Eder, 2005); and the lack of management, regulation and enforcement (Green, 2003).

This dissertation firstly recommends, that the national government should provide a framework to urge the cooperation between the different stakeholders to make the laws and regulations work (Eder, 2005). The stakeholders would then decide how to organise themselves as Ostrom (1990) proposed. For instance, representatives of the different regions and sectors could be elected to create an assembly where the fishers themselves will have the power to modify the PFC. This will require the assistance of different moderators and the information of scientists in order to achieve an agreement. The role of the government would be to harmonise national policy to unite the current competing commercial and municipal fishers into the same direction that will help to sustain the fisheries for the interest of both sectors (Green, 2003).

Secondly, the national government should provide the necessary resources for this agreement to take place. Resources should be increased and be redirected to Coastal Resource Management (CRM), monitoring, control and surveillance to assist provincial offices and LGUs in fisheries management and coastal law enforcement (Green, 2003). Both levels, regional and local should be in full coordination to create fisheries plans that will satisfy the objective of the agreement. Education and training measures should be improved to protect the long-term health of the environment and of the communities depending on near-shore fisheries (Shannon, 2002).

Additionally, reef management solutions are also required in this case. Marine Protected Areas (MPAs) are vital when it comes to maintaining healthy coral reefs even while surrounding areas are degraded. MPAs are marine areas that are actively managed for conservation (Burke *et al*, 2011). In Southeast Asia reef management exists in the region throughout numerous MPAs but many of them appear only on paper without any staff or funding (Wilkinson, 1998). Studies show that 61% of MPAs in Southeast Asia are considered ineffective in reducing overfishing. It is necessary that the local communities are involved in MPA management as they tend to realise the benefits of complying and enforcing

regulations vigorously (Burke *et al*, 2011). The suggestion given above concerning the increase in funding and resources along with education and training, should be also applied to MPAs.

5.2. Limitations and Further Research

This dissertation's limitations come primarily from the low availability of the data. One of the main calls from the international communities and initiatives such as The International Coral Reef Initiative (ICRI) was to recompile more information and data on the status of coral reefs (Wilkinson, 1998). Also, the currently lacks quantitative analysis on the long-term trends in its national fisheries production. There is a great need to examine the fisheries trends and its possible consequences to help data-based decision-making in the management of the fisheries (Anticamara and Go, 2016).

For future studies, a re-evaluation of government strategies for fisheries development would be very beneficial for the Philippines' population and the future status of these ecosystems (Green *et al*, 2003).

6. Appendix A

Glossary

Coral Triangle: The area of the Coral Triangle, which comprises parts of six countries: Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste, contains 73,000 sq. km. of coral reefs, accounting for 29% of the global total (Burke *et al*, 2012).

Demersal fish: fish living close to the floor of the sea or lake (Collins English Dictionary, 2017).

Pelagic fish: categorised as coastal and oceanic fish, based on the depth of the water they inhabit. Examples of species include: anchovies, sardines and shad (NOAA National Ocean Service, 2017).

El Niño: a warming of the Eastern tropical Pacific happening every few years and altering the weather pattern of the tropics (Collins English Dictionary, 2017).

La Niña: a cooling of the eastern tropical Pacific taking place in certain years (Collins English Dictionary, 2017).

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