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# How Well Has Environmental and Social Protection Been Ensured for Small Farmers and Fisherfolk? Sustainable Development of Philippine Agriculture and Fisheries

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## Abstract

Transforming Philippine agriculture and fisheries (AF) into a dynamic, high-growth sector is essential to poverty reduction, food security, and inclusive economic prosperity. However, unsustainable AF practices have impacts on the environment and climate, and at the same time, ecosystem degradation and climate change impact the productivity and sustainability of the AF sector, with disastrous consequences on food security, income, and livelihoods, especially of small-scale farmers and fishers. Agriculture and fisheries rely on natural capital and are both providers and consumers of ecosystem services, and at the same time pose a threat to nature. This report describes the range of pressures affecting the state of the AF sector, and the response measures being undertaken. Integrating environmental sustainability and climate resilience in AF development and modernization plans has emerged as a necessity in policy and practice. Interventions and priorities need to be defined according to local contexts but within the integrated river basin, coastal zone, and marine area framework. Various practices in ecosystem-based management in agriculture and fisheries exist, and supported by key policies, but sectoral and silo approaches still dominate. The challenge for policymaking is to facilitate dialogue, knowledge-sharing, and collaboration, create the market and/or regulatory conditions to incentivize uptake of sustainable practices, and help farmers and fisherfolk access the necessary inputs, financing, and technologies, and acquire the skills that will allow them to follow the economically feasible, environmentally sound, and societally desired path.



**Keywords:** sustainable development, ecosystem services, climate change, agroecosystems, soil, fisheries, aquaculture, overfishing, IUU fishing, pollution

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## 1.0 Introduction

### *1.1 Background*

Recognizing the role of agriculture and fisheries sector in the country's economic development, Congress enacted Republic Act (RA) No. 8435, otherwise known as the **Agriculture and Fisheries Modernization Act** (AFMA), to provide the policy framework for the transformation of the rural economy. AFMA focuses on five (5) major concerns: poverty alleviation and social equity, food security, global competitiveness, **sustainable development**, and income profitability, especially for small farmers and fisherfolk.

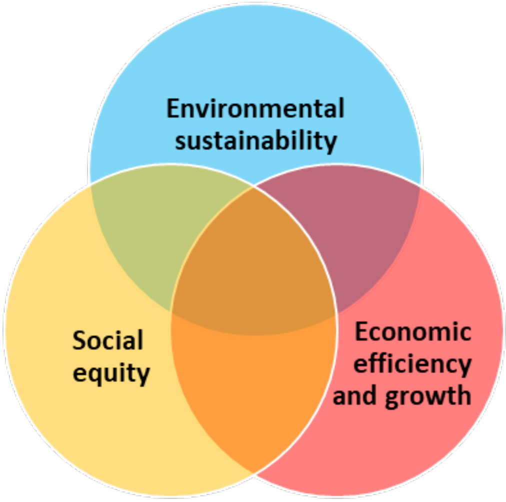
Modernization is defined in Section 4 of AFMA as: "*the process of transforming the agriculture and fisheries sectors into one that is dynamic, technologically advanced and competitive yet centered on human development, guided by the sound practices of sustainability and the principles of social justice*." Thus, AFMA does not promote any type of modernization, rather it subscribes to the principle of sustainable development.

The concept of sustainable development was described by the 1987 Brundtland Commission Report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN World Commission on Environment and Development 1987, p.41). In line with the principles of sustainable development, AFMA aims to "promote development that is compatible with the preservation of the ecosystem in areas where agriculture and fisheries activities are carried out, exerting care and prudence in the use of the country's natural resources in order to attain long-term sustainability." (DA 2011, p.3).

It is also commonly perceived that sustainable development involves three pillars—society, environment, and economy—with this tripartite description often presented in the form of three overlapping circles with sustainability being the overlapping center (**Figure 1.1**). According to the UN, sustainable development is a paradigm for thinking about the future in which environmental, societal, and economic considerations are balanced in the long term in pursuit of an improved quality of life.

The **2030 Agenda for Sustainable Development** is a plan of action for people, planet, and prosperity adopted by all UN Member States in 2015. The 17 Sustainable Development Goals (SDGs) and 169 targets aim to end poverty and hunger in all their forms and dimensions; ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature; protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations; foster peaceful, just and inclusive societies; and mobilize the means required to implement the Agenda through partnerships (United Nations 2015). As a global framework for international cooperation, the SDGs are integrated, apply to all member countries, and balance the economic, social, and environmental dimensions of sustainable development.

**Figure 1.1 Sustainable development**




The agriculture and fisheries sector is well-placed to contribute to the SDGs, given that this is the primary sector for food production, and considering its it role in food security, nutrition, health, livelihoods, and poverty alleviation as well as potential impact on ecosystems and climate. As the prime connection between people, planet, and prosperity, the agriculture and fisheries sector can help achieve multiple SDGs. In particular, targets from seven SDGs (2, 6, 11, 12, 13, 14 and 15) are relevant to reducing the impacts of unsustainable agriculture and fisheries production, over-exploitation of resources, pollution, and degradation of terrestrial, freshwater, and marine ecosystems. These SDGs cover sustainable agriculture, food security and nutrition (SDG 2); sustainable management of water, sanitation, and wastewater (SDG 6); sustainable consumption and production (SDG 12); inclusive, safe, resilient cities and communities (SDG 11); climate action (SDG 13); and sustainable use of marine and terrestrial ecosystems while ensuring their protection, restoration, and conservation (SDGs 14 and 15).

SDG 2, "*End hunger, achieve food security and improved nutrition and promote sustainable agriculture*," recognizes the inter-linkages among targets supporting sustainable agriculture and fisheries and other issues addressed within the set of 17 SDGs. SDG 2 aims to improve productivity and end rural poverty, and includes targets on empowering small farmers, pastoralists, and fishers, promoting gender equality, ensuring healthy lifestyles and wellbeing, protecting soil resources, and reducing risks from disasters and climate change. The following targets under SDG 2 are relevant to AFMA implementation (United Nations 2015, pp.19-20):

- *Target 2.3: By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.*
- *Target 2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality.*

SDG 12, "*Ensure sustainable consumption and production patterns*" identifies decoupling economic growth from resource use, and requires enabling conditions for the transformation of social and physical infrastructure, markets, consumer behavior, and business practices along global value chains. The following targets under SDG 12 are important for ensuring sustainable agriculture and fisheries (United Nations 2015, pp.26-27):

- *Target 12.2: By 2030, achieve the sustainable management and efficient use of natural resources.*
- *Target 12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.*
- *Target 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.*
- *Target 12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse.*

SDG 14, "Life below water: *Conserve and sustainably use the oceans, seas and marine resources for sustainable development*," recognizes that advancing food security, livelihoods and other benefits from marine resources will require effective strategies and management to restore and protect marine and coastal ecosystems, and combat the adverse effects of overfishing, growing ocean acidification, and worsening marine pollution due to coastal eutrophication and marine debris (United Nations 2015).

SDG 15, "Life on land" focuses specifically on managing forests sustainably, halting and reversing land and natural habitat degradation, combating desertification, stopping biodiversity loss, restoring degraded land and soil, including land affected by desertification, drought and floods, and protecting, restoring, and sustainably using terrestrial and inland freshwater ecosystems (United Nations 2015).

## *1.2 Statement of the problem*

Agricultural production in the Philippines has been growing and diversifying over time, in response to market opportunities both domestically and overseas. Transforming Philippine agriculture and fisheries (AF) into a dynamic, high-growth sector is essential to poverty reduction, inclusive growth, and getting to the next level income and development. Since the 1980s, the growth in the gross value-added (GVA) of the AF sector has been erratic. There have been some effective attempts at engaging the farmers and fisherfolk, but these interventions have yet to have any significant and lasting effect. Moreover, there are various factors affecting the long-term productivity and sustainability of the AF sector, and among them are the unsustainable practices that are not mitigated, impacts of unplanned development and other human activities, inadequate response measures by the government, inconsistent application of environmental policies, and lack of integration with other key sectors. Improvements in agricultural productivity have often come with social and environmental costs, including water scarcity and pollution, soil degradation, ecosystem stress, biodiversity loss, decreasing fish stocks and forest cover, and high levels of GHG emissions.

Food production is likely to maintain priority over environmental protection although both could benefit from technology, innovations, and changes in practices. Inappropriate modernization measures and unsustainable agricultural and fisheries practices have impacts on the environment and climate, and at the same time, environmental and climate changes impact the productivity and sustainability of the AF sector, with disastrous consequences on the income and livelihood of small farmers and fishers. This feedback loop raises more challenges considering the current governance, and economic and social conditions. There is a need to enhance the understanding of the mutual causality between the impoverishment of people and the environment, and human and environmental health.

It is essential to assess if and what measures have been undertaken to modernize the AF industry *in a sustainable way* as well as evaluate their impacts not only on the economy and food security, but also on the environment and wellbeing of farmers and fishers. The way production and modernization are being carried out has to be examined, considering the AF sector's contribution to the environmental degradation in the country and climate change, which in turn, could affect the long-term productivity, sustainability, and resiliency of agriculture and fisheries as these economic activities rely on healthy soils, water availability, clean rivers and ocean, biodiversity, and stable climate. The pressures from other human activities, economic sectors, and existing governance structure and how they affect the AF sector also need to be examined.

## *1.3 General Objective*

This chapter examines the current situation vis-à-vis the desired outcomes pertaining to Objective 9 of AFMA. It focuses on the outcomes of development and modernization measures undertaken for the AF sector, and identifies which measures resulted in outcomes that are consistent with the sustainable development principles. The main objectives of this study are as follows:

a. Ascertain progress achieved by the agriculture and fisheries sector in attaining **Objective 9** of the AFMA: *To provide social and economic adjustment measures that increase productivity and improve market efficiency while ensuring the protection and preservation of the environment and equity for small-scale farmers and fishers (SFF)*
b. Identify and evaluate constraints and opportunities that have determined the past pace of progress as well as the prospects for future agriculture and fisheries modernization that is sustainable, environmentally sound, and disaster and climate resilient.
c. Discuss strategies going forward to facilitate the attainment of AFMA objective related to ensuring sustainability and environmental protection.

## *1.4 Specific Objectives*

In particular, the study aims to:

a. To review available literature and data for assessing AFMA Objective 9
b. To develop a Theory of Change (TOC) which will serve as a framework for evaluation of AFMA Objective 9, tracing linkages from AFMA or other interventions to outcomes and impacts
c. To apply the TOC in evaluating the extent to which a social and economic adjustment measures for increasing productivity, improving market efficiency, while ensuring protection and preservation of the environment and equity for small farmer and fisherfolk have been provided, using evidence and indicators
d. To provide plausible explanations for the pace and extent to which the aforementioned adjustment measures and environmental protection have been provided
e. To identify a benchmark for determining attainment of an adequate set of adjustment measures have been provided, and assess prospects for attaining this benchmark

f. To draw out policy implications for government and other key stakeholders of agriculture and fisheries modernization.

## 1.5 Significance of the study

### 1.5.1 Benefits and challenges of agriculture and fisheries

Agriculture's benefits since the time humans have shifted from hunting and gathering to domesticating plants and animals have been recognized as the mark of human civilization. Farming enabled people to grow food, raise animals for food, and engage in trade, and this requires a system of governance, infrastructure, and specialization. Availability of food led to increased population, and then to the development of towns and cities. Agriculture plays an important role not only in ensuring food security but also in providing jobs and contributing to economic growth, which consequently led to other advancements. Recognition of this role is critical in policy choices. "With the exception of a few natural resource-rich countries, no country has successfully transitioned from middle- to high-income status without having achieved an effective transformation of their agri-food systems" (World Bank 2020).

The agriculture, forestry, and fishery sector accounts for 10.2 percent of the country's GDP in 2020. In addition, one of the critical roles of AF in the Philippines is as source of employment. The AF sector provides employment, accounting for 22.9 percent of the country's labor force. With almost 10 million people engaged in AF, this sector has huge potential to provide social and economic growth for rural communities and the whole country.

Fisheries and aquaculture also contribute food, nutrition, jobs, revenues, and export earnings for millions of people in the Philippines, and food around the world—although at a high cost to marine ecosystems. The Philippines is at the apex of the Coral Triangle, which is considered as the *global center* of marine biodiversity and, therefore, a global priority for conservation. The Verde Island Passage (which is in the Coral Triangle) has the highest number of aquatic species per square area, making it the center of the center of marine shorefish biodiversity in the world (Springer and Carpenter, 2005). The Philippines is among the world's biggest producers of fisheries in volume and species diversity. The country is also the fourth biggest producer of seaweeds. Furthermore, many Filipinos depend on the seas and fisheries industry for cheap source of protein, and for their livelihoods and income. Among them are around two (2) million fishers who are among the poorest, with a poverty incidence of 26.2% in 2018 as against the national figure of 16.6% for the same year (PSA 2020).

There are huge benefits in improving and modernizing the AF industry, especially in enhancing food security and reducing poverty. By 2050, there will be 148 million people in the Philippines. Farmers and fishers will need to supply more rice, meat, eggs, fish, milk, vegetables, etc. than ever before, while using fewer resources. Labor productivity in agriculture needs to improve since it is lower relative to the other sectors and the structural transformation taking place in the Philippine economy is rather slow and weak (Brown, Ebora and Decena 2018).

The modernization of agriculture and fisheries calls for massive public investments in physical infrastructure, rural credit and finance, human capital, institutions, research, appropriate technologies, and innovations, with additional emphasis on climate resiliency and environmental sustainability. Measures and investments for pollution reduction and ecosystem protection, which would benefit the AF sector should be given more emphasis and coordinated with other sectors. The drive to increase production as population increases as well as approaches towards intensification have unintended consequences on the environment, and health of ecosystems and people. At the same time, other human activities impact the environment upon which agriculture and fisheries rely on. Agriculture and fisheries are both users and providers of ecosystem services as well as recipients and producers of ecosystem 'disservices'. These interrelationships must be understood and considered when developing plans and programs to modernize the AF sector. Farmers and fishers also need to be empowered through greater knowledge sharing and through delivering accessible, quality extension and support in management, sustainable and innovative practices and technologies, and marketing.

### 1.5.2 Major issues

The following environment- and climate-related issues affecting agriculture were described in the ***Agriculture and Fisheries Modernization Plans (AFMP) 2011-2017***:

- **Environmental degradation**. Of the country's total land area, 5.2 million ha (about 17%) are severely eroded and another 8.34 million ha (27.3%) are vulnerable to drought, alternating with floods and typhoons, annually. In the lowlands, the continued use of unsustainable production practices, such as the extensive use of chemical inputs, expansion of grazing lands, slash-and-burn agriculture, and deforestation, especially in watershed areas, have resulted in land degradation (i.e., erosion and declining soil fertility) and problems of water quality and availability. In the upland ecosystem, climatic drivers and human-induced activities have resulted, not only in land degradation, but also in the loss of biodiversity (Bureau of Soils and Water Management 2004).
- **Vulnerability to weather risks and climate change**. Adding further pressure on agricultural production, which is already stressed by other resource scarcities and economic challenges, are the effects of climate change, including changing rainfall patterns, rising temperatures, increasing frequency and intensity of typhoons and dry spells, and sea level rise. Scenarios from the Department of Science and Technology's Philippine Atmospheric, Geophysical and Astronomical Services Administration (DOST-PAGASA) for 2020 and 2050 project widespread warming in most parts of the country.
- **Competing uses of agricultural lands**. Agriculture, together with the natural resource sector, has been adversely affected by shifts in land use. Particularly sensitive for its implications on food security are the conversion of prime agricultural lands to non-agricultural uses (i.e., residential, commercial, and institutional) and the rising demand for industrial crops (e.g., those used for the manufacture of biofuel). Alternative land use activities have also encroached upon ecologically fragile lands. These point to the need for a national land use policy that will rationalize the optimal allocation of land among competing uses.
- **Incomplete implementation of the Strategic Agriculture and Fishery Development Zones and Preparation of Integrated Development Plans**. The identification of strategic agriculture and fishery development zones (SAFDZs), as provided for under AFMA, has not been fully implemented (AFMA Review, 2007). This has limited the ability of government to focus on areas of high agriculture potential and thus avoid spreading investments too thinly and dissipating impact in the rural areas.

Note that the above issues are mostly related to agriculture, especially the crops subsector. While the Philippine fisheries contribute significantly to the community, it is also under numerous threats. Over-exploitation, destructive fishing, habitat degradation, pollution, invasive alien species, and rising sea temperature and ocean acidification due to climate change are just some of the issues undermining its productivity and sustainability.

The natural stock replacement rates of fisheries are higher overall than cattle, swine, and poultry—if fishing is done sustainably. Fish stock assessments conducted by BFAR-NFRDI, however, shows overfishing in most regions of the country. Ten (10) out of the 13 major fishing grounds already showed overfishing according to a report in 2009.[1]

To reduce overfishing, fish culture or aquaculture offers good potential – if done well – using green technologies and ecosystem-based approach to increase production, lower feed conversion ratio, lower its carbon footprint, and lower its demand pressure on capture fisheries for feed stocks. The share of aquaculture in the fisheries production is increasing, but its environmental impacts and conflicts with municipal fishing, shipping, and other water- and marine-based sectors should be addressed.

The ***Comprehensive National Fisheries Industry Development Plan (CNFIDP) 2016-2020*** (DA-BFAR 2016, p.3) lists the following major problems of the fishery industry:

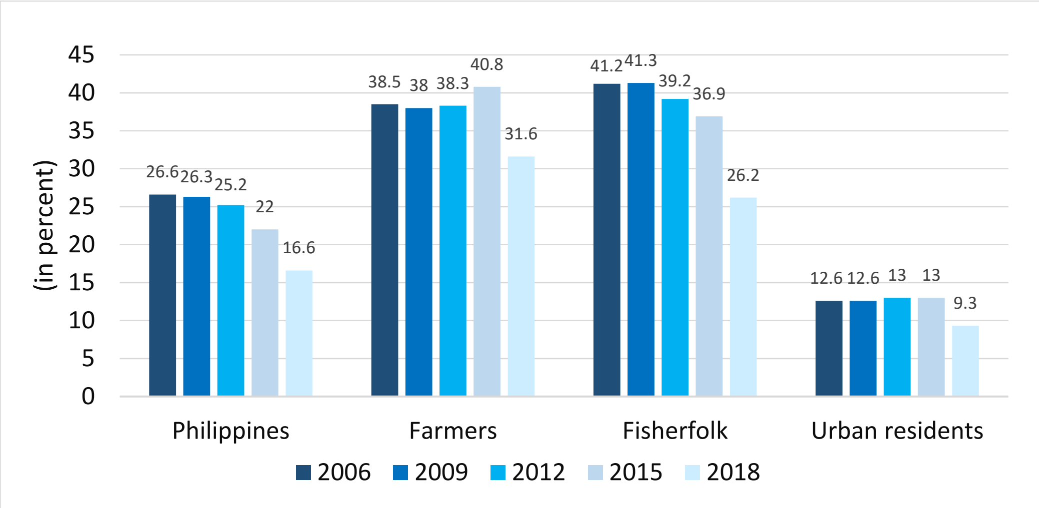
- Depleted fishery resources largely brought about excessive fishing effort and open access regimes
- Degraded fishery habitats due to destructive fishing methods, conversion of fishery habitats into economic uses and negative impacts from land-based activities
- Intensified resource use competition and conflicts among fisher groups and other economic sectors
- Unrealized full potential of aquaculture and commercial fisheries as there are still underutilized areas for industry development
- Uncompetitive products due to inferior quality and safety standards
- Post-harvest losses in terms of physical, nutritional and value losses; inadequate post-harvest facilities
- Limited institutional capabilities from the local up to the national levels of governance
- Inadequate/Inconsistent fisheries polices that should promote conducive environment for sustainable development
- Weak institutional partnerships among government agencies, civil society organization, and private sector.

Almost 40 percent of the total fish production and income of Filipino fishermen go to waste due to unavailability or inaccessibility of post-harvest equipment for their fish catch (DA-BFAR 2018). Similarly, agriculture has been hampered by inadequate post-harvest facilities and access to markets. Moreover, extreme events like droughts and strong storms and typhoons due to climate change, combined with inadequate preparedness, adaptation and response systems also affected the AF sector.

A major consequence of these agricultural and fisheries issues is the poverty incidence among the farmers and fishers, which remains high compared to the urban sector and national average. (**Figure 1.2**).

[1] Fisheries Report under the *4th National Report to the Convention on Biological Diversity of the Philippines* in 2009.

**Figure 1.2. Poverty Incidence by Sector**




Source: PSA.

PSA. 2019. Press Release (06 December 2019): 2018 Full Year Official Poverty Statistics. https://psa.gov.ph/content/proportion-poor-filipinos-was-estimated-166-percent-2018

PSA. 2016. Press Release (05 December 2016): 2015 Official Poverty Statistics.

PSA. 2015 Poverty Statistics for Basic Sectors - Summary Tables.

PSA. 2015. Table 2. Annual Per Capita Poverty Threshold, Poverty Incidence and Magnitude of Poor Population, by Region and Province - 2006, 2009, 2012 and 2015.

### 1.5.3 Implications of AFMA on sustainability of fisheries

**Agriculture** is the art or science of cultivation of crops through soils and other medium, including the tillage, harvesting of crops; growing of trees; rearing and management of livestock; and processing and marketing of product of farm activities and practices. As defined by FAO (1988), agriculture involves farming of plants and animal raising on land, while aquaculture is the aquatic equivalent. Both involves growing or rearing process to enhance production. Capture fisheries are solely related to *catching* wild fish (and may include harvesting of aquatic plants in the sea), and not farming or raising fish.

According to FAO (1988), aquaculture or farming in water:

- involves the cultivation of aquatic produce, both animals (e.g., finfish and invertebrates), and plants (e.g., seaweeds)
- implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.
- implies individual or corporate ownership of the stock being cultivated.

Agriculture is predominantly based on use of land (soils) while aquaculture occurs in inland freshwater and coastal (brackishwater and marine) areas.

**Capture fisheries** involves the harvesting of aquatic organisms (both animals and plants), which are exploitable by the public as common property resources, with or without appropriate licenses. It can be done in freshwater bodies (rivers, lakes, reservoirs) and coastal and offshore areas. Fish stocks are considered renewable resources because they can reproduce, but overfishing, destructive fishing, pollution, and other threats can affect their reproduction, and can result in their depletion. Agriculture and aquaculture are also among the causes of the pollution of aquatic habitats. Thus, the management of the agriculture and fisheries sector should also consider the interconnections within its subsectors.

Agriculture and fisheries, and their stakeholders – land-based farmers and water-based fisherfolk – work in different ecosystems. Moreover, crops, livestock, poultry, capture fisheries, and aquaculture apply different technologies, have different market conditions, and are thus affected differently by the policy frameworks and institutional settings. This calls for an alternative approach in identifying underlying issues and the response measures. First, their issues should be treated as two distinct sectors, but pinpoint those areas where there are overlapping concerns or where one sector or subsector affects the others and vice versa. Examining each sector separately at the initial stage will help ensure that the fundamental causes in each sector and subsector are understood, and no bias being given to one sector/subsector. In this way, appropriate measures can be identified for each. Second, there has to be an assessment of their impacts on their ecosystems, and how such changes in their ecosystems affect AF productivity and sustainability. Third, there should be recognition of the linkages of these ecosystems, and where integrated measures are needed.

AFMA became effective ahead of RA 8550 or the Fisheries Code of 1998, which became effective on March 23, 1998. Both laws coincide in some general objectives, such as achieving poverty alleviation, social equity, food security, rational use of resources, people empowerment, and sustainable development. The AFMA was more concerned with providing the appropriate budgetary and logistical requirements for the modernization of the country's entire agricultural and fisheries base. It places priority on sustained increase in production, industrialization, and employment, and the additional goal of seeking global competitiveness. The Fisheries Code, on the other hand, was the product of a long-drawn lobby effort by concerned fisheries groups, and it prioritizes management, conservation and protection of fishery and aquatic resources, optimal utilization of existing resources, and maintenance of ecological balance and the quality of the environment.

Batongbakal, J. (n.d.) discussed key policy issues concerning AFMA and its possible consequences on sustainable fisheries, and differences of aims and approaches between AFMA and the Fisheries Code of 1998. The AFMA clearly makes industrialization as the main objective of modernization of the agricultural and fisheries sectors. Modernization of agriculture involves shifting to technologies and practices that would increase production or improve productivity. Such modernization for the fisheries sector would, however, entail increases in the utilization of limited coastal space and more efficient extraction methods, and it is therefore more likely to increase the rate of overfishing, destruction of vital habitats, and the exploitation of resources beyond sustainable levels. These outcomes run counter to achieving sustainable fisheries and the stated objectives of the Fisheries Code and other environmental laws.

Even for aquaculture, care must be taken to ensure that the technologies and practices are environmentally sound and sustainable. Instead of relieving fishing pressure, many forage fish stocks and so-called "trash fish" can be overfished in an effort to derive fish oil and fish meal to feed farmed fish. Aquaculture has also caused the destruction of mangroves and seagrass beds, which are important habitats for fish and other marine organisms. Over-stocking, excess feeds, and wastes from aquaculture can cause oxygen levels in the water to fall resulting in fish kills even outside the aquaculture farms.

Thus, the fisheries sector must be treated separately from the rest of agriculture, or under a different framework. It must be regarded with a different perspective that de-emphasizes the maximization of production if fisheries production is to become sustainable. Production can be maximized only up to the sustainable level, which can be determined using biological (e.g., maximum sustainable yield, exploitation rate, etc.) and economic (e.g., maximum economic yield, marginal cost) indicators. The AFMA implementation for fisheries should be oriented towards conservation and ecosystem protection to prevent collapse of fish stocks, and ensure sustainable fisheries, consistent with the Fisheries Code of 1998 (RA 8550) and the Amended Fisheries Code (RA 10654) and aligned with international fisheries agreements and related Multilateral Environmental Agreements of which the Philippines is a party to. Appropriate fisheries management is crucial to avoid disastrous effects, not only on the environment, but on social and economic conditions.

Environmental degradation and climate change have been mentioned in the AFMPs as factors impacting the agricultural sector. However, agricultural intensification also has unintended consequences on the terrestrial and aquatic ecosystems. Key agricultural practices that have impacts on the environment include: (a) conversion of forests and wetlands to agricultural farms and ranches; (b) excess fertilizer and pesticide use, improper agricultural waste disposal, and lack of wastewater management, especially for livestock and poultry – which result in pollution loading in rivers and seas, contamination of groundwater, soil quality loss; and (c) greenhouse gas (GHG) emissions from agriculture (rice paddies), livestock, manure, and burning of agricultural waste – which contribute to climate change.

## *1.6 Review of Related Literature*

A review of the Agriculture and Fisheries Modernization Plans (AFMPs), measures and actions undertaken by DA, and the past assessments of AFMA and the agricultural sector resulted in the following observations:

First, **previous reviews and assessments of the AFMA considered sustainability in terms of economic and financial aspects and disaster resiliency only and have not given enough attention to evaluating AFMA from the environmental sustainability lens**. The environmental impacts—whether positive or negative—of modernization measures and unsustainable practices have not been pointed out for agriculture (crops), livestock and poultry, capture fisheries, and aquaculture.

Second, **most of the modernization measures are more applicable to agriculture**, and not enough attention was given to *environmentally sound* modernization of fisheries and aquaculture.

Third, **although the AFMA and Agriculture and Fisheries Modernization Plans (AFMPs) include environmental protection and sustainability objectives for both agriculture and fisheries, the measures and identified actions to achieve these objectives are again more applicable to agriculture only**. For instance, the environment- and climate-related issues described in the *AFMP 2011-2017* and *AFMP 2018-2023* relate more to those issues affecting crops and livestock.

Fourth, **some modernization, sustainability and environmental protection measures have been introduced for fisheries, but they are based on strategies and approaches that are**

**supported more by other policies**, such as the Fisheries Code of 1998 (RA 8550) and the Amended Fisheries Code of 2015 (RA 10564).

Likewise, the Food Security Development Framework of the Department of Agriculture (DA) (**Figure 1.3**) includes the fisherfolk in the vision, but the strategies—farm consolidation, modernization, industrialization, export promotion, and infrastructure development (and the bullets under each strategy)—do not explicitly include the environmental protection measures needed for the fisheries sector. (This could be due to environmental management being under another department). Moreover, the key result area on environment pertains more to climate and disaster resiliency of the agriculture sector, and not so much on minimizing the unsustainable agricultural practices as well as ensuring environmental and resource protection for agricultural productivity and sustainability. There are also impacts of unsustainable agricultural practices on the aquatic environment, and hence, on fisheries. Therefore, it is not clear how the balanced natural ecosystems (one of the key results areas) can be achieved given the limited strategies. It is worth noting though that there are some initiatives towards linking agriculture, fisheries, forestry, and environment, but need strengthening, mainstreaming, and institutional changes.

**Figure 1.3. Food security development framework of the Department of Agriculture**


*Source:* DA, May 2020.

## 2.0 Conceptual framework

### *2.1 Pressures-State-Impacts-Response Framework*

For the assessment of outcomes of AFMA and other related policies and measures and current status of the AF sector, and potentially for the benchmarking system, it is necessary to apply an embedded structure and logic in order to structure the assembly of data and assessment of gaps. There are many potential frameworks and indicators that can be used in examining the relationship between the environment and human activity and can contribute to monitoring and evaluating sustainability. For example, the first World Ocean Assessment (WOA) came up a baseline report on the state of the planet's oceans using a framework that distinguishes driving forces, pressures, states, impacts and responses—called the "DPSIR framework" (GRID-Arendal and UNEP 2016)[2]. According to this framework, "there is a chain of causal links starting with '*driving forces*' (economic sectors, human activities) through '*pressures*' (emissions, waste) to '*states*' (physical, chemical and biological) and '*impacts*' on ecosystems, human health and functions, eventually leading to political '*responses*' (prioritization, target setting, indicators)" (Kristensen 2004). The DPSIR framework "presents a logical, stepwise chain of cause-effect-control events that describe the progression from identification of a problem to its management" (Patricio *et al*. 2016, pp.8-9). The DPSIR framework was developed as a means of identifying and selecting key indicators and organizing data to show the relationships of environmental and socioeconomic dimensions of sustainable development and support environmental policymaking. There is increasing usage of the DPSIR-type conceptual framework, with over 25 derivative models, as a means of structuring and analyzing information in management and decision-making across ecosystems (Patricio *et al*. 2016).

This paper uses the simplified 'pressures-state-impacts-response' (PSR) framework. The DPSIR framework was developed from the original PSR framework, and adopted by the Organisation for Economic Co-operation and Development (OECD), United States Environment Protection Agency (US EPA), United Nations Environment Programme (UNEP), European Union, etc. (Patricio *et al*. 2016). Similar to the DPSIR framework, the PSR model is based on the concept of causality and interconnections: human activities exert *pressures* on the environment and change its *state*—quantity and quality of natural resources and environment, with consequent environmental, economic, and social *impacts*, and society *responds* by addressing the pressures through environmental policies, economic and sectoral measures, plans, institutional arrangements, and other interventions (**Figure 2.1**).

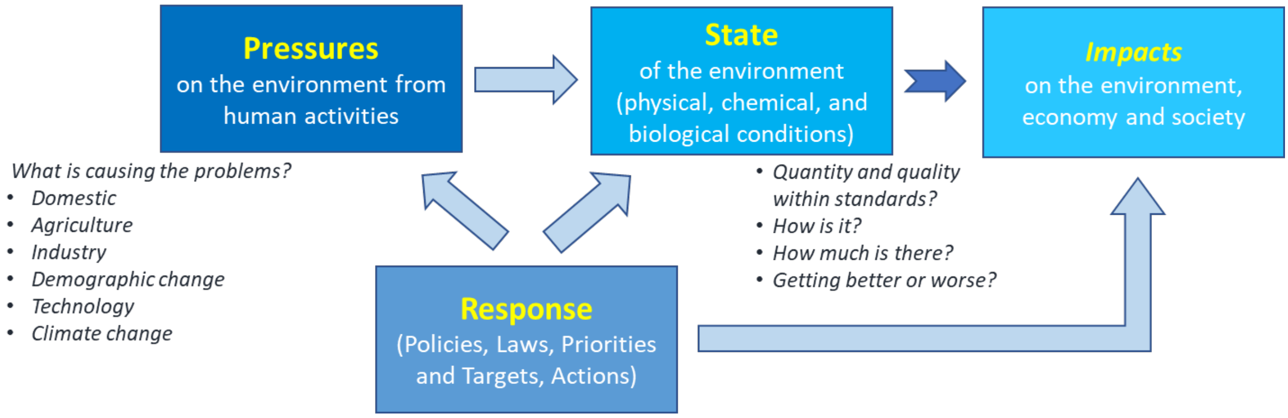
As pointed out by Garcia (1996), the selection of indicators should be issue driven, focusing efforts on:

- ***indicators of pressures*** (direct and indirect): stresses that human activities place on the environment as a result of consumption and production processes. There are demographic, economic, and sociocultural forces driving human activities, which put pressures on the environment. These human activities are (i) excessive use of environmental resources, (ii) changes in land use, and (iii) emissions of chemicals, waste, radiation, noise) to air, water, and soil (Kristensen 2004).
- ***indicators of the state:*** changes and current condition of the environment, marine water quality, habitats, biodiversity, and other resources (Garcia 1996)

[2] For more information on the DPSIR framework, please see: http://www.grida.no/graphicslib/detail/dpsir-framework-for-state-of-environment-reporting_379f. For a review of DPSIR and its derivatives and usage, see Patricio *et al*. 2016.

- ***indicators of impacts***: effects of the changed environment (e.g., hypoxia and algal blooms, loss of ecosystem services, impact of decreased agricultural and fisheries production on income and welfare of farmers and fishers, extreme events due to climate change, economic costs of environmental damage, change in social welfare, etc.)
- ***indicators of response:*** policies, actions, and other measures taken (by management, or industry, or other stakeholders) to affect the *pressure* (mitigation, regulation) or improve the *state* (compensation, rehabilitation) (Garcia 1996).

**Figure 2.1. Pressures-State-(Impacts)-Response (PSR) Framework**




The PSIR framework therefore supports the integration of the environment into concerned sectors of the economy. It also provides a feedback mechanism by allowing a more systematic assessment of the effectiveness of response measures and policy choices in tackling the pressures, improving the state of the resource or environment, reducing negative impacts, and achieving set goals, desired outcomes and impacts. **Table 2.1** presents the application of the PSIR approach in the fisheries sector.

**Table 2.1. Examples of indicators of pressure, state, impacts, and response in fisheries**

| Issue | Pressure | State (Condition) | Impacts | Response (Mitigating action) |
|---|---|---|---|---|
| Overfishing | Overcapacity | Biomass < MSY<br>Low catch rates<br>Overcapacity | Lower income<br>Economic losses | Limit access<br>Reduce effort<br>Suppress subsidies |
| Littoral habitat degradation | Coastal trawling | % seagrass cover<br>Juvenile mortality | Economic losses due to lower productivity<br>Loss of shoreline protection and other ecosystem services | Protected areas<br>Closed seasons<br>Increased penalties |
| | Extensive aquaculture<br>Conversion of mangroves | % mangrove cover | | Mangrove replanting<br>Decrease access |
| Algal blooms | Pollution (from agricultural runoff, and wastewater discharges) | Nutrient load<br>Frequency of crises<br>Algal productivity | Economic losses due to fish kills and HABs | Control of land-based sources of pollution<br>Aquaculture feed management |

Source: Modified from Garcia 1996.

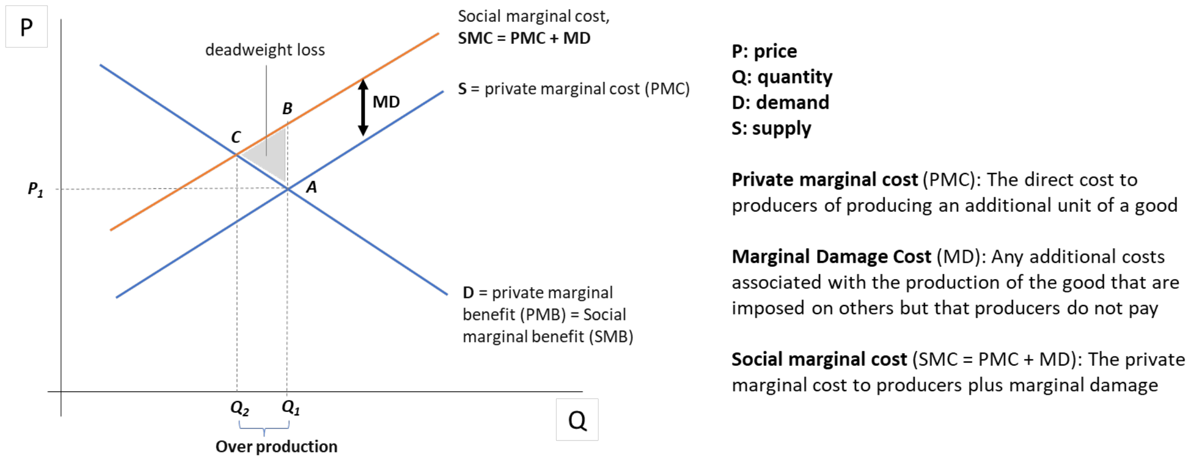
### 2.2 Context of environmental policymaking

#### 2.2.1 Externalities, public goods, and the tragedy of the commons

In properly functioning markets, the price of a product or service is a result of equating demand (benefits) and supply (costs). Price provides the incentive to both the household (consumer) and firm (producer). Markets are the mechanisms that coordinate producers and consumers and determine the price, and the price determines what is produced or the quantity produced. *Market failure* occurs when prices do not reflect the demand and supply of a product or service correctly, resulting in less-than-optimal market outcomes—either over-production or under-production—that affect society's overall well-being ("welfare perspective"). This happens when there are monopolies, externalities, missing markets, etc.

*Externalities* occur when the investment decisions, consumption, or production of goods and services by individuals, households, and firms impose costs and affect people who are not directly involved in the transactions, and such indirect effects are not reflected in the pricing of those goods and services. As a result, there are differences between private costs and the costs to society as a whole, and the market outcome is not efficient (**Figure 2.2**).

**Figure 2.2. The economics of negative externality**




Source: Gruber 2012.

In the case of pollution—the common example of a *negative externality*—a polluter makes decisions based on maximizing profits subject to its direct production cost (e.g., capital, labor, raw materials) only, and does not consider the indirect costs to third parties or those harmed by the pollution resulting from the production. For instance, wastewater dumped by a pig farm or chemicals dumped by an industrial plant into a lake or river may cause diseases and/or kill fish and plant life and affect the livelihood of fishermen and farmers using that lake or river. The damage costs of pollution include morbidity and health care costs, forgone earnings due to premature mortality, forgone production opportunities when pollution harms activities, such as fisheries and tourism, and reduced amenities. When these indirect costs (marginal damage cost in Figure 2.2) are not borne by the producer or polluter, market outcomes would result in overproduction, i.e., the polluter will continue producing at $Q_1$ instead of $Q_2$ and generate more pollution. This is a form of market failure as private market–based decision-making fails to yield the efficient outcomes from a general welfare perspective. Since the actual social or total costs of production (social marginal cost or SMC in Figure 2.2) are larger than the private costs (private marginal cost in Figure 2.2), the optimal price should be higher to account for the damage cost.

In welfare economics, the overall well-being of society is determined by the structure of markets and the allocation of goods and resources to maximize the total utility received by all individuals or the social benefits, or to minimize the social costs. When *negative externalities* affect society and result in market inefficiency, it becomes a *raison d'être* for governments to intervene in the economic realm. Governments usually issue laws and regulations and impose penalties and charges on violations (command-and-control approach). Arthur Cecil Pigou, in *The Economics of Welfare*, suggested an economic-based approach, wherein governments tax polluters an amount equivalent to the cost of the damage or harm to others.

The proposal requiring government regulation and taxation to prevent less-than-optimal market outcomes due to externalities was intensely deliberated after Pigou's seminal work. Ronald Coase (1960) proposed a different approach, in which market inefficiencies due to externalities are resolved through market mechanisms, in particular, **bargaining** among affected parties to reach mutually beneficial outcomes, instead of taxation or direct government intervention. However, for bargaining solutions to be feasible, property rights must be well defined and enforceable, bargaining transaction costs must be low, there are no free riders, and there must be no uncertainty or *asymmetric information* (when one side has more information than the other). In this setting, government intervention will be needed, and could take the form of establishing accessible information systems, and institutional frameworks that define the property rights and allow for proper bargaining to take place among the parties involved. Then again, where there is a large number of people and firms involved, it would be difficult to assign property rights. The Coasian approach ignores the difficulty of bargaining or negotiating when there is a large number of individuals on one or both sides of the negotiation.

Moreover, when *public goods* are involved, defining property rights also becomes a problem. These goods are both (a) *nonexcludable*—the good is available to everyone and no person can be excluded from benefiting from it, i.e., whoever produces or maintains the public good, even at a cost, cannot prevent other people from using it or enjoying its benefits, and (b) *nonrivalrous*—consumption by one individual does not reduce the supply nor affect the opportunity for others to use or consume it. Samuelson (1954, 1955) provided the distinction between private good like bread, and public goods like lighthouses, streetlights, and law and order, and the resulting differences in allocation. There are also *global* public goods, such as clean air, fish in the open sea, and biodiversity, which are largely nonrival and nonexcludable goods since they are 'free', available to everybody, and have wide spillover effects around the world. Without a price system for nature, households and firms do not place enough value on these public goods, and the cost of using these natural resources is not internalized in their consumption and production decisions. With many users and without well-defined property rights for these natural goods, the bargaining approach to reach efficient market outcomes will not be feasible. This often results in the degradation of air, water, and soil quality, depletion of forests, fish, water, and other natural resources, and biodiversity loss. Nordhaus (2005, p.2) notes that "markets can work wonders, but they routinely fail to solve the problems caused by global public goods."

The *tragedy of the commons* is an economic and environmental problem where individuals have access to a shared resource (e.g., pastures, fishing grounds) but act in their own interest, to the detriment of the common, societal good. In a seminal paper, Garrett Hardin (1968) argued that due to lack of property rights, users of shared resources—commons—are caught in a process that leads to the destruction of the resources on which they depend on. The ‘tragedy of the commons’ illustrates the conflict between individual benefit and group benefit in common resource exploitation. The problem arises when individuals overuse a collectively-owned resource and fail to limit their consumption, leading to the situation where the shared resource is depleted and becomes unavailable. While no single act of consumption contributes much to the problem, the aggregate of all the individual actions consequently results in a situation where the commons can no longer sustain overall consumption or use of the resource. Hardin's model of the Tragedy of the Commons assumes that individuals are short-term, self-interested "rational" actors, seeking to maximize their own utility and gains in exploiting the commons, at the expense of the long-term collective gain.

For example, a bay or lake that is abundant in fish initially allowed fishers to catch as many fish as they desired without negatively impacting the fish population. However, when the number of fishers increase, or the fishers caught more fish, and even the juvenile fish, the reproduction rate of the fish is compromised, resulting in the eventual decline in the number of fish that can be caught, and the collapse of fish stocks and the fishing industry.

Similarly, groundwater is a renewable but depletable resource. As the number of groundwater users increase or pump more water from the aquifer, the extraction rate may exceed the recharge rate, resulting in the depletion of the groundwater, as well as other impacts, such as saltwater intrusion and land subsidence.

Another example of the Tragedy of the Commons is the degradation of a river, lake or bay caused by individuals and/or firms using the water body for discharging their untreated wastewater. As the number of households and companies increase and dump their waste into the river, the assimilative capacity of the river will eventually be exceeded, and the river becomes polluted, which affect the fish and wildlife in the river, and the people relying on its water and resources.

This situation in which individuals with access to a shared or common resource act in their own interest to benefit themselves in the short term but neglect the well-being of society in the long term, and ultimately degrade or deplete the resource, is the Tragedy of the Commons. Thus, environmental issues often face a *collective* action problem and need some form of government intervention. There is also a need to determine the carrying capacity of ecosystems and ways to avoid exceeding it.

It is a challenge when actions of one country, for example, higher $CO_2$ emissions, affect the whole world. When global resources are involved and when there are transboundary externalities (e.g., atmosphere, ozone layer, ocean, large marine ecosystems, migratory species), this would call for intergovernmental or multilateral environmental agreements, and international collective action to protect global public goods. But it is possible that some parties (States) behave in a noncooperative way, especially when it is not in their sovereign interest.

**Environmental policymaking**

In its simplest form, environmental policy merely requires internalizing negative externalities and providing public goods. Externality is internalized when either government intervention or private negotiation (bargaining) brings about the party involved to fully reflect the external costs of that party’s actions and leads to the optimal outcome. However, environmental policy is made in a setting of both market failure and government failure. As previously pointed out, leaving environmental protection to the free market, and assuming, given the benefits, altruistic consumer behavior and corporate social responsibility as rational behavior, will not necessarily deliver optimal results. For the environment, unlike other areas of economic activity, relying on the 'free market' or on 'information provision' may not deliver the optimal outcomes because firms have inadequate incentives to internalize externalities without government intervention or societal pressure. The Coasian approach is useful in certain situations, such as those involving small-scale, localized externalities, where bargaining and private negotiation can take place.

The alternative approach of "nationalizing the delivery of environmental protection is likely to fail because nation states rarely have the depth and quality of information required to instruct all the relevant agents to make appropriate decisions" (Hepburn 2010, p. 117). Governments do not have complete information, and this can result in 'imperfect economies' as outlined by Stern (2009). In many areas of environmental policy, the information requirements of optimal policy are substantial. "Determining the 'optimum' often requires aggregating complex scientific information on damages, determining consumer preferences such that those damages can be valued in monetary terms, and then obtaining detailed information on aggregated private-sector abatement costs so that a balance between costs and benefits can be struck" (Hepburn 2010, p. 127-128). This situation shows that there could be gaps in the policy or regulations, and due to lack of complete information, governments would be hard-pressed to develop the perfect plan to achieve the best outcome.

The work of Buchanan and Wagner (1977) emphasized the role of rent-seeking in policy formation, and that governments can be subjected to lobbying and persuasion by others who have an incentive to shape policy for their own benefit. In cases where civil servants or policymakers are particularly susceptible to capture by private interests, policy is unlikely to provide a level playing field and efficient results.

There is also an increasing awareness that policies do not succeed or fail on their own merits; rather their success or progress is dependent upon the process of implementation. In this situation, four broad contributors to policy failure can be identified: overly optimistic expectations; implementation in dispersed governance; inadequate collaborative policymaking; and the vagaries of the political cycle (Hudson, Hunter and Peckham 2018).

Thus, for many areas of policy, the impossibility of a 'free market' approach and the inefficiency of centralized or 'nationalized delivery' implies a role for government in the middle of the spectrum, and applicable models of environmental intervention will lie between these two extremes (Hepburn 2010). Some form of government measure is needed to set in place the enabling conditions for the markets to produce the acceptable optimal outcome.

There are many ways in which interventions might be used to address one or more causes of environmental market failure. Public policymakers employ two types of measures to resolve the problems associated with negative externalities:

1) **Command and control approach**: Under this approach, the government imposes laws, regulations, and environmental standards, with applicable penalties for violations, to force firms to produce the socially efficient quantity and abate the production of negative externality, e.g., pollution. The government can also issue permits and licenses, with specifications and restrictions on the quantity of the resource that can be

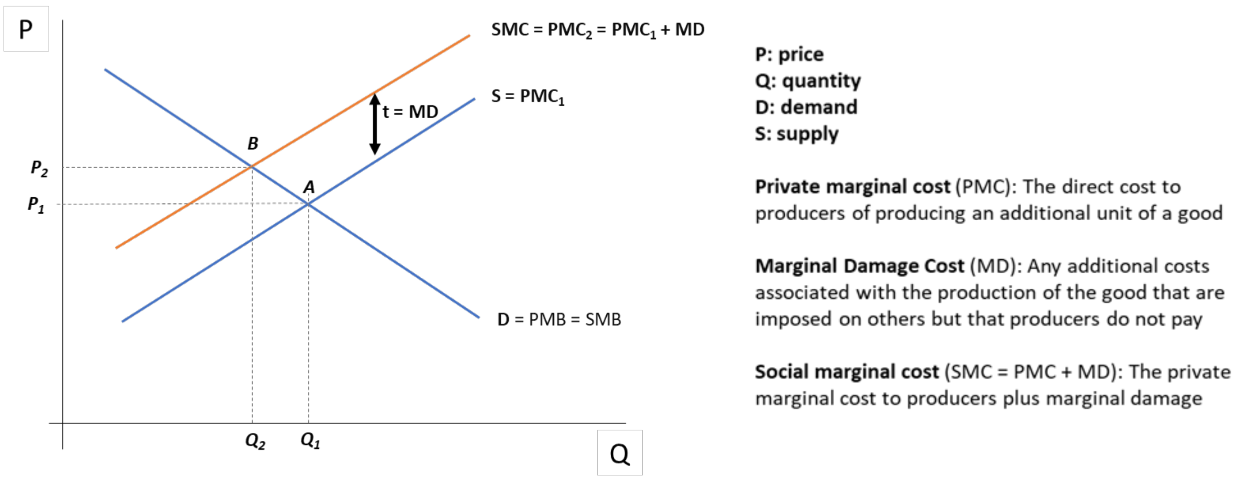
extracted, and the technologies and practices to be used. This requires government to have all of this information.

2) **Economic** or **market-based approach**: This approach uses fiscal incentives and disincentives, and other market-based measures to *change price signals* that could lead to changes in decisions and behavior of consumers and producers towards desired policy objectives and more sustainable practices. Economic instruments include tax and nontax instruments.

   **Tax instruments** are government interventions that focus on changing market prices to incorporate environmental costs and benefits into the budget constraints of households and firms and make them internalize the marginal damage cost.

   Arthur Cecil Pigou, in *The Economics of Welfare*, suggested that governments tax polluters an amount equivalent to the cost of the damage or harm to others. The term *Pigouvian tax* is often used to illustrate environmental taxes. As shown in **Figure 2.3**, such a tax, **t**, (equal to the marginal damage cost, MD) would yield the market outcome ($Q_2$) as the marginal damage cost of the negative externalities would be included in the budget constraint and therefore internalized by the polluters, and production will be cut back to the optimal level.

**Figure 2.3. Pigouvian tax (corrective taxation)**




Source: Gruber 2012.

   **Incentives** and **subsidies** (e.g., tax discounts, tax holiday) also change price signals and can be offered to encourage investment in and adoption of production processes and technologies that will address the negative externalities.

   Studies are needed to determine the damage costs. It is important that the tax be set at least equal to the damage cost to encourage firms (polluters) to invest in pollution abatement, otherwise, if the tax is lower, firms would rather just pay the tax than to mitigate its pollution. With either tax or incentives, the government does not dictate the production process or the technology.

   **Non-tax instruments** include emissions trading, tradeable quotas, deposit-and-refund, eco-labeling, etc.

Choice of instruments depends on each locality or country's situation. For example, to reduce carbon emissions, some countries apply carbon tax, while others use the cap-and-trade (carbon emissions trading) approach.

### 2.2.2 Sustainability and sustainable development

UNESCO (2012, p.1) defines *"sustainability* as a long-term goal (i.e., a more sustainable world), while s*ustainable development* refers to the many processes and pathways to achieve it (e.g., sustainable agriculture and forestry, sustainable production and consumption, good government, research and technology transfer, education, training, etc.)".

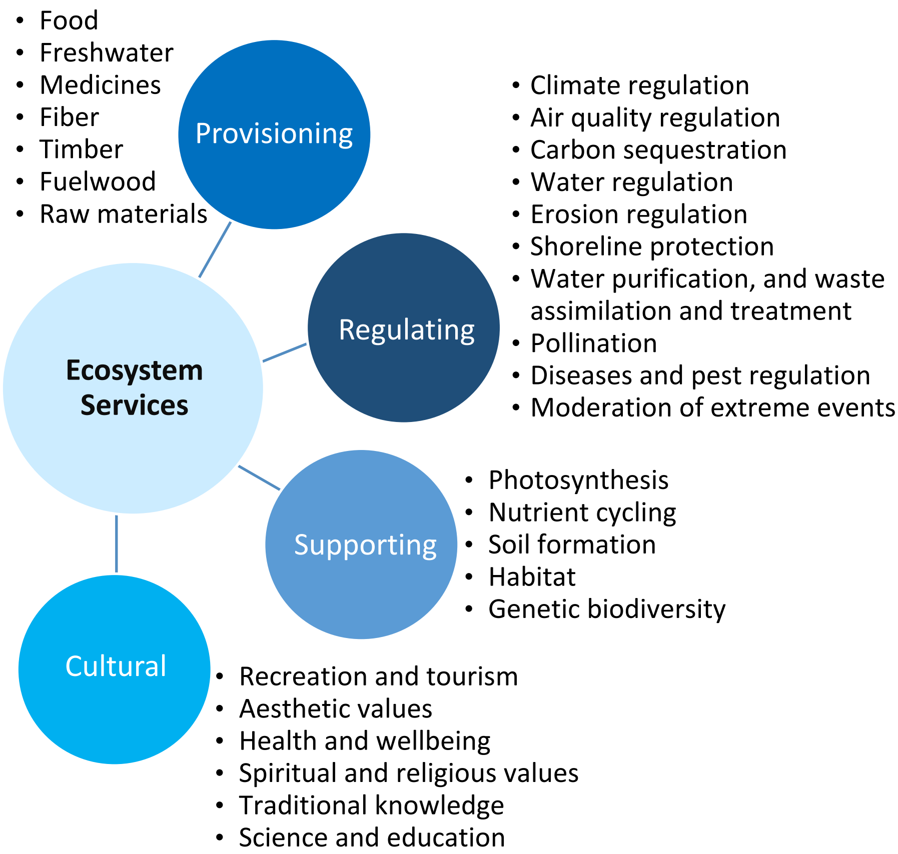
Due to the effects of poverty, inequality, environmental degradation, and climate change in the face of rapid economic growth, more emphasis is now being given to shared and equitable prosperity and environmentally sustainable and resilient development. As shown by many indicators and data, the natural environment is being used in a non-sustainable way, that is, in a way that diminishes their condition and future flow of goods and services.

In the context of agriculture, fisheries, and rural development, FAO defines sustainable development as *"*the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in the agriculture, forestry, and fisheries sectors) conserves land, water, plant and animal genetic resources, is **environmentally non-degrading, technically appropriate, economically viable, and socially acceptable***"* (FAO 2014, p.2; FAO 1989).

"Ecosystem *functions* refer variously to the habitat, biological, or systems properties or processes of ecosystems. Ecosystem goods (e.g., food) and services (e.g., waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions" (Costanza *et al*. 1997). Agriculture and fisheries rely on the natural capital and are both providers and consumers of ecosystem services[3] (**Figure 2.4**), and at the same time pose a threat to nature. Thus, sustainability has emerged as a necessity in policy and practice in this sector. As AFMA adopts the principle of sustainable development, the measures done under AFMA, other related policies, plans, and programs on agriculture and fisheries, and their outcomes should therefore be assessed in terms of the sustainable development aspects, and how the natural capital is being maintained to ensure the flow of ecosystem services and that future generations can also meet their needs.

[3] **Natural capital** is a way of thinking about nature as a *stock* that provides a flow of benefits to people and the economy. Natural capital consists of the **stocks of natural assets** – both biotic and abiotic. It includes air, water, soil, minerals, oil, gas, coal, forests, mangroves, coral reefs, seagrass beds, and all living things. It is from this natural capital that humans derive a wide range of goods and services, which make human life possible. An **ecosystem** is a complex community of living organisms, their physical environment, and all their interrelationships in a particular unit of space, and these biotic and abiotic components are linked together through nutrient cycles and energy flows. The goods and services that natural capital provides, such as food, water, energy, climate regulation, or shoreline protection, are called **ecosystem services**. These provide people everywhere with the means for healthy lives and underpin all economic activity. **Ecosystem services** are the *flows* of benefits, which people gain from natural capital and ecosystems, while **natural capital** consists of the *stock* of natural ecosystems or stock of renewable and nonrenewable natural resources from which these benefits flow.

**Figure 2.4. Ecosystem services**




Sustainable agricultural practices should be implemented and expanded in the Philippines to achieve more productive and equitable food system, protect the environment and natural resource base, and maintain and improve soil fertility and water quality while producing the food needed by society amid the changing climate.

The fisheries sector in the Philippines should also maintain a delicate balance between the requirements of increased production to contribute to food security and the need to conserve and protect the fishery resource and habitats for long-term sustainability. The biological components of sustainability have been enshrined in the 1982 UNCLOS and concept of maximum sustainable yield (MSY). The fishery tips into unsustainable level when fishing effort goes beyond the MSY. The MSY concept is more of a measure of fishery potential, and there should be caution when MSY is used as the management target. When the marginal cost of fishing is considered, the maximum efficiency yield (MEY) or the level of catch that provides the maximum net economic benefits could be lower than the MSY.

Sustainable fisheries denotes optimizing the contribution of fisheries to food, recreation, trade, and ensuring the livelihoods of people who rely on fishing, and related activities without depleting fish stocks. Critical also are the questions of food safety, access, affordability, and social equity—who is benefiting from the resources: the rich investors using modern fishing gears and technologies or the common fisherfolk relying only on the traditional low input-low output kind of fishing. The FAO Code of Conduct for Responsible Fisheries (FAO, 1996), as an agreed international instrument (although voluntary), and together with its guidelines for practical implementation, provides the requirements for sustainable fishing and production in harmony with ecosystems and biodiversity. However, since its endorsement in 1996, the fisheries and aquaculture sector has changed significantly with a constantly growing demand and consumption of aquatic food, and a shift of source from capture to culture (FAO 2021a, p. iii).

## *2.3 Stocktaking, benchmarking, and Theory of Change*

The stocktaking is the product of review of literature and desktop research of data, statistics, publications, and documents on official portals and websites of key government agencies, research institutions, international organizations, scientific bodies, etc.  This report discusses the various environmental pressures affecting agriculture and fisheries, and the key factors behind market and policy failures, explores the different approaches to policy support, and identifies key messages for policy design and interventions.

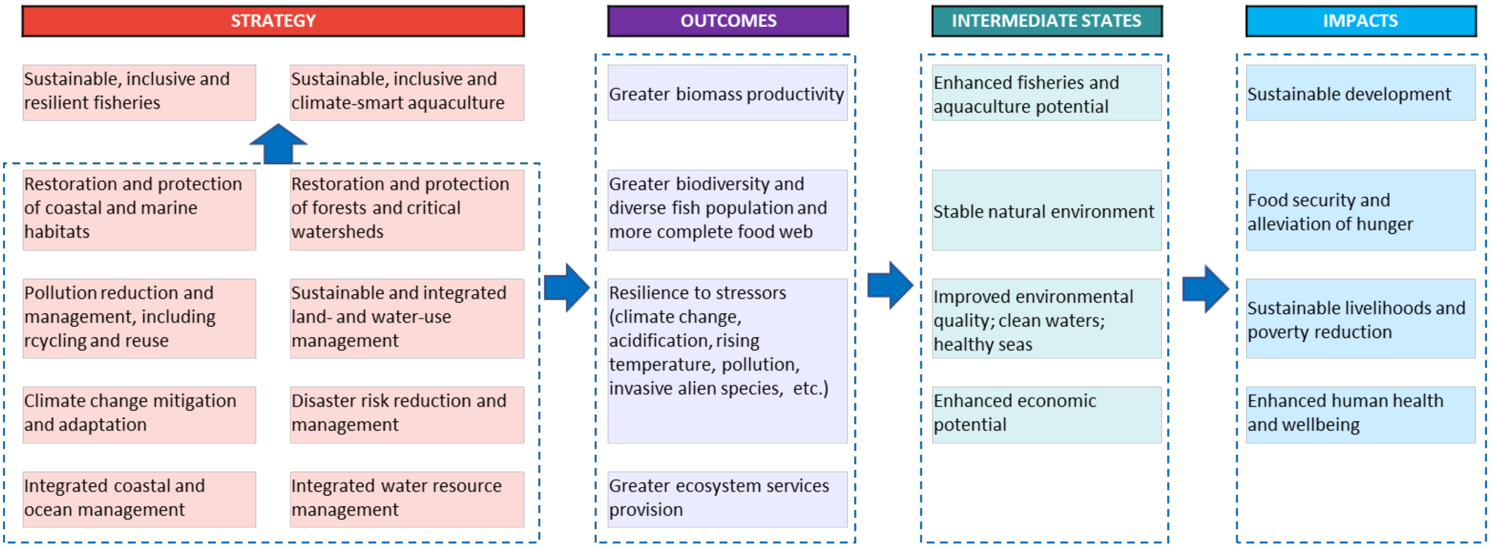
Based on the stocktaking and analysis of issues and existing measures, the needed strategies, and desired outcomes, using the theory of change, will be used in reviewing the implementation of AFMA, AFMPs, and other measures taken by the government and other partners and stakeholders. The benchmarking is based on results of ongoing practices versus ideal or best practices, comparison of the country's performance with existing benchmarking indices, targets of national plans and international agreements to which the Philippines is a party to, and comparison with other countries in the East Asian region.

This study reviews the key economic, social, and environmental adjustment measures that have been introduced since the adoption of AFMA in 1998 and their outcomes in terms of ensuring environmental protection and the livelihood and wellbeing of fisherfolk. In line with this, the study reviews national and collective accomplishments, and examines the challenges faced; identifies key policies and strategic action plans; points out gaps and conflicting policies and initiatives; captures best practices and lessons learned; and identifies options for addressing gaps and needs. The study also proposes recommendations of possible measures to address the issues and move forward that build on existing strengths.

A theory of change sets out an impact pathway for efforts to reach a logical set of outcomes or impacts considering the experience and expertise of those undertaking efforts (Thornton *et al*., 2017). Based on Objective 9 of AFMA, the desired outcome is increased productivity and market efficiency that is environmentally sound and equitable, and this is consistent with the three pillars of sustainable development.

The thinking around a Theory of Change (TOC) can be applied to policy, strategies, and the projects and programs involved. The TOC also offers a way to describe the set of the strategies or steps and assumptions that would lead to the long-term goal of interest. It helps to explain how activities are understood to produce a series of results and outcomes that contribute to achieving the final intended impacts. To achieve the key outcome of AFMA's Objective 9, there are changes that need to happen in order to achieve it. These are sometimes called 'necessary pre-conditions'—in other words, things that need to change before the long-term outcome can happen. **Figure 2.5** shows the TOC for sustainable fisheries. The PSR framework facilitates the identification of needs and gaps in terms of the underlying pressures that affect the current state of agriculture and fisheries, and the strategies and response measures intended to address those pressures and improve the state to achieve desired outcomes and impacts.

**Figure 2.5. Sustainable Fisheries: Theory of Change**



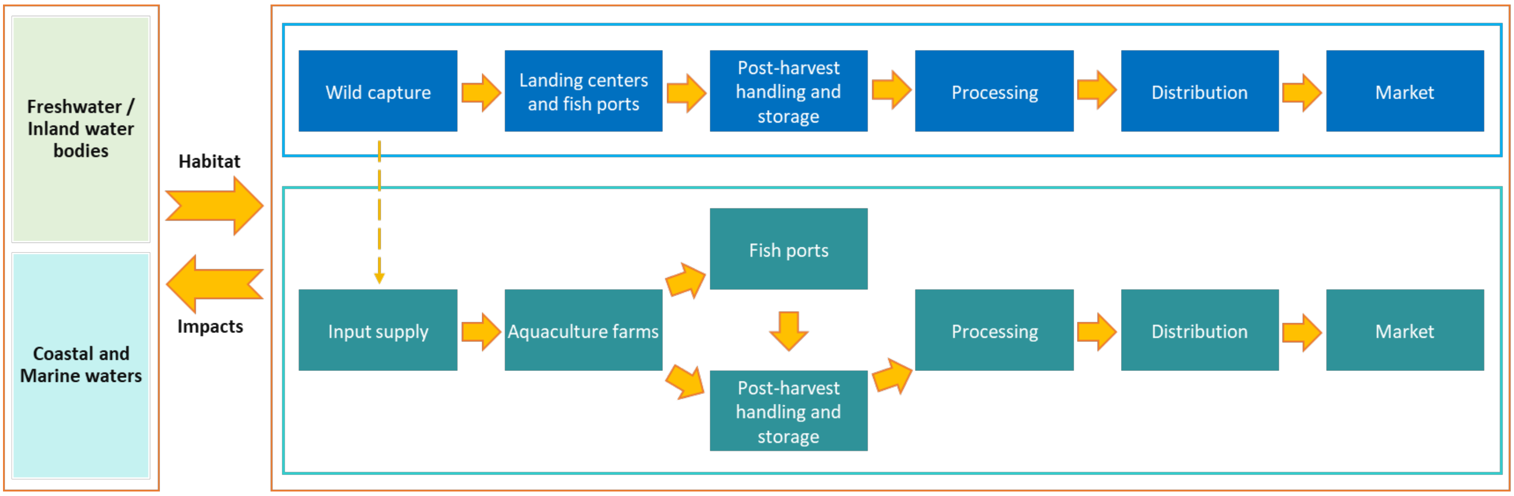
## 3.0 Sustainable development and modernization of fisheries

One of the policy objectives of the Fisheries Code (1998) is "to ensure the rational and sustainable development, management and conservation of the fishery and aquatic resources in Philippine waters including the Exclusive Economic Zone (EEZ) and in the adjacent high seas, consistent with the primordial objective of maintaining a sound ecological balance, protecting, and enhancing the quality of the environment (Section 2.c)."

Determining the pressures on fishery resources and how they will change over time and space, and framing the actions required would require an examination into the following:

- critical dimensions of pelagic species and systems, including migration patterns, and impacts of climate change, for both nearshore pelagic fish and commercial tuna species.
- demersal marine fish and invertebrate production, and the pollution, siltation, and land use pattern affecting water quality coupled with altered monsoonal sequences and rising sea surface temperatures that interfere with biological processes.
- aquaculture production practices, including effluents, maintenance of ponds, sourcing of fry, use of feeds and antibiotics, conversion of mangrove areas to fish farms, overstocking, intensified seaweed farming, etc.
- environmental sustainability in each stage of the supply chain of capture fisheries and aquaculture (**Figure 3.1**).
- consumer demand and preferences, such as considerations on safety, nutrition, sustainably sourced and organically produced products, and fair trade
- governance structure influencing (a) ecosystem-based management, (b) conservation of wild species, (c) sustainable aquaculture production, (d) non-tariff measures, such as sustainability standards, traceability, eco-labelling, and fair trade, (e) access of fisherfolk to technologies, post-harvest facilities, and markets, and (f) participation of women in fisheries development planning and management.

**Figure 3.1. Water bodies and supply chain of capture fisheries (top) and aquaculture (bottom)**

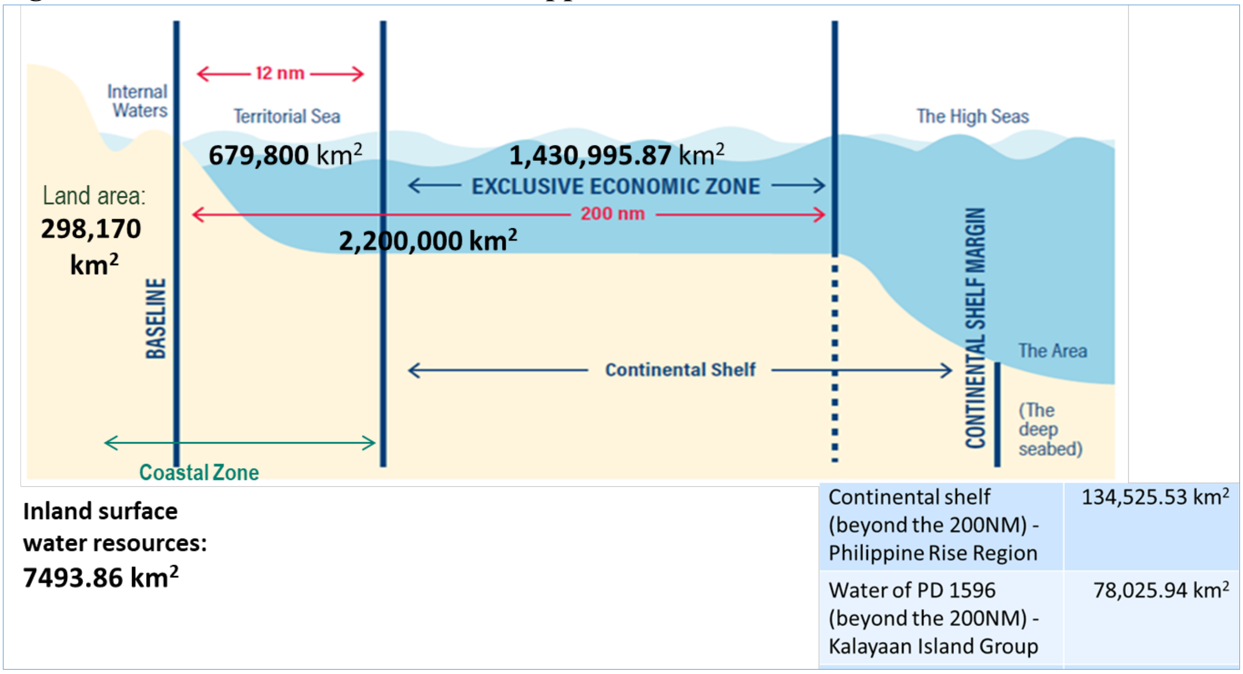



### *3.1 Status of the fisheries and aquaculture sector*

#### 3.1.1 Water resources

The Philippines is an archipelago that consists of 7,641 islands, with a coastline of 37,000 kilometers (km). The land area of the Philippines is 298,170 square kilometers ($km^2$). The area of territorial waters up to 12 nautical miles (NM) from the baseline is 679,800 km$^2$—more than double the land area, and the territorial waters plus the exclusive economic zone (EEZ) area cover an area of 2.2 million km$^2$ (**Figure 3.2**). The Philippines also has a continental shelf area beyond the 200 NM EEZ area. Inland surface water resources (rivers, streams, lakes, and reservoirs) have a total area of 7,493.86 km$^2$ (DA-BFAR 2020). The major river and lakes are listed in **Tables 3.1 and 3.2**. The government (DENR) is tasked with classifying these water bodies according to intended use and benefits (**Table 3.3**).

**Figure 3.2. Water Resources of the Philippines**




Source of data: NAMRIA

There are 18 major river basins and 421 principal rivers in the country. The major river basins, each with an area of at least 1,400 km$^2$, have an aggregate area of 108,678 km$^2$ and total river length of 3,120 km. (**Table 3.1**). The six largest (more than 5,000 km$^2$) are: (1) Cagayan River Basin in northern Luzon; (2) Mindanao River Basin in central and southern Mindanao; (3) Agusan River Basin in northern Mindanao; (4) Pampanga River Basin in central Luzon; (5) Agno River Basin in central Luzon; and (6) Abra River Basin in northern Luzon. These rivers are important for agricultural and municipal water supply. The priority rivers for clean-up, restoration, and water quality protection are listed in **Table 3.2**.

The country has 79 lakes. **Table 3.3** shows the ten major lakes considered as major hosts for aquaculture production. Laguna de Bay is the largest among these lakes It is surrounded by the provinces of Laguna and Rizal, and some cities in Metro Manila. Lake Lanao in Lanao del Sur is the largest lake in Mindanao.

**Table 3.1. Major river basins in the Philippines**

| River Basin | Catchment Area (km²) | River Length (km) | Administrative Coverage | | |
|---|---|---|---|---|---|
| | | | Region | Provinces | Cities/Municipalities |
| **Cagayan** | 25,649 | 505 | 3 Regions (CAR, R2, R3) | 13 | 122 mun./cities, 2,462 bgys. |
| **Mindanao** | 23,169 | 373 | 5 Regions (ARMM, R10, R11, R12, R13) | 9 | 91 mun./cities, 1,764 bgys. |
| **Agusan** | 10,921 | 350 | 3 Regions (R10, R11, R13) | 8 | 45 mun./cities. 646 bgys. |
| **Pampanga** | 9,759 | 260 | 5 Regions (R1, R2, R3, R4-A, NCR) | 10 | 101 mun./cities, 2,109 bgys |
| **Agno** | 5,952 | 206 | 4 Regions (CAR, R1, R2, R3) | 9 | 70 mun./cities, 1,206 bgys. |
| **Abra** | 5,125 | 178 | 2 Regions (CAR, R1) | 1 | 52 mun./cities, 519 bgys. |
| **Pasig - Laguna de Bay** | 4,678 | 27 | 3 Regions (NCR, R3, R4-A) | 6 | 96 mun./cities, 2,592 bgys. |
| **Bicol** | 3,771 | 136 | 2 Regions (R4-A, R5) | 4 | 50 mun./cities, 936 bgys. |
| **Abulog** | 3,372 | 175 | 3 Regions (CAR, R1, R2) | 4 | 24 mun./cities, 248 bgys. |
| **Tagum - Libuganon** | 3,064 | 89 | 3 Regions (R10, R11, R13) | 5 | 19 mun./cities, 209 bgys. |
| **Ilog Hilabangan** | 1,945 | 124 | 2 Regions (R6, R7) | 2 | 15 mun./cities, 184 bgys |
| **Panay** | 1,843 | 132 | 1 Region (R6) | 3 | 29 mun./cities, 483 bgys. |
| **Tagoloan** | 1,704 | 106 | 1 Region (R10) | 2 | 12 mun./cities, 102 bgys. |
| **Agus - Ranao** | 1,645 | 36 | 2 Regions (ARMM, R12) | 3 | 38 mun./cities, 835 bgys |
| **Davao** | 1,623 | 150 | 3 Regions (R10, R11, R12) | 4 | 9 mun./cities, 100 bgys. |
| **Cagayan De Oro** | 1,521 | 90 | 2 Regions (R10, R12) | 3 | 5 mun./cities, 1,206 bgys |
| **Jalaur** | 1,503 | 123 | 1 Region (R6) | 3 | 29 mun./cities, 604 bgys. |
| **Buayan Malungon** | 1,434 | 60 | 1 Region (R2) | 3 | 8 mun./cities, 68 bgys. |
| **TOTAL** | **108,678** | **3,120** | | | |

Source: DENR - River Basin Coordinating Office (RBCO). *mun. – municipality; brgy. - barangay

**Table 3.2. Priority rivers**

| Region | River | Classification |
|---|---|---|
| NCR | Marikina River (Lower) | C |
| | San Juan River | C |
| | Paranaque River | C |
| | Pasig River | C |
| CAR | Balili River | A |
| 3 | Meycauayan River | C |
| | Marilao (UPPER) | A |
| | Marilao (LOWER) | C |
| | Bocaue (UPPER) | A |
| | Bocaue (LOWER) | C |
| 4A | Imus River | C |
| | Ylang-ylang River | C |
| 4B | Mogpog River | C |
| | Calapan River | C |
| 5 | Anayan River | D |
| | Malaguit River | C |
| | Panique River | C |
| 6 | Iloilo River | C |
| 7 | Luyang River (UPPER) | A |
| | Luyang River (LOWER) | C |
| | Sapangdaku River | C |
| 10 | Cagayan de Oro River | A |

Note: These are the priority rivers in 2011 under the DENR's Sagip Ilog Pilipinas Movement.
Source: DENR-EMB 2013.

**Table 3.3. Major lakes in the Philippines**

| Name of Lake | Location | Area ($km^2$) |
|---|---|---|
| 1) Laguna de Bay | Laguna and Rizal | 900 |
| 2) Lanao | Lanao del Sur | 347 |
| 3) Taal | Batangas | 234 |
| 4) Mainit | Agusan del Norte & Surigao del Norte | 140 |
| 5) Naujan | Oriental Mindoro | 110 |
| 6) Buluan | Sultan Kudarat & Maguindanao | 65 |
| 7) Bato | Camarines Sur | 38 |
| 8) Buhi | Camarines Sur | 18 |
| 9) Dapao | Lanao del Sur | 10 |
| 10) Sebu | South Cotobato | 9.64 |
| **TOTAL** | | **1,871.64** |

Only the top ten lakes in terms of size are listed.
Source: BFAR.

**Table 3.4. Classification of water bodies**

| Water Body Classification and Usage of Freshwater | |
|---|---|
| **Classification** | **Intended Beneficial Use** |
| **Class AA** | Public Water Supply Class I - intended primarily for waters having watersheds, which are uninhabited and/or otherwise declared as protected areas, and which require only approved disinfection to meet the latest PNSDW. |
| **Class A** | Public Water Supply Class II - intended as sources of water supply requiring conventional treatment (coagulation sedimentation, filtration, and disinfection) to meet the latest PNSDW. |
| **Class B** | Recreational Water Class I - intended for primary contact recreation (bathing, swimming, etc.) |
| **Class C** | **1. Fishery water for propagation and growth of fish and other aquatic resources**.<br>2. Recreational Water Class II - for boating, fishing, or similar activities.<br>**3. For agriculture, irrigation, and livestock watering** |
| **Class D** | Navigable waters |
| **Water Body Classification and Usage of Marine Water** | |
| **Classification** | **Intended Beneficial Use** |
| **Class SA** | 1. Protected Waters - waters designated as national or local marine parks, reserves, sanctuaries, and other areas established by law (Presidential Proclamation 1801 and other existing laws) and/or declared as such by appropriate government agency, LGUs, etc.<br>2. **Fishery Water Class I - Suitable for shellfish harvesting for direct human consumption.** |
| **Class SB** | 1. **Fishery Water Class II - waters suitable for commercial propagation of shellfish and intended as spawning areas for milkfish (*Chanos chanos*) and similar species.**<br>2. Tourist Zones - for ecotourism and recreational activities.<br>3. Recreational Water Class I - intended for primary contact recreation (bathing, swimming, skin diving, etc.) |
| **Class SC** | 1. **Fishery Water Class III - for the propagation and growth of fish and other aquatic resources and intended for commercial and sustenance fishing**. 2. Recreational Water Class II - for boating, fishing, or similar activities.<br>3. Marshy and/or mangrove as declared as fish and wildlife sanctuaries. |
| **Class SD** | Navigable Waters |

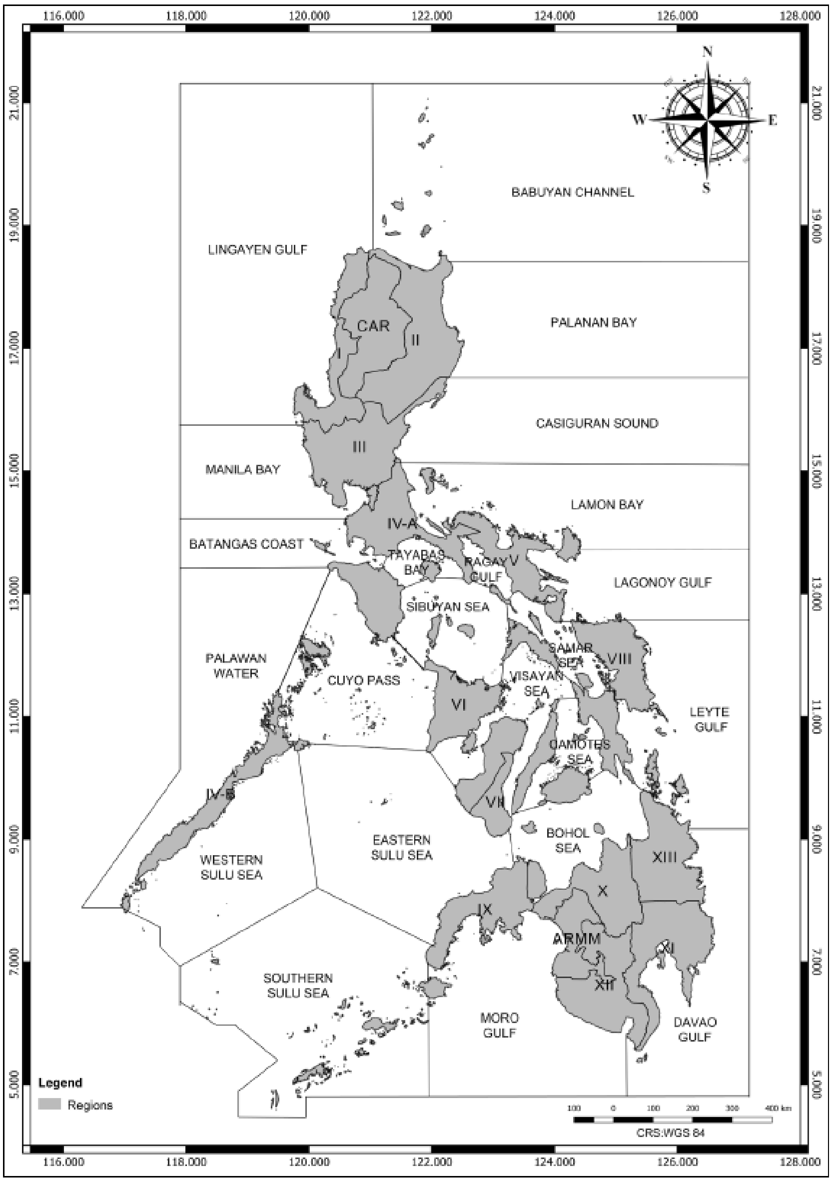
Source: DENR (DAO 2016-08).

### 3.1.2 Fishery production

The Philippine fishing industry comprises marine capture fisheries, inland capture fisheries, and aquaculture. Recreational fisheries are not significant.

The marine fishing grounds are shown in **Figure 3.3**. Most of the fisheries and aquaculture production are done in coastal and marine waters.

**Figure 3.3. Philippine Statistical Fishing Grounds**



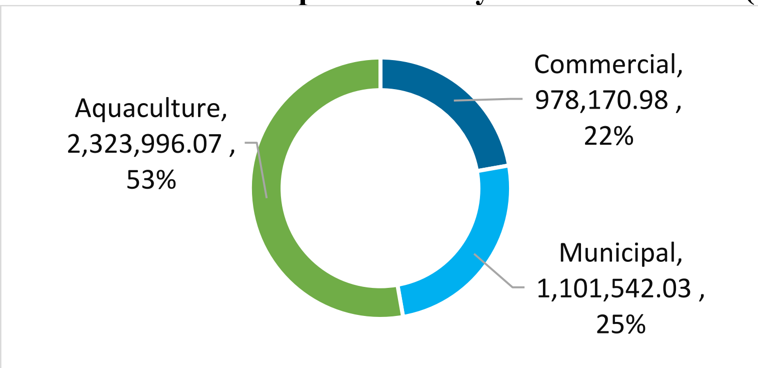

Source: Santos *et al*. 2017.

The share of municipal fisheries in total fisheries production was 25 percent in 2020 (PSA 2021; **Figure 3.4**). The municipal capture fisheries sector is further subdivided into marine and inland. *Municipal marine capture fisheries* operate in coastal waters within 15 km from the coastline ("municipal marine waters"), using vessels up to 3 gross tonnage (GT) or without the use of vessels. *Municipal inland capture fisheries* operate in enclosed freshwaters in inland areas, such as lakes, reservoirs, rivers, and estuaries, using vessels of 3 GT or less. Municipal marine and inland fisheries contributed 86 percent and 14 percent to the total municipal fisheries, respectively, in 2020 (PSA 2021).

*Commercial fisheries* operate outside municipal waters, using vessels 3 GT or larger. Small-scale commercial fishing is undertaken by fishers utilizing vessels between 3.1 GT and 20 GT. Medium-scale commercial fishing is undertaken by using vessels of 20.1 GT to 150 GT, and large-scale commercial fishing by vessels of more than 150 GT (RA 8550 or Fisheries Code of 1998). Commercial fisheries contributed 22 percent of the total fisheries production in 2020 (**Figure 3.4**).

*Aquaculture* includes fishery operation involving all forms of raising and culturing fish and other aquatic species in freshwater, brackishwater, and marine waters (RA 8550 or Fisheries Code of 1998). In 2020, 53 percent of the total fisheries production is from aquaculture (**Figure 3.4**). The Philippines is one of the few countries that have higher aquaculture production than capture fishing. Brackishwater and marine water aquaculture comprised 86 percent of total aquaculture production in 2019 (PSA 2021).

**Figure 3.4. Volume of fisheries production by subsector in 2020 (in tonnes)**




Source of data: PSA 2021

Fisheries production can also be categorized according to the type of fish species.

a. **Pelagic fish** inhabit and feed in the water column of the sea or lake—the pelagic zone—away from the seabed or lakebed. Marine pelagic fish can be further subdivided into *coastal* pelagic fish, which live in relatively shallow waters, and *oceanic* pelagic fish, which can go to the open ocean and live in waters beyond the continental shelf. Pelagic fish also range in small to large sizes.
b. **Demersal fish** live and feed on the seafloor or near the bottom of the sea or lake—the demersal zone. In coastal waters, demersal fish are found on the floor of inshore waters and further to the continental shelf or continental slope. However, deep-sea demersal fish have been discovered around seamounts. Demersal fish can be considered as bottom feeders. A sub-type is the *benthic* fish, which can rest on the sea floor like rays and halibut. *Reef fish* live in the coral reefs.

**Table 3.5** presents the type of fish caught in Philippine waters as monitored under the National Fish Stock Assessment Program of BFAR-NFRDI. The small pelagic fish comprised 27.5 percent of the fish caught. Oceanic tuna is the second major type of fish caught, with a share of 12.6 percent, followed by demersal fish (5.86 percent), and neritic tuna (4.4 percent.).

The *oceanic tunas* are transboundary and migrate over oceans and seas, while *neritic tunas* mostly live within the economic zones and subregional marine waters of Southeast Asia (Siriraksophon 2017). Neritic tunas are caught by commercial fishers using purse seines and ring nets in the Philippines, and by municipal and subsistence fishers using handline.

**Table 3.5. Total Catch in 2014, by Type of Species**

| Catch type | Species types | Total Catch (tonnes) |
|---|---|---|
| Oceanic tunas | Yellowfin Tuna, Bigeye Tuna, Albacore Tuna, Bluefin Tuna, and Skipjack | 209,197 |
| Neritic tunas | Bullet Tuna, Frigate Tuna, Kawakawa, Longtail Tuna, Striped Bonito, Spanish Mackerel, and Indo-Pacific Mackerel | 72,558 |
| Small pelagic fish | Anchovies, Sardines/Herrings, Scads, Indian Mackerel, Fusiliers, and Flying Fishes | 456,228 |
| Other pelagic fishes | Barracuda, Needle Fish, Halfbeaks, Cutlassfish, Snake Mackerel, Milkfish, Tarpon, Cobia, and Jacks | 49,091 |
| Other large pelagic fish | Black Marlin, Indo-Pacific Blue Marlin, Indo-Pacific Sailfish, Swordfish, Pompano, Dolphinfish, Wahoo, Ocean Sunfish, Opah, and Striped Marlin | 20,900 |
| Demersal fishes | Unicorn Leatherjacket, Lattice Monocle Bream, Splendid Ponyfish, Bluespot Mullet, Japanese Threadfish Bream, Purple-spotted Bigeye, Butterfly Whiptail, Orangefin Ponyfish, Toothed Ponyfish, and Tiger Perch | 97,126 |
| Sharks and Rays | Scalloped Hammerhead, Megamouth, Fox Shark, Whitecheek Shark, Spottail Shark, Blue Spotted Stingray, Blue Spotted Maskray, Honeycomb Stingray, Brown Stingray, and Spotted Eagle ray | 1,664 |
| Invertebrates | Flower Crab, Swordtip Squid, Spider Prawn, Indian Squid, Hawaiian Arrow Squid, Oval Squid, Indian White Prawn, Indian Ocean Squid, Cuttlefish, and Purpleback Flying Squid | 44,680 |
| **TOTAL** | | **1,657,576** |

Source: Santos *et al.* 2017.

### 3.1.3 Contribution to the national economy[4]

In 2020, the gross value added (GVA) in the agriculture, forestry, and fishing (AFF) sector amounted to around PHP 1.781 trillion (in constant 2018 prices), contributing 10.2 percent to the country's GDP. The GVA in AFF declined by 0.2 percent in 2019-2020.

The GVA of the fisheries subsector was PHP223.2 billion in 2020. This is 12.5 percent of the GVA in AFF, and 1.3 percent of the GDP in 2020. The GVA of fisheries declined by 1.3 percent in 2019-2020.

In 2019, the GVA in AFF was PHP 1.784 trillion (in constant 2018 prices). The AFF sector accounted for 9.2 percent of the GDP in 2019, and it registered a 1.2 percent growth from the previous year. The fisheries sector contributed PHP 226.14 billion in GVA or 1.2 percent to

[4] Source of data: PSA 2021 (https://psa.gov.ph/national-accounts/base-2018/data-series).

the country's GDP (at constant 2018 prices) in 2019. Fisheries accounted for 12.7 percent of the GVA in AFF for the same year.

### 3.1.4 Contribution by region[5]

The top producers by category and region in 2019 are listed below (BFAR 2020):

Out of the total fish production of 4.42 million tonnes, ARMM has the largest contribution of 0.936 million tonnes.

***Marine capture fisheries***. The top municipal fishery producers are Regions IV-B, IX, V, ARMM and VI. For commercial fisheries, Region XII is top in production.

For ***aquaculture***, Region III is the top producer of tiger prawn and tilapia, while Region X tops in mudcrab production. As for milkfish species, Region VI has the highest production of this commodity.

***Brackishwater fish cage***. Caraga Region topped in milkfish production for brackishwater fish cage in 2019, generating a 73% share of the 1,193 tonnes fish production.

***Brackishwater fish pens***. Region I leads in the production of milkfish with a 95 percent contribution to the total 1,928 tonnes production in brackishwater fish pens.

***Marine water fish pens***. Region I had the highest production from marine waters followed by Region III and Region XI. With a total of 8,294 MT in marine water fish pens, 90 percent of this came from Region I.

Major producers for mariculture are ARMM, Regions IV-B, IX and VI. Almost all of the regions produce seaweeds as their main commodity (except NCR, CAR, III & IV-A). ARMM's 46.5 percentage share in the total aquaculture production of seaweed makes it the top producer of the said commodity in the Philippines.

### 3.1.5 Contribution to jobs

The fisheries sector provided 1.95 million people with jobs and livelihood in 2019. This is 4.7 percent of total employment in the country. Based on the FishR 2019 database, fisherfolk were engaged in various fishing activities (**Table 3.6**). Most of these fisherfolk were involved in capture fishing (49 percent). Other sources of their livelihood include aquaculture (11 percent), vending (six percent), gleaning (12 percent), and fish processing (two percent).

As of 2019, there are 2,954 operators and 7,442 commercial fishing vessels in the Philippines. NCR, Region XI and Region IX comprise the most numerous number of these vessels.

Non-powered fishing vessels still dominate the fishing fleet. In 2018, powered fishing vessels constitute only 38.6 percent of the total number of fishing vessels (**Table 3.7**).

[5] Source of data: PSA 2021 (https://psa.gov.ph/national-accounts/base-2018/data-series).

**Table 3.6 Employment in Fisheries Sector in 2019**

| Activity | Number of persons |
|---|---|
| Capture fishing | 957,551 |
| Aquaculture | 217,198 |
| Fish vending | 110,851 |
| Gleaning | 241,138 |
| Fish processing | 36,129 |
| Others | 390,892 |
| **TOTAL** | **1,953,759** |

Source: BFAR 2020

**Table 3.7. Number of fishing vessels (2018)**

| Fishing vessels | Number |
|---|---|
| Powered | 183,998 |
| Non-powered | 292,180 |
| **TOTAL** | **476,178** |

Source: FAO 2020.

### 3.1.6 Contribution to food security

According to the Rome Declaration on World Food Security and the World Food Summit Plan of Action adopted by the United Nations' Committee on World Food Security in 1996, "food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life" (FAO 1996, p.1).

The Philippines passed the *Fisheries Code of 1998* (RA 8550), which aims to "achieve food security as the overriding consideration in the utilization, management, development, conservation and protection of fishery resources in order to provide the food needs of the population. A flexible policy towards the attainment of food security shall be adopted in response to changes in demographic trends for fish, emerging trends in the trade of fish and other aquatic products in domestic and international markets, and the law of supply and demand (Section 2.a)."

On average, per capita fish consumption was estimated to be 101 g/day or 36.8 kg/year in 2015 according to the Food and Nutrition Research Institute of the Department of Science and Technology (FNRI-DOST). Of this, each Filipino consumes 24.7 kg of fresh fish, 5.2 kg of dried fish, 4.9 kg of processed fish, and 3.0 kg of crustaceans and mollusks (BFAR 2020). Fish and other fish products take up 39 percent of the body-building food group in 2015 (**Table 3.8**). This indicates that fish remain to be the most common source of protein.

A decline in fisheries production was observed from 2012 to 2016, with volume dropping from five million tonnes to 4.35 million tonnes. This 13-percent drop in production could have implications to food security and nutrition.

Per capita food consumption decreased from 861 g/day in 2008 to 844 g/day in 2015. Fish accounted for 12.8 percent of total food intake in 2008 compared to 11.9 percent in 2015 (**Table 3.8**). Fish is the second biggest component of food consumption, next to rice.

**Table 3.8. Mean One-Day Per Capita Food Consumption**

| Food Group/Sub-group | 2008 (g/day) | 2013 (g/day) | 2015 (g/day) | % of total intake for 2015 |
|---|---|---|---|---|
| **Body-building Food** | | | | |
| **Fish Meat and Poultry** | **193** | **207** | **190** | **22.5** |
| Fish and Fish Products | 110 | 109 | 101 | 11.9 |
| Meat and Meat Products | 58 | 65 | 61 | 7.3 |
| Poultry | 24 | 33 | 28 | 3.3 |
| **Eggs** | **14** | **16** | **18** | **2.1** |
| **Milk and Milk Products** | **42** | **45** | **42** | **5.0** |
| Whole Milk | 33 | 34 | 33 | 3.9 |
| Milk Products | 10 | 11 | 9 | 1.1 |
| **Dried Beans, Nuts and Seeds** | **9** | **9** | **8** | **1.0** |
| **Energy-giving Food** | | | | |
| **Cereals and Cereal Products** | **361** | **346** | **358** | **42.4** |
| Rice and Rice Products | 317 | 299 | 308 | 36.5 |
| Corn and Corn Products | 21 | 23 | 24 | 2.9 |
| Cereal Products | 23 | 25 | 26 | 3.0 |
| **Starchy Roots and Tubers** | **17** | **14** | **12** | **1.5** |
| **Sugar and Syrups** | **17** | **12** | **11** | **1.3** |
| **Fats and Oil** | **15** | **15** | **15** | **1.8** |
| **Regulating Food** | | | | |
| **Vegetables** | **110** | **114** | **123** | **14.6** |
| Green Leafy and Yellow | 34 | 39 | 43 | 5.1 |
| Other Vegetables | 76 | 75 | 80 | 9.4 |
| **Fruits** | **54** | **41** | **37** | **4.4** |
| Vitamins C-Rich Fruits | 10 | 8 | 6 | 0.7 |
| Other Fruits | 44 | 33 | 31 | 3.7 |
| **Miscellaneous** | **29** | **34** | **29** | **3.5** |
| Beverages | 16 | 23 | 18 | 2.1 |
| Condiments and Spices | 10 | 10 | 10 | 1.2 |
| Others | 3 | 2 | 1 | 0.2 |
| **ALL FOOD** | 861 | 854 | 844 | |

Source: BFAR 2020

### 3.1.7 Contribution to trade

The Philippines is a considerable seafood exporter with tuna and seaweeds bringing in the biggest earnings. Tuna is one of the largest seafood export commodities of the Philippines in terms of value. Recently the country has gained GSP+ status from the European Union, making the country's export products even more competitive. The Philippines is best known for its high quality, fresh yellowfin tuna *(Thunnus albacares)* and is currently the largest supplier of fresh yellowfin tuna to the European Union (Seafood Trade Intelligence Portal 2018).

The Philippines is a net exporter of fish and seaweeds. Foreign trade performance of the fishery industry in 2019 registered a net surplus of USD 377 million, with total export value of USD 1,125 million and import value of USD 749 million (**Table 3.9**).

**Table 3.9. Balance of Trade**

| Item | 2018 | | | 2019 | | |
|---|---|---|---|---|---|---|
| | Quantity | FOB Value | | Quantity | FOB Value | |
| | (tonnes) | (PHP million) | (USD million) | (tonnes) | (PHP million) | (USD million) |
| Exports | 464,248 | 83,907 | 1,583 | 264,254 | 57,854 | 1,125 |
| Imports | 515,905 | 35,373 | 673 | 506,192 | 38,865 | 749 |
| **Trade Balance** | **(51,657)** | **48,534** | **911** | **(241,938)** | **18,989** | **377** |

Source: BFAR 2020

The major export commodities in 2019 were tuna, seaweeds, and shrimps/prawns. These fishery exports account for 66 percent (174,526 tonnes) of the total export volume (264,254 tonnes) in 2019, and 68.5 percent (USD 770.3 million) of the total export value USD1,125 million in the same year (BFAR 2020).

Tuna remains to be the top exported fishery product in the Philippines, followed by seaweeds, and then crabs and its associated products. The export volume decreased by 43 percent, from 464,248 tonnes in 2018 to 264,254 tonnes in 2019, pulled down by the decline in tuna exports, which decreased by 30 percent in terms of volume (BFAR 2020). On the other hand, seaweed exports went up by 21 percent, from USD 207 million in 2018 to USD 250 million in 2019.

The major countries of destination of exported fish and fishery products in terms of value include USA, Japan, UK, Germany, Spain, China, Hong Kong, Taiwan, Netherlands, and South Korea.

The major import commodities are frozen fish, prawn feeds, meals, and pellets, and they account for 60 percent (USD387 million) of the total import value (USD748.7 million) for 2019.

- 48 percent in chilled/frozen fish
- 2.1 percent in prawn feeds
- 1.6 percent in flour, meals and pellets of fish, crustaceans, and mollusks fit and unfit for human consumption

The top ten countries where imported fish and fishery products originated include China, Viet Nam, Papua New Guinea, Japan, Taiwan, South Korea, USA, Micronesia, Chile, and Indonesia.

Viron (2019) pointed out the following issues being faced by the domestic and international markets of the Philippines:

- Limited marketing networks for the distribution of products from highly productive areas to food-fish deficient areas
- Inadequate post-harvest and transport services, which resulted in high cost of distribution of fish raw materials and products
- Outdated trading facilities
- Low marketability of fish and fishery products in terms of variety, labelling, packaging, etc.
- Unstable market prices
- Stringent and tedious export-import procedures
- Inability to comply with regulatory requirements for food quality and safety, environmental standards, and labor standards (e.g., standards of HACCP, US, EU, etc.)

### 3.1.8 Fish landing sites and trans-shipment ports

The fishery products from capture fisheries and aquaculture undergo post-harvest handling and processing before ending up in markets. Fish catches all over the Philippines are typically landed in private, traditional, or government-owned landing centers.

The government-owned landing centers are fish ports managed by the Philippine Fisheries Development Authority (PFDA), Local Government Units (LGUs), or jointly managed by both.

Commercial fish ports can also be privately or publicly owned and/or operated. They cater to the general public and to vessels weighing more than 30 tonnes.

The *Regional Fish Ports Program* involves the provision and operation of fish port complexes in strategic fish landing centers nationwide. These fish ports are equipped with facilities, such as breakwater, landing quay, market halls, refrigeration and processing facilities, slipway, and related facilities. In particular, the program addresses the needs of the commercial fishing boat operators, aquaculture operators, fish processors/exporters, and some municipal fishermen.

There are eight **regional fish port complexes** owned and operated by PFDA (Navotas, Iloilo, Zamboanga, Camaligan, Lucena, Sual, Davao, and General Santos). The General Santos and the Navotas Fish Port Complex account for 83 percent of the landings landed at these eight fish ports (Seafood Trade Intelligence Portal 2018).

The government-owned major fish port complexes provide landing quays and market halls for fish traders and handlers. The Navotas Fish Port Complex has the highest number of piers and market halls in the country, followed by the General Santos City Fish Port Complex. These major fish ports basically cater to the commercial fisheries subsector. The aquaculture subsector also primarily uses the regional fish ports in the country for the auctioning of aquaculture produce in the domestic market.

The regional fish port complexes provide landing quays to local fishing vessels, although the Davao and the General Santos Fish Port Complexes report arrivals of foreign fishing vessels. Designed for unloading and marketing of marine fish and fishery products both for local and foreign markets, the operations of the General Santos Fish Port Complex cater to tuna hand line boats, purse seiners, and huge capacity refrigerated foreign vessels, and it is equipped with processing and refrigeration facilities (PFDA 2021).

The catch from the municipal fisheries subsector is typically unloaded in the traditional landing sites, e.g., municipal fish ports and community fish landing centers (CFLCs). The *Municipal Fish Port Program* entails the provision of fish landing and market facilities in selected fishing communities nationwide. There are 118 municipal fish ports located in various LGUs around the country (**Table 3.10**). Some of these municipal fish ports act as satellite ports for the regional fish ports. The PFDA provides the needed training on port operations and maintenance for the eventual turnover of the ports' management to the LGUs. Likewise, the government has set up around 700 CFLCs for the small-scale fishers. The tendency to unload most catches in traditional landing sites, where the handling practices cannot be efficiently controlled, is partly because there are only eight major fish port complexes in the country. Only 16 percent of the total marine catch was landed in PFDA-operated fish ports in 2012.

**Table 3.10. Municipal Fish Ports**

| Project funding source | Region | No. of Fish Ports |
|---|---|---|
| 2015 Subsidy to PFDA | IV-A, IV-B, VII, VIII | 5 |
| FY2014 Supplemental Appropriations | I, VI, XI | 4 |
| BFAR Post-harvest and other infrastructure | VIII | 1 |
| Corporate | IV-A | 1 |
| Countrywide Development Fund (CDF) | VI | 1 |
| Disbursement Acceleration Program (DAP) | X, V, VI | 3 |
| Fisheries Sector Program (FSP) | III, IV-A, IV-B, V, VI | 9 |
| GATT | VII, IX | 15 |
| Ginintuang Masaganang Ani (GMA) | CAR, I, II, III, IV-A, IV-B, NCR, V, VI, VII, VIII, IX, ARMM | 41 |
| Agrikulturang Makamasa Program | II, VIII, X | 6 |
| National Equity | VII, VIII | 2 |
| National Fisheries Program | I, II, III, IV-A, IV-B, V, VIII, X, XI, XII | 19 |
| PAMANA Program | V | 1 |
| Poorest of the poor | IV-A, VI, IX, XI, XII | 5 |
| ARMM-TISP | ARMM | 4 |
| PFDA | VII | 1 |
| | **TOTAL** | **118** |

Source: PFDA

### 3.1.9 Processing of marine products

Most of the country's fish catch is sold in local markets or shipped to Metro Manila and other urban areas. Around 70 percent of the catch is consumed fresh or chilled, while 30 percent is processed (cured, canned, frozen products or disposed of live).

Fish drying is the most common form of processing, particularly for the smaller size species caught by commercial trawlers. Smoked and salted fish are also prepared in various forms for selected species like the anchovies.

Trash fish or bycatch, locally known as "rejects" from trawl, is also used as raw materials in the preparation of local fishmeal, sold fresh or dried, to be used as feeds for aquaculture and swine, and as raw materials in fish/feed meal manufacturing plants. Trash fish is an important feed component in the aquaculture of high value species, e.g., grouper, sea bass, and mud crab for fattening.

Technological development and adoption have been quite rapid in the fish processing sector, especially for medium- and large-scale establishments processing tuna, seaweed, prawn, and milkfish. In addition to the traditional canned sardines and mackerel and dried fish, there has been an increase in the diversity of products, such as canned tuna and bottled sardines and milkfish in various recipe, dried seaweed, and fish and prawn crackers.

The Philippines has a substantial tuna canning industry. General Santos City, as the center of the tuna industry, hosts 15 of the 19 fish processors and exporters of the country. Seven out of nine tuna canneries in the country, with a combined capacity to process raw tuna at 950 tonnes per day or about 189,000-216,000 tonnes annually, are located in General Santos City (DA-BFAR 2018b).

Nevertheless, there are issues in the sourcing of tuna. Apart from the need to gain the GSP+ status from the European Union (a major market for fish exports), companies are facing increasing pressure to fulfil food safety and quality criteria and environmental standards. Greenpeace has published reports ranking the performance of tuna canneries in Southeast Asia against the seven-point criteria[6] on their tuna sourcing practices to promote sustainably and equitably sourced tuna. In the *Sea to Can: 2018 Southeast Asia Canned Tuna Ranking Report* (Greenpeace 2018), only five canneries were identified as overall green performers: Alliance Select Foods International (Philippines), PT International Alliance Foods Indonesia (Indonesia), PT Samudra Mandiri Sentosa (Indonesia), PT Sinar Pure Foods International (Indonesia), and Tops Supermarket (Thailand).

Another key issue affecting the canning industry is the set of anti-IUU fishing measures being implemented by the government of Indonesia as these have impacted the raw material supply to Philippine canneries.

#### 5.4.6 Role of women

There is increasing recognition of the role of women in fisheries livelihood within the context of their scale of operations and fish distribution networks. Activities, such as gleaning, by women (and their children) are now being acknowledged for their important role in securing household food and nutritional requirements. Other household activities include mending nets, fish drying, fish processing, vending, and marketing. However, the current lack of data on women's contributions and engagement highlights a critical gap in fisheries management.

During the lockdown due to the COVID-19 pandemic, fishing was restricted, and the role of women became more visible—as decision-makers, scientists, entrepreneurs, and community leaders. For example, the Pantad Women Fisherfolk Association in Dumalinao, Zamboanga del Sur ventured into the production of seaweed crackers and other local seaweed-based delicacies to earn income for their families. For these empowered women, the COVID-19 pandemic is not an obstacle. Using their savings, they eventually started their business on buying and selling raw dried seaweeds and retailing of agri-fishery and veterinary supplies (PRDP 2020).

### *3.2 Environmental impacts of unsustainable fisheries*

The climate crisis, acidification, sea level rise, rising sea temperatures, and more frequent extreme events threaten the health, stability, and resilience of our seas, and this is further aggravated by overfishing, destructive fishing, pollution, marine litter, habitat destruction,

[6] Globally, Greenpeace uses seven-point criteria to rate companies. Each criterion is given weight indicating relevant importance. The criteria are: Sustainability (30%), Sourcing Policy (25%), Traceability (10%), Legality (10%), Driving Change (10%), Equity (7.5%), and Transparency and Customer Information (7.5%). The overall rating—**Good** (green), **Fair** (yellow), or **Poor** (red)—indicates the total score for all seven criteria (Greenpeace 2018).

overuse of marine resources, and poor governance. Unsustainable fisheries undermine sensitive ocean ecosystems, jeopardize national and global food security, threaten climate stability, and imperil marine wildlife. Millions of people rely on fish for protein, and fishing is the principal livelihood for two million people in the Philippines.

***Overfishing.*** Overfishing is the catching or removal of a species of fish from a body of water at a rate that is too high, and the species cannot replenish through natural reproduction and consequently, the fish stocks become too depleted to recover. It is defined by FAO (2020, p.54) as "stock abundance reduced by fishing to below the level that can produce maximum sustainable yield." National and global fish stocks are being overharvested at ecologically and economically indefensible levels. Studies have pointed out that the MSY for Philippine fisheries has been reached in the 1980s for the small pelagic species and 1990s for the demersal species (FAO 2005; Israel and Banzon 1998; Santos *et al.* 2017).

Overfishing has resulted in smaller fish sizes, changes in species composition, steep declines in fish abundance, and lower catches and incomes of fishers. (See Section 3.6.1).

***Illegal, unreported, and unregulated (IUU) fishing***. IUU fishing is a major threat to ocean ecosystems and fisheries. It is also a significant economic and social disruptor, is detrimental to the legal fishery trade, and has been linked to organized crime. The depletion of fish stocks through IUU fishing threatens global food security, along with the livelihoods of millions of people who are engaged in capture fishing alone, plus millions more in associated industries.

***Destructive fishing methods***. Bottom trawling and drift net fisheries destroy delicate marine habitats, including coral reef, seagrass, and seabed communities.

***Marine plastic debris.*** Discarded, lost, and abandoned fish nets, and fish aggregating devices (FAD) at sea—"ghost gear"— contribute to the marine debris, which also pose hazards to marine life and consequently on the food chain (UNEP 2018b; WWF 2020a) "It is estimated that ghost gear makes up at least 10 percent of marine litter. That means somewhere between 500,000 and 1 million tonnes of fishing gear gets left in the ocean every year" (WWF 2020a, p.10).

***Oil and grease***. Some fishing vessels have been pouring or dumping used oil and engine grease into the sea. Oil is harmful to marine life. It can block gills of fish, affect coral reefs, harm seabirds, etc.

***Greenhouse gas emissions.*** Fisheries are highly energy-intensive, and the emissions from fishing vessels are the largest contributor to fisheries-related GHG emissions (Northrop and Finch 2021). It has been estimated that the GHG emissions from the fishing industry increased by 28 percent in 1990-2011 (Parker *et al*. 2018). In the Philippines, the carbon footprint of municipal and commercial fishing boats and the fisheries supply chain has not been fully assessed.

The Nationally Determined Contributions (NDCs) in the Paris climate agreement can serve as the entry point for the government to quantify and include non-fuel related emissions from motorized and non-motorized vessels as part of their national targets (WRI 2021), but there is a need to continue the registration of fishing vessels. According to WRI (2021), the options for including fisheries in new or updated NDCs include: expanding the existing economy-wide GHG targets by including emissions reductions from fisheries, including aquaculture, wild capture, and processing; defining energy efficiency targets to improve postharvest production, including cold storage and ice production; fishing vessel and gear improvements to increase fuel efficiency while limiting catch to sustainable levels.

## *3.3 Pressures: Issues affecting the fisheries industry*

### 3.3.1 Overfishing

Catch per unit of effort (CPUE) is the number or weight of fish caught by a unit of fishing effort, e.g., weight in kilograms (kg) per hour or day of fishing. It is often used as a measure of fish abundance or fishing gear efficiency. CPUE is highest in Region 1, followed by Region IV-B and VII (**Table 3.11**). Region V recorded the highest number of fishing boats landed, but it has the lowest CPUE.

**Table 3.11. Total Effort and Catch per Unit of Effort**

| Region | Total Effort (Actual) | Catch per Unit of Effort (CPUE) by Ringnet |
|---|---|---|
| | Number of boats landed | Average CPUE (kg/boat/day) |
| I | 9,971 | 4,165 |
| II | 18,991 | 632 |
| III | 67,197 | 1,342 |
| IV-A | 89,556 | 92 |
| IV-B | 15,212 | 2,060 |
| V | 128,085 | 75 |
| VI | 5,811 | 313 |
| VII | 22,162 | 2,005 |
| VIII | 21,245 | 131 |
| IX | 7,625 | 1,353 |
| X | 27,156 | 161 |
| XI | 19,234 | 124 |
| XII | 38,700 | 830 |
| CARAGA | 60,412 | 311 |
| ARMM | 34,384 | 597 |
| **TOTAL** | **566,741** | **14,191** |

Source: Santos, *et al*. 2017.

According to FAO (2005): "The Philippines reached the maximum economic yield from its demersal fish stocks as early as the late 1960s, except in the offshore hard bottoms around Palawan, Southern Sulu Sea, and the central part of the country's Pacific coast. Studies on pelagic fisheries also indicated overfishing and declining CPUE. At present, exceptions are found in lightly fished areas in the waters off Palawan, parts of the country's Pacific coast and some parts of Mindanao. Such findings are supported by an observed change in species composition, i.e., anchovies have partially replaced sardines, scads and mackerels in the catch, an indication of the gradual stock collapse of the larger, commercially exploited species (Green *et al*. 2003)." If overfishing continues, there will not be enough fish left in the ocean to feed future generations.

The major fishing grounds in the country are Babuyan Channel, Lingayen Gulf, Northern Zambales, Visayan Sea, Camotes Sea, Honda Bay, Camiguin Island Waters, Macalajar Bay, Iligan Bay, Davao Gulf, Hinatuan and Dinagat Waters, Sorsogon Bay, and Lagonoy Gulf. All of the aforementioned fishing grounds are overfished, except for Macalajar Bay and the Camiguin Island Waters, which have exploitation values that are within the normal range and below the minimum range, respectively. In 2009, it was reported that 10 out of the 13 major fishing grounds in the country were experiencing overfishing[7].

The fish stock assessment report (NFRDI 2017) provides the data supporting the 2009 report. **Exploitation Values I**[8] using 2015 length frequency data and **Limit Reference Points** (LRP) are used to assess the fishing status for small pelagic fish, demersal fish, neritic tuna, and oceanic tuna in major fishing grounds. E higher than the LRP would suggest unsustainable harvest of the fish stocks. The overall view as presented by the maps in **Figures 3.5 to 3.8** suggests that most of the Philippine traditional fishing grounds continue to be subjected to unsustainable fishing activities. More than 75 percent of the country's fishing grounds are overfished, due mainly to the long period of neglect in implementing the Fisheries Code of 1998 (RA 8550), leading to the destruction of coastal and marine resources.

Threats to the fisheries stocks include the ever-increasing fishing pressure brought about by:

- the growing number of fishers per fishing area
- use of more efficient fishing gears and mechanized fishing operations
- use of destructive fishing methods (e.g., cyanide, blast fishing, and fine mesh nets)
- by-catch and discards from trawling.

[7] Fisheries Report under The 4th National Report to the Convention on Biological Diversity of the Republic of the Philippines entitled "Assessing Progress Towards the 2010 Biodiversity Targets" in 2009.

[8] Exploitation rate (E) is computed by getting the ratio of fishing mortality over total mortality (Z), with which the condition of the fishing area can be determined. Based on Pauly and Ingles (1984), the optimum fishing mortality of an exploited stock should be equal to its natural mortality ($F_{opt}$ = M); thus, optimum exploitation should equate to E = 0.50 (Pauly, 1984). In the Philippine setting, Exploitation rate at E = 0.50, the estimated optimum exploitation, has been set by NSAP as the Limit Reference Point (LRP) for most commodity fish stocks except for small pelagic fish, where the optimum E value = 0.60 based on its high fecundity and relatively short life cycle of about 3 years, and E = 0.40 for oceanic tunas, which are long lived with a life cycle of about 10-12 years.

**Box 3.1. Overfishing in key fishing grounds**

In 2008, length-frequency analysis of 129 commodity species across major Philippine fishing grounds pointed to predominantly **high exploitation I values**, particularly suggesting high extraction patterns (i.e., fishing mortalities) observed in Lingayen Gulf, the Babuyan Channel, Northern Zambales, Lagonoy Gulf, Sorsogon Bay, Visayan Sea, Camotes Seas, Honda Bay, Hinatuan Passage, and Davao Gulf (DENR et. Al., 2009). Similarly, fisheries stock assessment reports at the regional level, e.g., Western and Central Visayan Sea (Guangco, et al., 2009), Sorsogon Bay (Olano et al., 2009), Lagonoy Gulf (Olano et al., 2009), Honda Bay (Ramos et al., 2009) and Northern Zambales Coast (Rueca et al., 2009) showed a similar scenario. These findings also suggest that continuous fishing pressures, brought about by **increasing fishing effort** and the **availability of more efficient fishing gears**, have posed major threats to the country's fishery stocks.

It is important to note that areas with lower fishing activities like typhoon-path areas (e.g., Northern Philippines (Batanes) and the Pacific seaboard), and areas where there are armed conflicts (Jolo-Sulu), and areas with existing management strategy, such as seasonal fishing closures implemented in Northern Palawan, Davao Gulf and Zamboanga Peninsula, generally show "better" stock status than the rest of fishing grounds in the country. This suggests that fishing grounds in the country could be utilized sustainably if proper management is in place and implemented effectively.

Source: Santos *et al*. 2017.

**Figure 3.5. Status of Philippine Small Pelagic Fish (based on Exploitation Values (E) using 2015 length frequency data and Limit Reference Point set at E=0.6)**

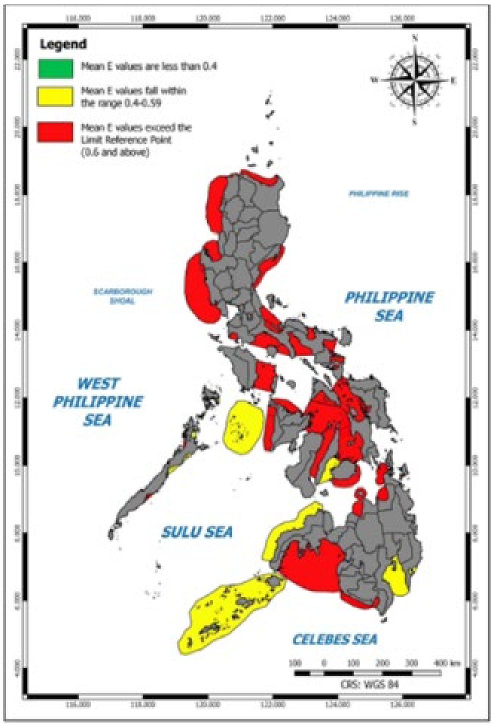



**Figure 3.6. Status of Philippine Demersal Fish (based on Exploitation Values (E) using 2015 length frequency data and Limit Reference Point set at E=0.5)**

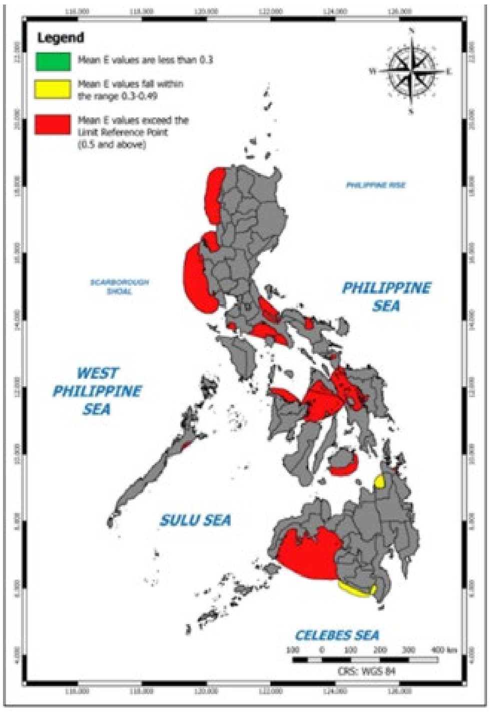


**Figure 3.7. Status of Philippine Neritic Tuna Fish (based on Exploitation Values (E) using 2015 length frequency data and Limit Reference Point set at E=0.5)**

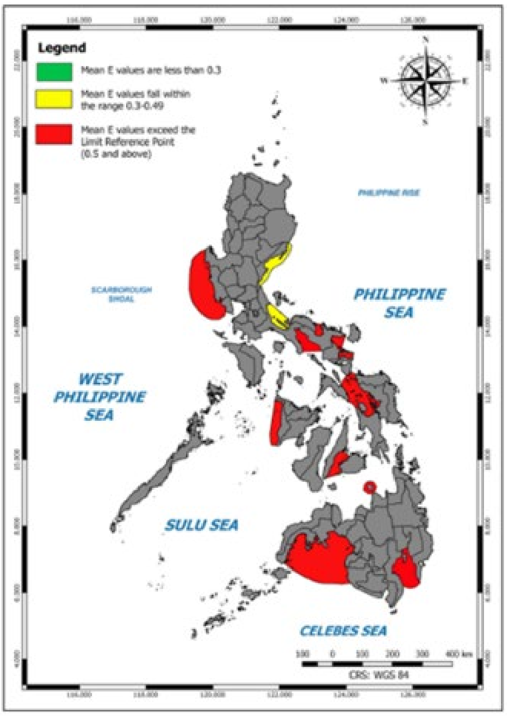
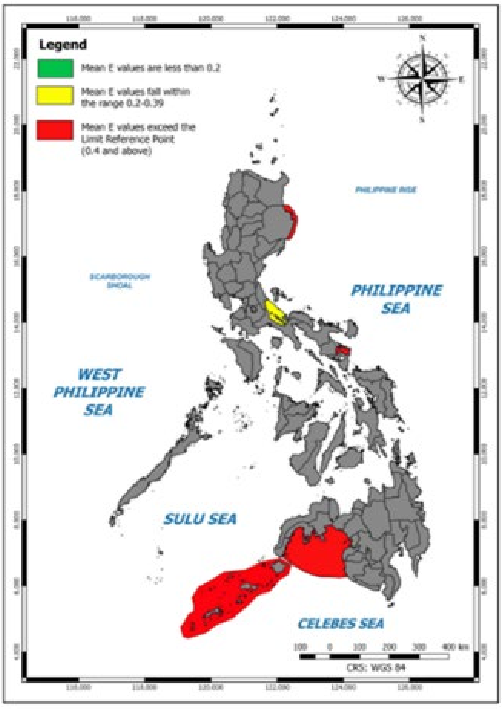



**Figure 3.8. Status of Oceanic Tuna Fish (based on Exploitation Values (E) using 2015 length frequency data and Limit Reference Point set at E=0.4)**




Source: Santos, *et al*. (NFRDI) 2017

### 3.3.2 Illegal, unreported, and unregulated (IUU) fishing

*Overfishing* occurs when too many fish are caught, even juveniles, and there are not enough adult fish to breed and sustain a healthy population. *Illegal fishing* typically refers to fishing without a license, fishing in a closed area, fishing with prohibited gear, fishing over a quota, or fishing of prohibited species (Marine Stewardship Council[9]). *Destructive fishing* includes use of cyanide and explosives. IUU fishing and destructive fishing contribute to overfishing, and also impact non-target species and habitats, with serious consequence on the health of the ocean.

The FAO Committee on Fisheries (COFI) adopted the *International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU)* in 2001 as well as the *Code of Conduct for Responsible Fisheries*. The IPOA-IUU uses a comprehensive and integrated approach, and covers flag, port, coastal and market State responsibilities (FAO 2001). It also defines and provides reference to activities considered as illegal fishing, unreported fishing, and unregulated fishing.

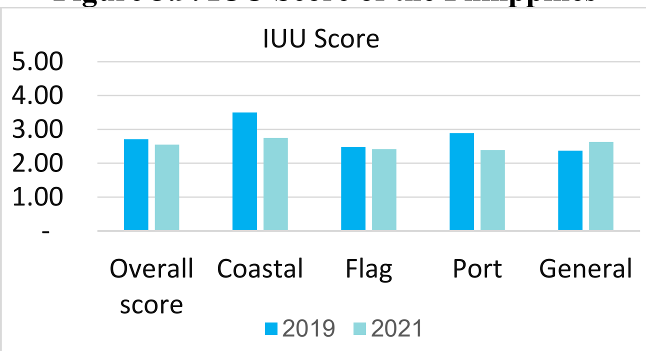
According to the report of the Coastal Resource Center (2021): (a) **IUU fishing amounted to 27 to 40 percent of fish caught in the Philippines in 2019**, which translates to approximately PHP42-63 billion (USD1.3 billion) annually; (b) At least 30,000 or 30 percent of municipal vessels, and 1,600-2,700 commercial fishing vessels remain unregistered; (c) Commercial fishers do not report 274,000 to 422,000 tonnes of fish each year.

[9] https://www.msc.org/what-we-are-doing/oceans-at-risk/overfishing-illegal-and-destructive-fishing

A key benchmarking tool is the **IUU Fishing Index**[10], which allows countries to be assessed for their vulnerability, prevalence, and response to IUU fishing. This index provides a measure of the degree to which states are exposed to and effectively combating IUU fishing. Indicators included in the IUU Fishing Index relate to the responsibilities of a state: (a) *coastal* responsibilities refer to the management of fisheries within a state's exclusive economic zone; (b) *flag* responsibilities relate to the management of the state's fleets or those in its vessel register; (c) *port* responsibilities refer to the steps a state can make to control fishing activity on its ports; and (d) *general* indicators are those that address responsibilities shared by all state types, are not specific to flag, coastal, or port State responsibilities, and include market-related indicators[11]. The index provides scores for each of the key types of state responsibilities (coastal, flag, port, and general), and an overall score. The IUU Fishing Index fills a key gap by analyzing and evaluating the national and global implications of IUU fishing, thereby helping policymakers identify where interventions are most needed.

The IUU Fishing index provides an IUU fishing score for all coastal states of between 1 and 5 (1 being the best performing, and 5 the worst performing, i.e., higher scores indicate worse/poor performance.). The scores of the Philippines for state responsibilities are shown in **Figure 3.9**. In 2019, the overall IUU Fishing Index score for the Philippines was **2.71**, which is above the world overall score of 2.29. In 2021, the Philippines score was **2.55**, which is above the world overall score of 2.24. This indicates that the country needs to do more to end, deter, and eliminate IUU fishing. However, the country's score went down, and its world ranking also went down, from 13th in 2019 to 20th in 2021 among 152 countries, indicating an improvement compared to other countries (ranks closer to 1 indicate worse/poor performance). It is ranked 6th among 15 Asian countries in 2019 and 2021.

**Figure 3.9. IUU Score of the Philippines**




Source: IUUFishingIndex.net

### 3.3.3 Destruction of forests and coastal and marine habitats

Conversion of forests and agricultural lands to commercial spaces has increased the amount of soil erosion and sedimentation that flow out into the coastal waters. It was estimated that approximately one billion $m^3$ of sediment is lost to coastal waters annually (Burke *et al*., 2002). In the Philippines, deforestation and land use change have reduced forest cover from about 90 percent in the 16th century, to 70 percent by 1900, and to about 23 percent in 2018 (UNDP Ecosystems & Biodiversity 2019). Forest land covers around 24 percent of total land area in 2020 (World Bank 2021). Total degraded lands in the Philippines are estimated at 132,275

[10] The IUU Fishing Index was developed by Poseidon Aquatic Resource Management Ltd., and the Global Initiative Against Transnational Organized Crime, with funding provided by the Norwegian Ministry of Foreign Affairs (https://www.iuufishingindex.net/about).
[11] IUU Fishing Index (https://iuufishingindex.net/methodology.pdf)

km$^2$, affecting over 33 million Filipinos (UNDP Ecosystems and Biodiversity 2019). (The resulting impacts – erosion, siltation, and sedimentation – are discussed in Section 4. The time series data on area of forests are shown in **Figure 4.5.**)

This is further exacerbated by the loss of mangrove forests and seagrass cover, which is considered to be the first line of defense in the marine ecosystems against land-sourced run-offs and sedimentation. **Table 3.12** shows the change in areal extent of coral reefs, seagrass meadows, and mangrove forests. These coastal and marine ecosystems are not just important for fisheries; they also provide a range of ecosystem services, such as recreation and tourism, genetic resources, nutrient cycling, carbon sequestration, and shoreline protection against waves, storm surge, coastal erosion, and flooding.

Harvesting of mangroves for fuel wood, construction and charcoal-making contributed largely to the destruction of the resource. Illegal cutting and overharvesting subsequently degraded the habitat and ecosystem (White and de Leon 2004). But conversion of mangrove areas to fishponds accounts for a large portion of mangrove loss (66%). In the Philippines, about 279,000 ha of mangroves lost from 1951 to 1988 were due to the conversion into culture ponds. The rate of mangrove loss has increased during this period despite the government ban on further conversion of mangroves to fishponds in 1980 (White and de Leon 2004). However, with increasing awareness of the benefits provided by mangroves, coastal communities, with support from the government, NGOs, and private sector, have undertaken mangrove planting activities. As part of the National Greening Program of the national government, mangrove area has increased by 22.5 percent, from 247,626 ha in 2009 to 303,373 ha in 2016 (**Table 3.12**).

Around 30 to 50 percent of Philippine seagrass beds have been lost due to industrial development, ports, and recreation (Fortes 2012). Seagrass ecosystems are threatened by the loss of mangroves areas, which act as 'filter' for sediment from land, as well as loss of coral reefs, which serve as buffer against waves and storm surges (Philippine National Science Society 2004).

The *National Assessment of Coral Reef Environments* (NACRE) program funded by DOST-PCAARRD and implemented by University of the Philippines – Marine Science Institute (UP-MSI) and De La Salle University – Shields Ocean Research Center (DLSUSHORE) in 2015-2017 confirmed the disappearance of excellent live hard coral cover category reefs. The threats to coral reef health are destructive fishing, pollution, unregulated coastal development, and sedimentation. Warmer sea temperatures during El Niño episodes have also caused coral bleaching.

**Table 3.12 Change in the area of coastal and marine habitats**

| Ecosystem | Area (ha) | |
|---|---|---|
| | 2009 | 2016 |
| Coral reefs | 2.50 million | 797,719 |
| Seagrass beds | 2.73 million | 489,006 |
| Mangroves | 247,626 (2005) | 303,373 |
| Mudflats | No data reported | 200,000 |
| **TOTAL** | | **1,790,098** |

Source: DENR-NAMRIA, 2017; PBSAP 2015-2028.

### 3.3.4 Water pollution

ASEAN developed the *ASEAN Marine Water Quality Criteria* (AMWQC) and *ASEAN Long-Term Goals*, which can be used to benchmark coastal and inland water quality in the member countries. In the Philippines, water quality is evaluated based on the criteria set by the DENR and classes or intended uses of the water body, using DENR's *Department Administrative Order* (*DAO) 2016-08*. Water bodies are classified by DENR-EMB into Class AA, A, B, C, and D for freshwater, and Class SA, SB, SC, and SD for marine waters, according to their beneficial uses, e.g., as sources of drinking water, recreational use, fishery water, etc. (**Table 3.4**). The results of water quality monitoring are compared to the criteria corresponding to the class of the water body, and the government (EMB) determines whether the water body satisfies the water quality standard or not.

***a. Dissolved oxygen (DO) and biochemical oxygen demand (BOD)***

The presence of dissolved oxygen (DO) in water is crucial to the survival of aquatic species. The higher the DO concentration, the more it is capable to sustain aquatic life. However, as the presence of organic matter increase and the water body becomes more polluted, the amount of dissolved oxygen free to sustain aquatic life becomes limited.

On the other hand, the biochemical oxygen demand (BOD) measures the rate of which organisms use the oxygen in water to decompose organic matter. BOD5 is a measure of biodegradable pollutants, operationally defined as the amount of dissolved oxygen needed to decompose the pollutant in 5 days. Thus, DO and BOD are inversely related.

The *DAO 2016-08* sets the criteria for DO and BOD in Class C water at 5 mg/L and 7 mg/L, respectively. Of the 158 water bodies monitored for DO, and 140 water bodies for BOD in 2017, 82.9 percent passed the criteria for DO under their respective classifications, while 75.7 percent passed the criteria for BOD (**Table 3.13**). All the major river systems in the National Capital Region (Parañaque River, Malabon-Navotas-Tullahan-Tenejeros river system, and Meycauayan-Valenzuela river system) have failed the BOD and DO criteria in 2017. According to the Pasig River System – Water Quality Index (PRS-WQI) for 2017, all 14 stations in Pasig River got a ''FAILED' grade, using the grading scale for six indicators: BOD, DO, nitrates, phosphates, oil and grease, and fecal coliform (PRRC, 2017).

**Table 3.13. Results of Monitoring of Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD)**

| | 2016 | | 2017 | |
|---|---|---|---|---|
| | DO | BOD | DO | BOD |
| **Total Water Bodies Monitored** | 147 | 127 | 158 | 140 |
| Passed (number) | 121 | 101 | 131 | 106 |
| Passed (%) | 82.31% | 79.53% | 82.91% | 75.71% |
| Failed (number) | 26 | 26 | 27 | 34 |
| Failed (%) | 17.69% | 20.47% | 17.09% | 24.29% |

Source: DENR-EMB 2018.

***b. Nutrients***

Nutrients are needed for good soil quality, which is essential in agriculture, but excess nutrients in the case of rivers, estuaries, lakes, and oceans can have devastating effects by causing algal blooms that deplete oxygen in the water. "This is the global *nutrient challenge*– the delicate balancing act between feeding and providing for growing global population and upsetting the natural balance that allows our ecosystems to function" (UNEP 2018a). Algal blooms, hypoxic or dead zones**,** and fish kills are the results of **eutrophication**, which is the process of enriching a water body by the increased load of nutrients.

**Nitrates** come from agricultural activities associated with the excessive application of nitrogen fertilizers. Nitrates in water bodies come from soil fertilizers during agricultural runoff as well as from sewage discharge. High nitrate concentrations can inhibit the growth of fish, impair the immune system, and cause stress in some aquatic species.

Monitoring of the priority rivers for nitrate in 2011-2015 showed that among the 19 rivers, Parañaque and San Juan Rivers have the lowest compliance ratings at 51 percent and 26 percent, respectively (DENR-EMB 2016).

**Phosphates** occur either as particulate phosphates or dissolved phosphates. Particulate phosphates include phosphates absorbed by soil particles and organic matter eroded during runoff from cultivated lands. On the other hand, dissolved phosphates include runoff from grass or forest land, which carries little sediment, and is available for biological uptake.

Phosphates are usually found in detergents, raw sewage, and nutrient fertilizers. The presence of excess phosphates can cause enormous **algal blooms**. Of the 19 priority rivers, only Cagayan de Oro River and both reaches of Luyang River met the phosphate criteria, and the other rivers have very low compliance ratings (DENR-EMB 2016).

**Dead zones**. In ocean, estuarine, and freshwater environments, eutrophication can lead to "**hypoxia**" or oxygen depletion, which causes aquatic dead zones, where neither fish nor plants are able to survive. Hypoxia is often associated with algal blooms. Once the excess algae die, they sink to the bottom, and decompose by oxidation—oxygen is consumed in the process—and the water is depleted of dissolved oxygen, which may result in fish kill.

**Harmful algal bloom.** Nutrient loading can increase the growth of certain species of algae. There are harmful algal species that release toxins, which make the water unsafe, cause fish kills, and contaminate seafood. Harmful algal blooms (HABs) are the result of high concentrations of single cell micro-organisms, called dinoflagellates. High nutrient concentrations, together with ideal conditions of temperature, salinity, and light, can trigger the bloom of dinoflagellates, which result in the reddish-brown discoloration of sea water, hence the term 'Red Tide'. .

Based on the findings of Yñiguez *et al*. (2021): (a) blooms of Paralytic Shellfish Toxin (PST)-producing species in the Philippines increased in frequency and duration during the early to mid-1990s but have stabilized since then; (b) the number of sites affected by these blooms continue to expand though at a slower rate than in the 1990s, and (c) the type of HABs and causative species have diversified for both toxic blooms and fish kill events. These patterns and the correlation with possible contributing factors, such as eutrophication, introduction of species through the expansion of aquaculture areas, El Niño Southern Oscillation (ENSO), and climate change, need further study as incidents of HABs result in morbidity and premature mortality cases (due to paralytic shellfish poisoning), loss of income and livelihoods, and loss of an important food and protein source.

### *c. Plastic pollution*

The Philippines is one of the countries with the biggest consumption of single-use plastics (e.g., 'sando' bags, shopping bags, and sachets) on a daily basis. With a still-developing solid waste management system, this plastic waste ends up in the oceans, making the country the third-largest contributor of marine plastic pollution (Jambeck *et al*. 2015). The most visible and disturbing impacts of marine plastics are the ingestion, entanglement, and suffocation of marine species, such as seabirds, whales, fishes, turtles, etc., which mistake plastic waste for prey and food. Plastic debris also enter the food chain, affecting food quality and safety, and nutrition.

The fishing industry is also a source of marine plastic pollution. The 'ghost gear' refers to any fishing gear that has been lost, abandoned, or discarded (UNEP 2018b; WWF 2020a). While there is increasing attention being given to single use plastics, there is less public awareness about ghost gear. Fish aggregating devices (FADs), called *payao* in the Philippines, are large floating objects deployed by fishing vessels to attract fish. FADs work because tuna and a whole range of other fish and marine animals instinctively gather around such floating objects for shelter and protection, and to feed on smaller animals already congregating there. Abandoned and discarded FADs and fishing nets ensnare seabirds, sea turtles and other marine animals, entangle corals, and litter the ocean floor. Moreover, plastic-based ghost gear can take up to 600 years to break down, shedding microplastics as it degrades (UNEP 2018b).

Mollusks — such as mussels, oysters, and scallops — collected off the coasts of Asia contained the highest levels of microplastics among seafood while fish and crustaceans, such as shrimps and crabs, contained plastic fragments as well, based on a review of 50 studies that tested samples intended for human consumption (Danopoulos *et al*. 2020). In the Philippines, a study shows high levels of microplastics in the digestive system of rabbitfish (*Siganus fuscescens*) in four coastal areas in Negros Oriental province (Bucol *et al*. 2020). It is therefore likely that microplastics is also being ingested since rabbitfish is a common species consumed by Filipinos. It is not yet clear how microplastic consumption harms human health, although particles may carry potential hazardous plastic constituents, microorganisms, and adsorbed chemicals (Nicole 2021).

The Philippines is implementing its *National Plan of Action on Marine Litter*, which has an overarching vision to achieve 'zero waste to Philippine waters by 2040' through a series of cross-cutting policy interventions. The system for collecting and recycling plastic waste needs to be improved, since most LGUs do not even have the facilities and staff to properly manage their municipal solid waste. Considering that single-use plastic waste makes up the waste that end up in rivers and seas, there is a need to identify alternatives to single-use plastics and reduce their use. For the other types of plastics that can be reused and recycled, there is potential income to be made. With only 28 percent of plastic resins recycled in 2019, around 78 percent of the material value of the key plastic resins – upwards of US$890 million per year – is lost in the Philippines when recyclable plastic products are discarded rather than recycled into valuable materials. (World Bank 2021b).

**Box 3.2. Major Issues in Selected Water Bodies in the Philippines**

**Manila Bay**

The following are the results of the BFAR-NFRDI studies (2012-2015):

- Results show that hypoxia was present throughout the year, but it was more severe during the wet season (July, September, November) compared to the dry season.
- The average bay-wide DO concentration ranged from 3.42 to 7.63 mg/l during the four-year survey.
- Low DO concentrations were associated with high concentrations on nutrients, particularly nitrate. Nitrate went up to as high as 44.6 μM concentration while DO concentration dropped to as low as 0.01 mg/l in the wet season.
- Surface DO concentrations were above the criteria value of 5 mg/l. However, lower DO concentrations were observed in areas near the coast, in depths of around 5 – 15 m as well as in the deeper areas near the mouth of the bay, and in depths of around 10 – 35 m.

The DO monitoring of EMB in Manila Bay in 2017 showed the following:

- A decreasing trend of DO from top to bottom of water column was observed in all stations except in station 5 where the value of the bottom DO is higher than the mid-depth DO.
- Surface DO levels conformed to the criteria of 5 mg/L in all stations, while only 4 stations conformed at mid-depth, and all stations failed the DO criteria at the bottom.

These results indicate that below the surface, Manila Bay is **hypoxic**. This has far-reaching consequences on marine life and fisheries. Oxygenated water is necessary for aquatic animals to breathe. The direct effects of hypoxia include **fish kills**, which not only deplete valuable fish stocks, but also damage the ecosystem, and harm local tourism.

A model based on a global point source model by Morée *et al*. (2013) was used to estimate the contribution of the population to nitrogen (N) and phosphorus (P) emissions, and this was then used in a water transport model to estimate the N and P loads to Manila Bay. The results suggest that the important determinants of N and P load into Manila Bay are sewage treatment, and the continued increase of the human population at current growth rates are (Sotto *et al*. 2015).

**Major river systems in the National Capital Region (NCR)**

According to the water quality monitoring of Parañaque River, Malabon-Navotas-Tullahan-Tenejeros river system, and Meycauayan-Valenzuela river system) by DENR-EMB, these rivers have failed the BOD and DO criteria. For Pasig River, according to the Pasig River System – Water Quality Index (PRS-WQI) for 2017, all 14 stations in Pasig River got a 'FAILED' grade, using the grading scale for six indicators: BOD, DO, nitrates, phosphates, oil and grease, and fecal coliform (PRRC 2017).

**Laguna de Bay**

Laguna de Bay, the country's biggest inland freshwater lake, is faced with declining agriculture and fisheries productivity and environmental degradation. An assessment from the Laguna Lake Development Authority (LLDA) gave the lake an overall ranking of "C-" for water quality (due to heavy phosphate and coliform loading), and "F" for state of fisheries, with major problems in terms of invasive species, overfishing, and declining natural food sources (on a scale of A-F, with F being the worst) (UNEP 2018). The following factors have extremely stressed the lake ecosystem and are eroding the lake's capacity:

- Urbanization, industrial development, deforestation of its watershed, and other land use changes
- Pollution from untreated sewage and industrial waste
- Over-fishing and illegal fish pens
- Agricultural and urban runoff and sedimentation
- Illegal reclamation
- Invasive species (e.g., 'janitor' fish, water hyacinth)

**Nutrient pollution is a major concern**. Nutrients, such as nitrogen and phosphorus, can result in the eutrophication, triggering algal blooms and dense plant growth, and the death of animal life from lack of oxygen. There have been numerous reports of fish die-offs in Laguna de Bay. Fish pens and navigational channels are clogged by water hyacinth. Key sources of nutrients include run-off from farmland treated with fertilizers, livestock runoff, detergents (which contain phosphates), and untreated sewage. Thousands of people living on the lake shores are informal settlers whose homes lack proper sanitation facilities, and they are discharging raw sewage into the lake. Millions more of people around the watershed of the lake also contribute to the problem due to the lack of access to wastewater, septage, and stormwater management. Systems.

**Erosion and sedimentation** have made the periphery of the lake shallower, and affected the hydrology, water storage capacity, and flood control service of the lake by changing the lake's bathymetry. The Pagsanjan River basin and the Marikina River basin make up half of the sediment loading in Laguna de Bay (WAVES 2016).

**Taal Lake**

Taal Lake is the third largest lake in the country, and the deepest, being a caldera. The lake and its watershed are declared as protected areas. The key issues in Taal Lake are:

- **Declining fish production due to overfishing, illegal fishing, and pollution**: Tawilis, the most important fish species for commercial fisheries in Taal Lake, had been reported to have dramatically decreased (from 744 tonnes in the 1996 to 294 tonnes in 2006) due to illegal operations of active fishing gears and pollution loads from aquaculture.
- **Alien and invasive species**: From five introduced species in 1997 inhabiting the lake to 14 species in 2011. Results of catch survey in 2014 revealed that introduced species comprised 63 percent of the total fisheries production in the lake.

Sources: DENR-EMB; PRRC; LLDA; BFAR; Santos *et al.* 2017.

### 3.3.5 Pressures from aquaculture

Aquaculture can contribute significantly to food security, employment, and foreign exchange generation. However, unsustainable aquaculture practices can also cause some serious ecological and socio-economic problems. The problems associated with the fish pen operations in Laguna de Bay, fish cage operations in Sampaloc Lake in Laguna, and marine cage/pen farming in Bolinao, Pangasinan were just some of the prominent examples in the past. Aquaculture, if not practiced properly, can result in various pressures to water bodies and marine ecosystems, thereby affecting fish, other marine life, and human health (**Box 3.3**). The degradation of water quality and coastal ecosystems consequently affects the aquaculture industry itself. Studies were conducted by BFAR and NFRDI in 2014-2016 to assess the possible contribution of aquaculture farms to the pollution loading in Manila Bay (**Box 3.4**).

**Box 3.3. Aquaculture-related pressures**

(a) **Alteration of Physical Environment.** The nets of cages, pens, and associated moorings change the environment by preventing efficient water exchange and changing the current patterns caused by friction with the water currents. Friction from the nets can alter the residence time of water in a bay. Sometimes these structures can also cause obstruction to navigation routes and migration paths of different species of fish.

(b) **Eutrophication from Aquaculture.** Aquaculture, like any other animal production activity, produces wastes in the form of particulates (mainly the uneaten food and faeces) and soluble substances (excreta), which increase the BOD, nitrates, and phosphates in the receiving waters. The risk of negative impacts of aquaculture wastes is greatest in enclosed waters or sites with poor water exchange rates, such as in slow moving rivers, lakes, and shallow bays. In these conditions, aquaculture production can lead to a build-up of organic sediments and addition of nutrients to the water column. This, in turn, can lead to secondary effects, such as eutrophication, algal blooms, and low dissolved oxygen levels. Harmful algal blooms have caused paralytic shellfish poisoning.

(c) **Changes in Ecosystem Structure and Function.** Some impacts of seaweed culture include changes in the marine ecosystem structure and function, alteration of currents and increasing shading of bottom environments. Nutrient stress, perhaps caused by too much seaweed culture in an area, has also been implicated in 'ice-ice' disease, which can result in lower yields of seaweeds. Changes in salinity, ocean temperature and light intensity as well as bacterial infection when seaweeds are stressed can cause the ice-ice disease (Largo *et al*., 1995).

Mussel and oyster farming also increases biodeposition of wastes on the seabed, with the resulting organic enrichment inducing changes in sediment chemistry and biodiversity. For shrimp culture, effluents from shrimp ponds are high in both dissolved and particulate nitrogen and phosphorus, which elevate nutrient levels in receiving waters and promotes eutrophication. In brackishwater ponds, intensification of production methods can result in greater production of wastes, which unless intercepted and treated (filter traps, settlement ponds, biofiltration beds), are discharged into the coastal environment causing eutrophication and self-pollution problems in some areas of the country (e.g., Bolinao in Lingayen Gulf).

Source: PEMSEA and DENR 2019; ADB 2014

**Box 3.4. Aquaculture's Impacts in Manila Bay**

BFAR and NFRDI conducted studies in 2014-2016 to: assess the possible contribution of aquaculture farms to the pollution loading in Manila Bay; establish baseline data on the pollution levels; and formulate appropriate intervention measures. Fishponds around Manila Bay contributed an average of 41.19 percent of the total aquaculture production in the country. The following are the key results of these studies.

(5) **Nutrients in aquaculture farms**[/a]

***Nutrients in the water source, coastal area/fish pens, and fishponds.*** Results showed that ammonia had the highest levels, followed by phosphorus, nitrate, and nitrite. The levels of these nutrients varied widely in relation to the water source, coastal areas (shellfish-growing areas and fish pens), and fishponds in the different blocks.

Ammonia accumulates in aquatic systems due to deposition as it is the principal metabolic waste product of fish, and decomposition of uneaten feed or dead algae and aquatic plants (Floyd *et al*. 2009). This is evident in most of the sampling sites. Nitrite has the lowest concentration since it does not accumulate in pond water due to faster turnover rate, and conversion to the least toxic nitrate. Nitrate levels are intermediate between ammonia and nitrite because: (a) nitrate are dependent on ammonia levels in the water (nitrification), and (b) nitrate has lower turnover rate than nitrite.

Geographically, higher concentration of nitrogen and phosphorus were observed in Eastern Bulacan aquaculture farms.

- *Ammonia*: Fishponds and coastal areas/fish pens in Eastern Bulacan had ammonia levels that ranged from 0.3911 to 3.7455 µg/ml, with the extremes noted in February 2015 and May 2014.
- *Nitrite*: Comparing the nitrite levels of aquafarms in the different blocks, Eastern Bulacan and Cavite samples have higher concentrations than the other blocks. Nitrite levels ranged from 0 to 0.1203 µg/ml in Easter Bulacan, and from 0.0006 to 0.1290 µg/ml in Cavite.
- *Nitrate*: Aquafarms in Cavite had significantly higher nitrate concentrations, ranging from 0.0203 to 0.4459 µg/ml, with the maximum value observed in the coastal area/fish pens during the wet season (November 2014).
- *Phosphorus*: Comparing the different blocks, phosphorus in Eastern Bulacan exhibited significantly higher concentrations, with a range of 0.0257 to 2.0116 µg/ml, with the maximum value observed in May 2014. Second to Eastern Bulacan, phosphorus levels in Pampanga ranged from 0.1093 to 1.3635 µg/ml, with the extreme values observed in November 2014 and February 2015.

Varying seasonal trends were also observed among the different nutrients as they react differently to changing climatic and weather conditions. Ammonia and TKN were significantly higher during flooding, which imply that water coming into the pond already contains high levels of such nutrients. In the case of phosphorus, the seasonal change is relatively not significant. Significantly higher levels of DO were recorded during flooding, which indicate that water coming into the ponds is more aerated.

Aquafarms in Eastern Bulacan applied the least variety of pesticides, fertilizers and feeding materials, and used natural food, which yield lesser nutrients. However, most of them did not follow proper pond preparation activities, such as drying of pond, soil scraping, and water flushing. Subsequently, residual waste tends to accumulate in the ponds. Moreover, Eastern Bulacan is adjacent to Metro Manila, which is a major source of nutrients. Although the aquafarms in Northern Bataan, Southern Bataan, and Pampanga used high nutrient-producing fertilizer and feeds, they have lower nutrient levels because most of the farmers performed important pond preparation activities that prevented the nutrient accumulation.

***Nutrients in the sediments.*** Nutrient levels in sediments are several times higher than in the water column. This is due to the nitrogen and phosphorus from fertilizers (e.g., urea, chicken manure), uneaten feeds, and metabolic waste from culture species deposited in the sediments. Many pond owners also did not practice scraping of sediments during pond preparation. Moreover, organic waste from runoff may have entered the ponds and deposited into the sediments.

**(b) Heavy metals in water and fishery resources in Manila Bay**[/b]

- **Heavy metals in water (of aquafarms)**

***Lead***: ranged from ND to 0.0759 mg/L (within DENR acceptable limits)
***Cadmium***: All sampling sites passed the DENR regulatory limit of 0.01 mg/L for cadmium in water.
***Mercury***: During the wet season, three out of 46 sampling sites exceeded the DENR regulatory limit of 0.002 mg/L for mercury in water. For the dry season, 14 out of 47 sites failed to meet the limit.

- **Heavy metals in fish tissue**

***Lead*****:** all the crustacean and bivalve samples were within the regulatory limit
***Cadmium***: All finfish (milkfish and tilapia), crustacean and bivalve samples had cadmium levels within the regulatory limit of 0.05 mg/kg (EC 1881/2006).

**I Coliform bacteria in water and fishery resources in Manila Bay**[/c]

***Coliform in pond water***: 25% of the samples exceeded the DENR standard limit for total coliform (5,000 MPN/100 mL) in the wet season, compared to 10% in the dry season.
***Coliform in fish tissue***: percentage of samples that exceeded the FDA standard limits: 25% of mussels; 24.44% of shrimps; 16% of tilapia; 14.67% of oysters; 8.89% of crabs, and 6.67% of milkfish.

Sources:
[/a] Opinion *et al*. 2017.
[/b] Perelonia *et al*. 2017.
[/c] Raña *et al*. 2017.

### 3.3.6 Climate change

Although the Philippine government incorporates the onset of El Niño or La Niña[12] into its GDP and crop production forecasts and plans, the connection and mechanism behind climate variability, local marine environment conditions, species vulnerability, and fisheries productivity have only started to be studied (Villanoy *et al.* 2011; Ferrera *et al.* 2017; Geronimo 2018; Monnier *et al*. 2020). Identifying appropriate mitigation and adaptation measures requires a good understanding of how local conditions and fisheries yield would change along with global climate change.

Climate change is changing the magnitude of key ocean parameters – sea surface temperature, dissolved oxygen, and pH (measuring water acidity) – which are the key ocean ecosystem drivers that have been shown to affect habitat suitability and species population viability. According to models, acidifying, warming, and rising waters will result in the following:

[12] The El Niño Southern Oscillation (ENSO) refers to cyclical environmental conditions and changes that occur across the equatorial Pacific Ocean due to natural interactions between the ocean and atmosphere (NOAA). El Niño and La Niña are opposite extremes of the ENSO. El Niño is caused by the warming of sea surface temperature in the Pacific, which can affect air and sea currents, and cause reduced rainfall that leads to dry spells and droughts, and stronger typhoons (FAO 2017).

changes in the fish habitats, migration of some fish species, food web changes, timing shifts in reproduction, slower growth, and decreasing fish size. Climate change impacts on ocean temperatures, currents, oxygen, and other parameters are projected to cause an eastward shift in the distribution of skipjack, yellowfin, and bigeye tuna in the Pacific Ocean (FAO 2019; PEMSEA 2018; Bell *et al*. 2011)[13]. Species that are over-fished would be less resilient and more susceptible to the effects of climate change, having smaller size than before, and less genetic diversity compared to other sustainably fished populations.

The Intergovernmental Panel on Climate Change (IPCC) also emphasized the importance of short-term variability and extreme events due to climate change. In particular, more intense, longer, and more frequent marine heat waves (MSW) are expected to have a major impact on coral reefs and ocean ecosystem, inducing high mortalities in certain species, and consequently modifying species abundance, composition and distribution, assemblages of species, and the functioning of food webs (Frölicher 2019; Monnier *et al*. 2020).

**Expected changes in ocean parameters within the Philippine EEZ:**

Based on the study of Monnier *et al*. (2020, p.33): "Within the Philippine EEZ, the temperature is expected to increase by between 3 and 3.7 °C, with an average of 3.4 °C, close to the expected global average (3.7 °C). Oxygen concentration and pH are also projected to decrease in the same order of magnitude as the worldwide average, -4.2% and -0.25 pH of a unit, respectively (IPCC 2019)."

Using global estimates and data on local conditions, Geronimo (2018) made the following findings:

- Seawater is warming since 1982 at an average rate of 0.20°C per decade or an average absolute increase of 0.65°C from 1982 to 2017.
- Coastal areas in western Luzon, the provinces of Aurora and Quezon, around Palawan, the Sulu Archipelago, Moro Gulf, and northwestern Mindanao are warming slower than the average rate.
- Offshore areas are warming faster than average.
- If global mitigation of GHG is implemented intensively by 2050s, the seas in the Philippines' EEZ will be **warmer** (by 0.77°C to 1.10°C), have **lower salinity** (by 0.10 to 0.45 psu or 0.3% to 1.3% of present value), and have **lower primary production** (by 4 to 36 mgC/m2/day or 0.5% to 11.8% of present value).
- The worst case, and the likely scenario given the current rate of GHG emissions and assuming minimal mitigation, will lead to much warmer (by 0.2°C to 3.1°C) and lower salinity (0.3 to 2.1 psu[14] or 1.0% to 6.7%) seas in the Philippines.

**Impacts of ocean parameter changes on fish species**

Increasing acidity of marine waters affects zooplankton, which form the base of the marine food chain, and marine organisms, such as shrimp, oysters, and mussels, which will experience more difficulty in forming their shells. Reef-building corals are also affected as ocean acidification reduces the availability of carbonate ions. Rising temperatures have caused coral

[13] The Global Environment Facility (GEF), the World Bank, Conservation International, and the Secretariat of the Pacific Community (SPC) conducted studies on the assessment of the impacts of climate change on tropical tuna species and tuna fisheries in the Pacific Ocean, covering the EEZ of Pacific Island Countries and high seas).
[14] PSU - practical salinity unit. One psu is equal to one gram of salt per 1000 grams of water.

bleaching, further damaging coral reefs that are already in poor condition and stressed from destructive fishing, pollution, and other human activities. The damage to coral reefs is causing losses valued at US$4 billion per year in terms of the impacts on fish habitats and shoreline and storm surge protection services (Tamayo *et al*. 2018).

Global models project **a decline of 9 to 24 percent in potential marine fisheries yield within the Philippines' EEZ by 2050** due to climate change, with the range of estimates varying depending on the global GHG emission reduction rates (Geronimo 2018, p. vi). Areas where favorable conditions exist may move, causing the fish population's numbers to decline in certain areas and increase in others, effectively shifting the population's range (Suh and Pomeroy 2020, p.2). Geronimo (2018) evaluated how habitat suitability for 59 of the top commercially-exploited marine fish species in the Philippines could be affected by on-going and intensifying climate change. In particular, (a) all 59 marine species will experience reductions in habitat suitability within the Philippines' EEZ with continued climate change, but the magnitude of change varies across species; (b) with the mild climate change future scenario (i.e., CMIP5; RCP4.5)[15], most species will experience a 15 to 30 percent reduction in habitat suitability driven mainly by the projected increase in sea surface temperatures (Geronimo 2018, p. vii).

To assess the impact on municipal fisheries, Monnier *et al*. (2020) explored the vulnerability and the risk of impact linked to climate change for different important commercial species in the small-scale tuna handline fisheries in Lagonoy Gulf and Mindoro Strait. This study shows that non-tuna species (blue marlin, wahoo, and common dolphinfish) are at *high* risk, while the tuna species have *medium* risk even with low vulnerability index because of the species' distribution in other parts of the oceans where changes in ocean parameters are expected to be strong (Monnier *et al*. 2020). Moreover, this study pointed out that most of the currently exploited species in the EEZ are at the higher edge of their temperature range and any warming is likely to affect them severely.

**Economic and social impacts**

Decreases in fisheries productivity leads to income reduction of households engaged in fisheries, further aggravating the poverty incidence of this sector, as well as decrease in contribution of marine capture fisheries to GDP. Using the CGE model, and one baseline scenario and two climate change scenarios—RCP 2.6 (strong mitigation) and RCP 8.5 (comparatively high GHG emissions)—for the simulation, Suh and Pomeroy (2020) estimated the climate change impacts on marine capture fisheries in the Philippines.[16] Results show that there will be a negative change in both the fisheries and economic variables where more extreme changes in climate occur. Simulation results indicate that **GDP is expected to decrease by 0.16% with mitigation scenario (RCP 2.6) and 0.37% with extreme scenario (RCP 8.5) up to 2060** (Suh and Pomeroy 2020, p.7), and the **contribution of marine capture to GDP is expected to decrease by about 9.41 percent of fisheries GDP with the mitigation**

[15] **CMIP5** is the fifth phase of the Coupled Model Intercomparison Project, which aims to produce a multi-model dataset on climate variability and climate change and contribute to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The Representative Concentration Pathway (RCP) is a GHG concentration trajectory adopted by the IPCC. Four pathways were used for climate modeling and research for the IPCC fifth Assessment Report (AR5) in 2014. **RCP 4.5** is an intermediate scenario.

[16] RCP 2.6 is a "very stringent" pathway, with strong mitigation measures. In contrast, in RCP 8.5, emissions continue to rise throughout the 21st century.

**scenario and 17.95 percent of GDP with the extreme scenario up to 2060, compared to the baseline scenario** (Suh and Pomeroy 2020, p.8)**.**

Changing rainfall patterns, droughts, and more frequent and intense typhoons and extreme monsoon rains are also impacting inland freshwater fisheries and aquaculture production. Increased rainfall in coastal and low-lying areas raises the risk of losing farmed fish during floods, as well as invasion by unwanted species and damage to fishponds, cages, and pens. On the other hand, periods of drought can result in water scarcity, which will affect the aquaculture operations. The high sea temperatures associated with the 2016 El Niño affected aquaculture production, which decreased by 6.27 percent in 2016 compared to its level in 2015 as high mortality and slow growth of species occurred during the dry spell (PSA 2016). Seaweed production in 2016 was lower by 10.3 percent compared to previous year's level due to increased diseases (ice-ice) and epiphytes, and the 2016 tilapia production declined by 3.52 percent as the hot weather conditions affected the stocking density in freshwater pens and cages, size of fish, and lower survival rate (PSA 2016). El Niño also affected both commercial and municipal fisheries, which declined by 6.35 and 6.47 percent, respectively, as there were less species and fish caught by commercial fisheries, and there were fewer municipal fishing activities in the coastal areas due to prolonged hot weather condition in the first half of the year, followed by rough seas and typhoons toward the end of the year (PSA 2016).

### 3.3.7 Post-harvest losses

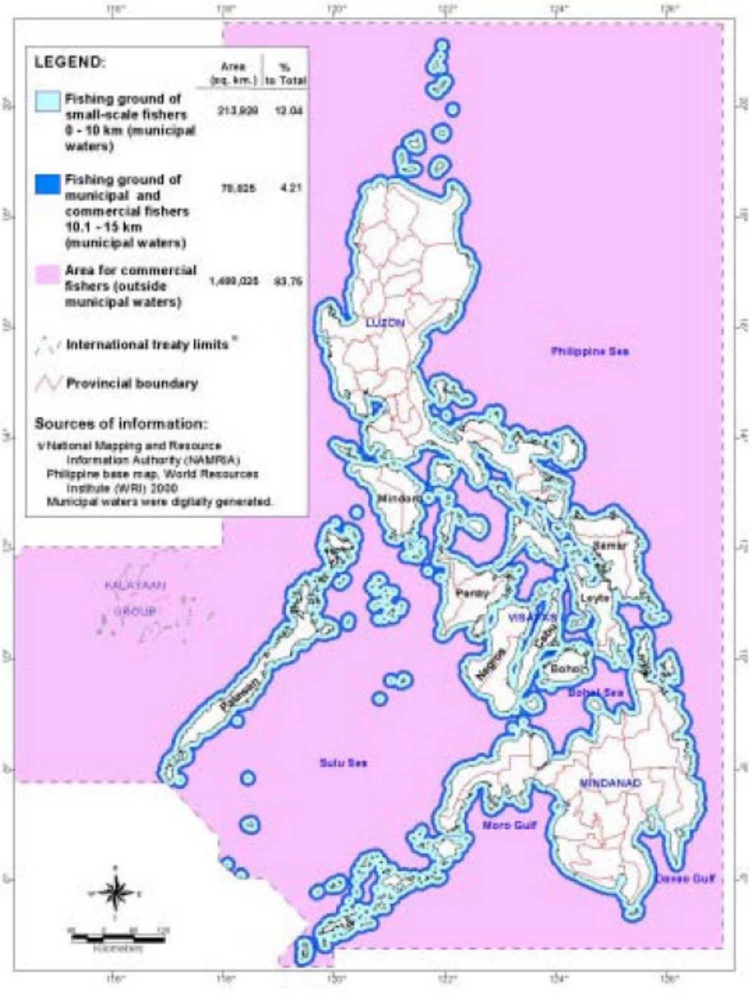
**Almost 40 percent of the total fish production and income of Filipino fishermen go to waste** due to unavailability or inaccessibility of post-harvest equipment for their fish catch (DA-BFAR 2018).

While the regional ports have ice plant and storage facilities, most municipal ports still lack these facilities. In some areas, the ice plants are small, and could not cater to the volume of fish landings in these municipal ports, and the performance of the freezers are also affected due to irregular power supply.

### 3.3.8 Multiple resource use conflicts

Of the ten top species caught by both municipal and commercial capture fisheries, 61.2 percent were harvested by commercial fishers compared with 38.8 percent caught by municipal fishers. This suggests that, although the commercial and the municipal fisheries are sometimes made out to be distinct sectors of the Philippine fishing industry, they are in fact direct competitors. There is more area for commercial fishing as it is allowed in the area outside the municipal waters up to 200 NM (within the EEZ). The law gives small fishers priority in municipal waters, but this is only 16 percent of the total marine waters of the country (**Figure 3.10**). Moreover, numerous reports have been done regarding the encroachment of commercial fishing vessels in municipal waters, and its effect on the catch of subsistence fishers. The use of *payao* (fish aggregating device) and luring lights by commercial purse seine and ring net vessels resulted in municipal fishers using handline (hook and line) to move farther away and eventually losing fishing ground in the municipal waters.

**Figure 3.10. Municipal and Commercial Fishing Grounds**




Source: NAMRIA

**Box 3.5. Commercial vs. municipal fishing in Lingayen Gulf: Impact on small pelagic fish**

An example of the impact of unsustainable commercial fishing is the status of small pelagic fish resources in the Lingayen Gulf. The exploitation ratio (E-values) of the dominant small pelagic species exceeded the optimum level of 0.5, an indication of overexploitation due to high fishing pressure. Almost 50 percent of the total fish harvest in Lingayen Gulf are small pelagic fish, and the commercial fisheries sector made the largest catch. The commercial fishing gears that mostly catch small pelagic fish are the Danish seine and trawl with an annual CPUE ranging from 899 to 1,186 kg/day and 65.98 to 119.77 kg/day, respectively. The municipal fishing gears, bottom set gillnet and bottom set longline had an annual CPUE ranging from 7.04-42.95 and 7.19-13.30 kg/day, respectively.

A key finding of this study is that the dominant species caught by commercial fishing gears are mostly juveniles while the dominant species caught by municipal fishing gears attained maturity before they are caught.

Source: Gaerlan *et al*. 2018

### *3.4 Environmental impacts of unsustainable aquaculture*

The capture fisheries production has gradually declined in recent years as fish stocks have been increasingly overfished. Aquaculture production has expanded considerably to meet the increasing demand for fish. The intensification and unsustainable practices have resulted in many negative impacts on the aquatic environment.

#### 3.4.1 Overfishing for aquaculture feeds

Stocks of forage fish, such as sardines, anchovies, etc. and other so-called 'trash fish' are being depleted. One of the causes is overfishing as they are caught to also serve as fishmeal in aquaculture farms. Forage fish are essential in marine food webs and play an important role in ocean ecosystems.

#### 3.4.2 Destruction of mangroves and coastal wetlands

Mangroves and coastal wetlands have been converted to aquaculture farms, especially for raising milkfish, shrimps, and prawns. Brackishwater pond culture is intertwined with mangroves due to policies promoting aquaculture as development strategy, which aimed at increasing fish production by converting large areas of mangroves into fishponds (Primavera 2000). The lack of understanding on the value of mangroves contributed to the significant loss of mangroves in the country.

#### 3.4.3 Pollution from aquaculture farms

High stocking density in fish cages and ponds can result in high waste generation, which can lead to eutrophication and oxygen depletion. Wastes—from uneaten feeds, body waste, and dead fish—can act as nutrients and may lead to harmful algal blooms (Red Tide), which can cause paralytic shellfish poisoning. Intensification of production entails increased application of inputs. Effluents from aquaculture farms contain nitrogen, phosphorus, and organic matter because fertilizers and feeds are used to enhance production. Wastes from aquaculture is considered as one of the causes of water quality deterioration in Manila Bay. (Results of monitoring of water quality in and around aquaculture farms in Manila Bay are summarized in **Box 3.4**.)

#### 3.4.4 Over-extraction of groundwater

Significant amount of freshwater is needed in intensive shrimp farms to keep pond water at the optimum salinity required for shrimp growth. This could lead to overextraction of groundwater if this is the water source used, and even cause saline water intrusion into aquifers.

#### 3.4.5 Invasive alien species

Another issue is introduction of invasive alien species (IAS), which can displace indigenous species by competition or by carrying a disease that can kill the native species. IAS (e.g., janitor fish) have been noted as one of the key issues in Laguna de Bay and Taal Lake. It is also one of the major causes of biodiversity loss as pointed out in the Philippine Biodiversity Strategic Action Plan.

### 3.4.6 Diseases and use of antibiotics

Diseases and parasites are problems in fish farms, especially where stocking densities are high. Even seaweeds are not free from diseases, especially during El Niño. However, the use of antibiotics for treatment can have harmful consequences.

"Antibiotics are used in aquaculture for the following purposes: (i) Prophylactic: the administration of medication to all animals in the lot to prevent diseases before they occur, with antibiotics used at sub-therapeutic exposure concentrations; (ii) Therapeutic: The administration of medication to treat sick animals; (iii) Metaphylactic: The use of mass medication to eliminate or minimize an expected outbreak of a disease; (iv) Growth promoters: Administered to animals to improve the growth rate and the food conversion." (Pepi and Focardi 2021, p.2). The use of antibiotics in aquaculture is well known, however, "this practice can cause the spread of antibiotic residues in the marine environment, increasing the rates of antibiotic resistance in aquatic bacteria and, critically, transfer that resistance to human pathogens" (Pepi and Focardi 2021, p.2). As an alternative, both probiotics and prebiotics are now commonly used in aquaculture to promote good soil and water quality in ponds as well as limit or minimize the use of antibiotics (FAO/WHO 2001).

## *3.5 Performance of the fisheries and aquaculture industry*

### 3.5.1 Production composition and trends

Total fisheries production—consisting of municipal and commercial fisheries and aquaculture—was 4.4 million tonnes in 2020 (**Table 3.15**). In 2019-2020, municipal fisheries and aquaculture declined by 2.1 percent and 1.5 percent, respectively, while commercial fisheries production increased by five percent. Municipal fisheries accounted for 25 percent of fish production in 2020, while 22 percent for commercial fisheries and 53 percent for aquaculture for the same year.

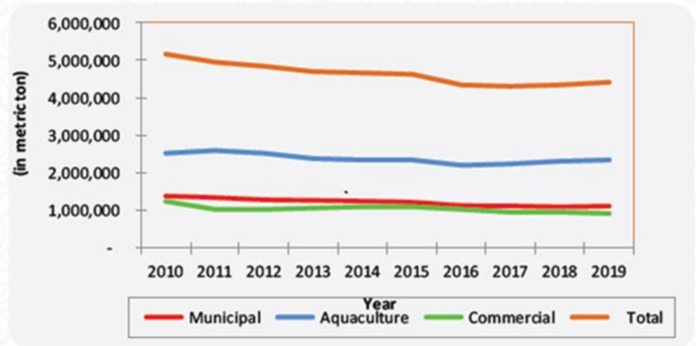
**Table 3.15 Volume of fisheries production (tonnes), 2018-2020**

| Sector | Volume of Production (tonnes) | | | Percentage Change (%) | |
|---|---|---|---|---|---|
| | 2018 | 2019 | 2020[p] | 2018-2019 | 2019-2020 |
| Fisheries | **4,356,874.77** | **4,415,001.68** | **4,403,709.08** | **1.3** | **-0.3** |
| Commercial | 946,437.62 | 931,451.05 | 978,170.98 | -1.6 | 5.0 |
| Municipal | 1,106,071.84 | 1,125,217.47 | 1,101,542.03 | 1.7 | -2.1 |
| *Marine* | *941,870.86* | *968,758.60* | *951,468.29* | *2.9* | *-1.8* |
| *Inland* | *164,200.98* | *156,458.87* | *150,073.74* | *-4.7* | *-4.1* |
| Aquaculture | 2,304,365.31 | 2,358,333.16 | 2,323,996.07 | 2.3 | -1.5 |

p – preliminary
Source: PSA 2021

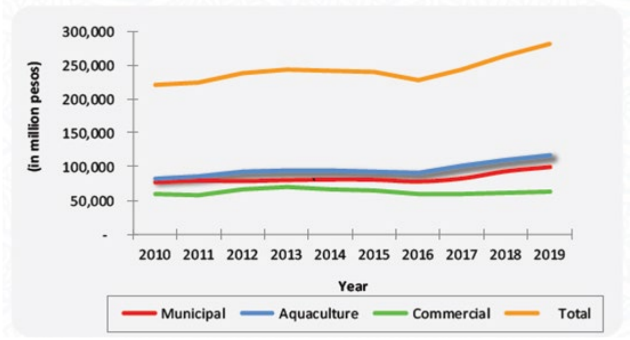
Slowly decreasing trend in volume of fish catch was observed from 2010-2020 (**Figure 3.11**). Total fisheries production decreased by 5.8% from 4.65 million metric tons in CY 2015 to 4.415 million metric tons in CY 2019. Average annual production growth rate within that period was registered at -1 percent. However, in terms of value, the 2019 fisheries production was valued at PHP281.65 billion as compared with the PHP239.7 billion in 2015, an average increment of PHP3.21 billion. (**Figures 3.11 and 3.12**)

**Figure 3.11. Volume of Fish Production, 2010-2019**




Source: DA-BFAR 2020

**Figure 3.12. Value of Fish Production, 2010-2019**



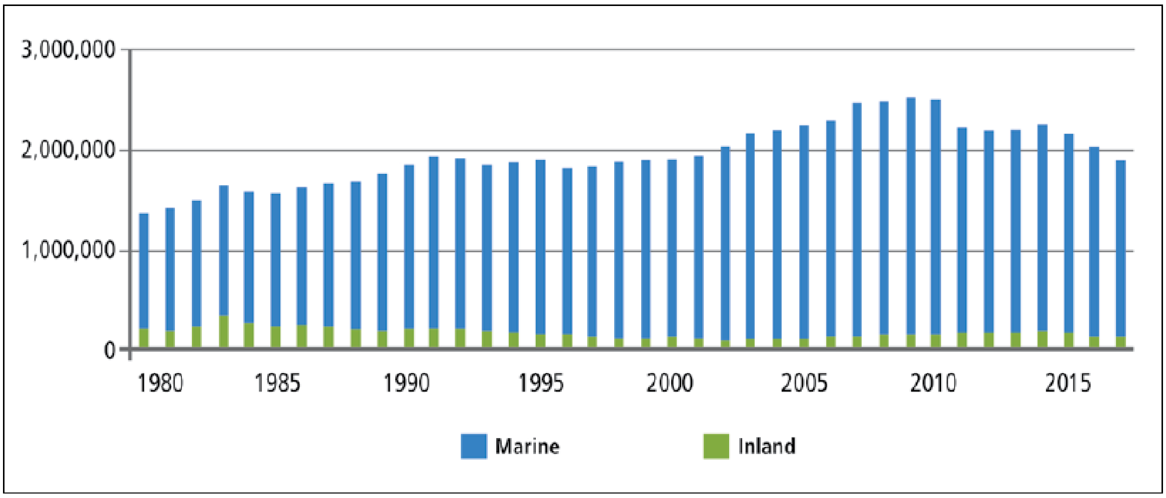

Source: DA-BFAR 2020

In 2019, municipal fisheries and commercial fisheries accounted for 26 percent and 21 percent, respectively, while the share of aquaculture was 53 percent of total fish production.

For municipal fisheries production in 2019, 86 percent is from marine waters, and only 14 percent is from inland waters. Municipal marine fishery catches have averaged to about two million tonnes per year for the last ten years (**Figure 3.13**).

Big-eyed scad, Bali sardinella, frigate tuna, roundscad, fimbriated sardines and squid are fish species with a large bulk of production in the marine municipal subsector. The top-produced fish species in the inland municipal subsector are tilapia, carp, mudfish, freshwater catfish, and milkfish.

**Figure 3.13. Capture Fisheries Production in Marine and Inland Municipal Waters, 1980-2017 (in tonnes)**

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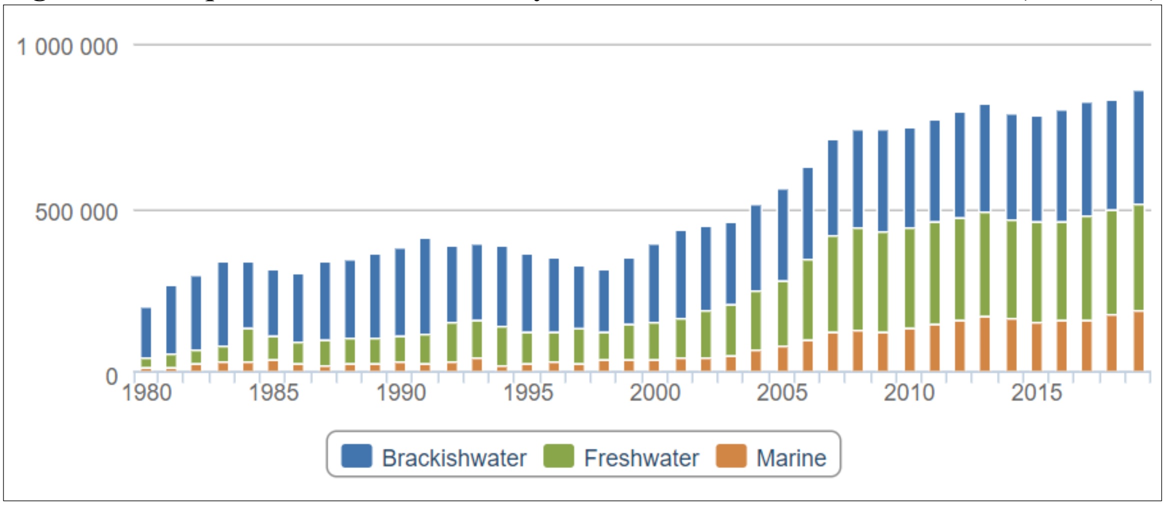
Source: FAO FishStat (http://www.fao.org/fishery/facp/PHL/en#CountrySector-Overview)

The bulk of total fisheries output came from aquaculture in 2018 to 2020. Aquaculture production has been predominantly done in brackishwater, although freshwater culture has been increasing since 2005 (**Figure 3.14**). Marine aquaculture is also increasing.

Aquaculture accounts for 53 percent of fish production in 2019, of which 64 percent is seaweed culture, and 29 percent is culture of milkfish and tilapia (**Figure 3.15**). The culture production of milkfish and tilapia helps in maintaining the supply of fish in the domestic market. Aquaculture has been perceived to play a significant role in meeting the increased demand for fish protein. Fish farming has been pushed as an alternative to wild capture and importation by BFAR, not just for milkfish but for other fish variants as well, including round scads (galunggong). Aquaculture can help in improving the welfare of small-scale fishers affected by the decline in wild fish catch (FAO 1998). Community-based seaweed culture also provides alternative livelihood in coastal communities.

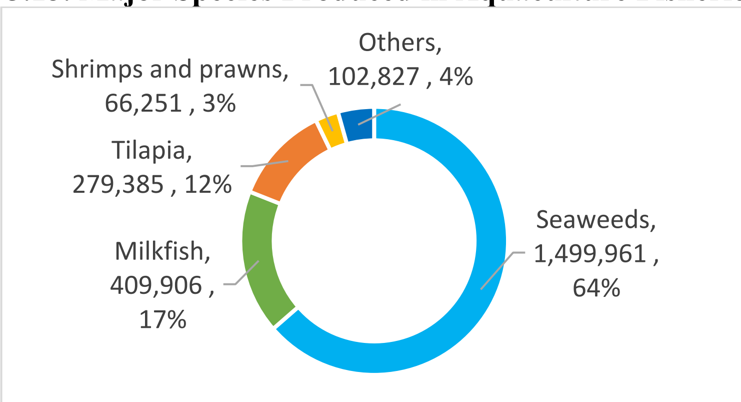
Although there is large potential for aquaculture development, there are several issues that need to be addressed. Aquaculture production has fallen by around nine percent during the last decade, 2010-2020. Most aquaculture producers are small family businesses producing unprocessed or minimally processed fish for the domestic market. Many of the aquaculture farms are characterized by low productivity. Declining availability of fish fry, due to impacts of overfishing and climate change, could force aquaculture farms to rely more heavily on hatcheries, resulting in increased production costs, or on imports. Some aquaculture farms have been abandoned. New investments are required to upgrade the ponds, introduce new technology to increase productivity and resiliency, manage feeds and waste, and convert abandoned ponds back to mangroves.

**Figure 3.14. Aquaculture Production by Culture Environment, 1980-2019 (in tonnes)**




Source: FAO Fish Stat

**Figure 3.15. Major Species Produced in Aquaculture Fisheries, 2019**



Source of data: PSA 2020

### 3.5.2 Country production in relation to world production

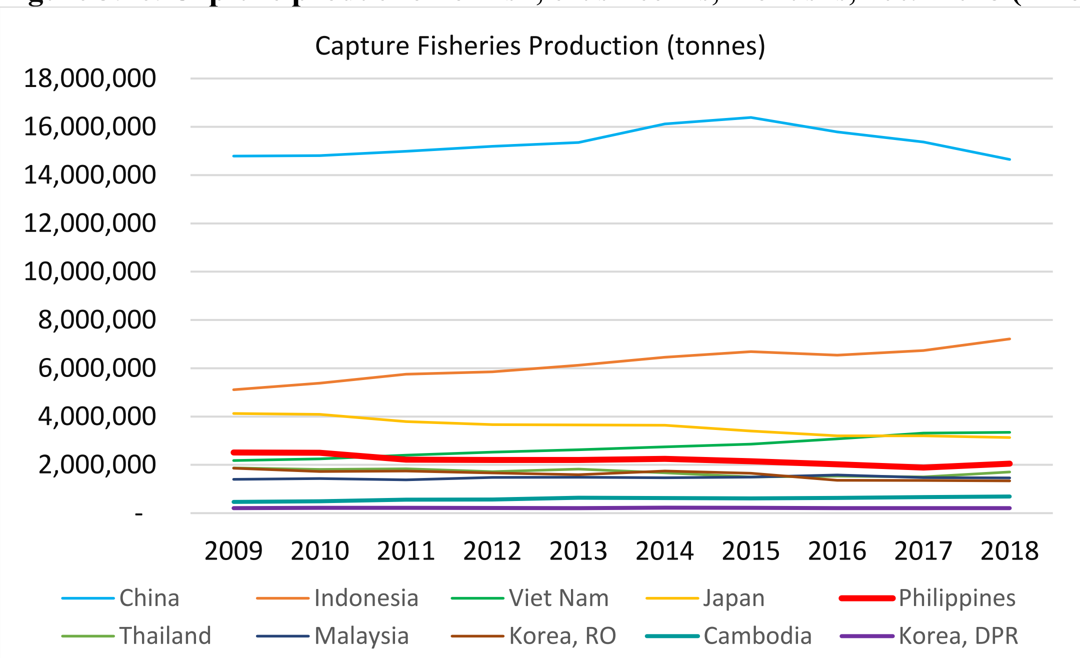
In 2017, the Philippines ranked 9th among the top fish producing countries in the world with its total production of 4.125 million tonnes of fish, crustaceans, mollusks, and aquatic plants (including seaweeds). The production constitutes 2.01 percent of the total world production of 205.56 million metric tons. In 2018, the Philippines ranked 8th among the top fish producing countries in the world with its total production of 4.354 million tonnes of fish, crustaceans, mollusks, and aquatic plants (including seaweeds). The production constitutes 2.06 percent of the total world production of 211.87 million metric tons (FAO 2020).

For capture production, the Philippines ranked 11th in the world in 2018, with its production of 2,049,572 tonnes of fish, mollusks, crustaceans, etc. In the East and Southeast Asian region, Philippines was ranked fourth in 2009, but was overtaken by Viet Nam by 2011 (**Figure 3.16**).

For aquaculture production of fish, crustaceans and mollusks, the Philippines ranked 11th in the world in 2018 with its production of 0.826 million tonnes, and this represents 1.01 percent share to the total global aquaculture production of 82.095 million tonnes (**Figure 3.17**). In terms of value, the country's aquaculture production of fish, crustaceans and mollusks amounted to over USD1.887 billion (FAO Statistics). In 2017, the Philippines' aquaculture production of fish, mollusks, and crustaceans was 0.801 million tonnes, with a value of USD1.834 billion (FAO 2020). The countries in East and Southeast Asia produced 73.7 percent of total global aquaculture production of fish, crustaceans, mollusks, etc. in 2018, led by China with 58 percent share.

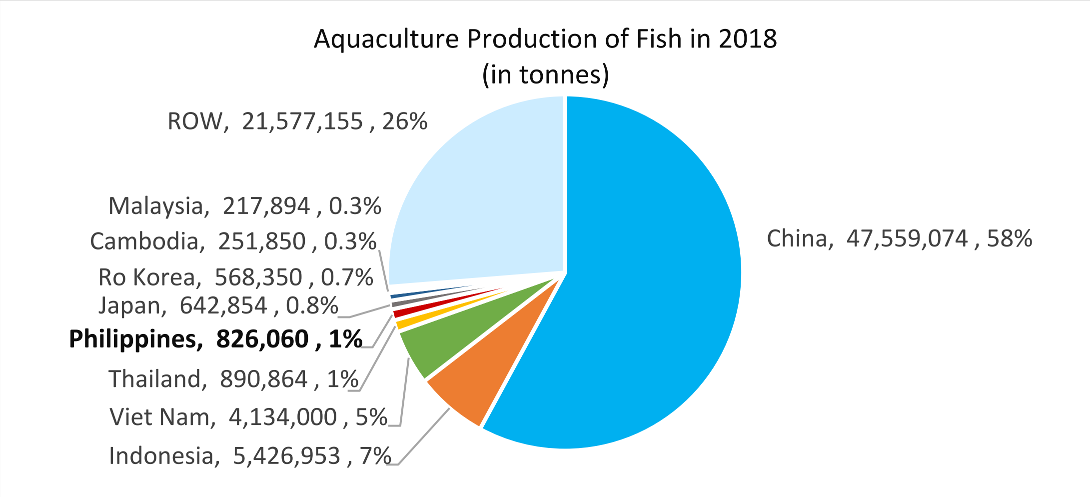
The Philippines is the world's 4th largest producer of aquatic plants (including seaweeds) in 2018, having produced a total of 1.478 million tonnes or nearly 4.56 percent of the total world production of 32.386 million tonnes (**Figure 3.18**).

**Figure 3.16. Capture production of fish, crustaceans, mollusks, 2009-2018 (in tonnes)**



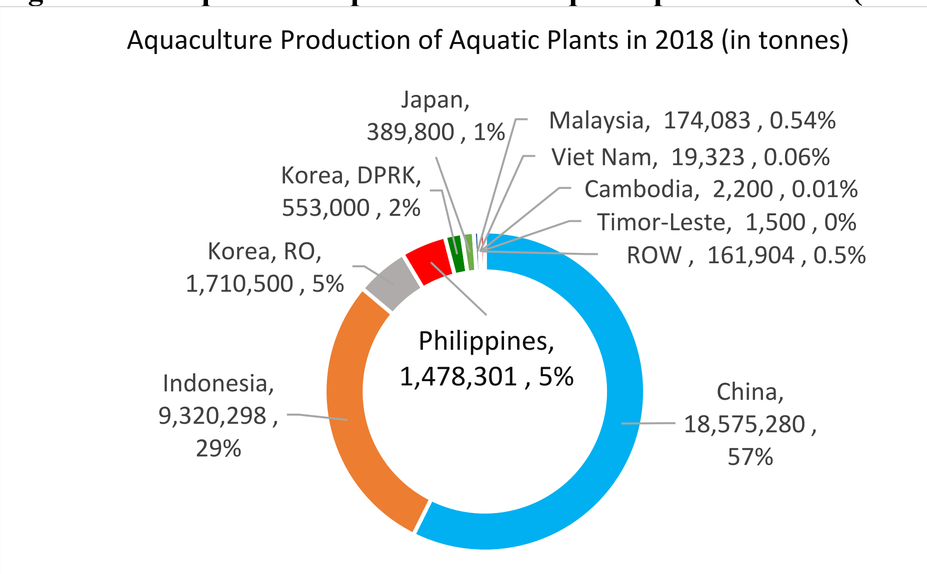

These countries are those with capture production of 200,000 tonnes or more in 2018.
Source of data: FAO 2020.

**Figure 3.17. Aquaculture production of fish, crustaceans, mollusks, etc. by principal producers in 2018 (in tonnes)**




These countries are those with aquaculture production of 160,000 tonnes or more in 2018.
Source of data: FAO 2020.

**Figure 3.18. Aquaculture production of aquatic plants in 2018 (tonnes)**




*Aquaculture production of seaweeds and other aquatic plants expressed in tonnes and on wet-weight basis.
Source of data: FAO 2020.

### 5.4.6 Certification and labelling of sustainable fisheries

The blue label of the Marine Stewardship Council (MSC) is given to sustainably sourced fish and environmentally-produced seafood. An independent assessment is made to verify the sustainability of the fish or seafood and assess if the globally accepted standards set by MSC have been met. One of the recipients—and the first—in the Philippines is the *Philippine Tuna Handline Partnership* (PTHP), which is a small-scale yellowfin tuna handline fishery group (**Box 3.6**). The MSC certification opens up new market opportunities for this group as more countries and consumers are increasingly demanding for sustainably sourced seafood.

**Box 3.6. Artisanal fishery group certified to the international MSC standard for sustainable fishing**

The following has been reported in the press release of the Marine Stewardship Council (MSC 2021):

The Philippine Tuna Handline Partnership (PTHP) is made up of 500 artisanal fishing boats harvesting yellowfin tuna using traditional handline fishing gear along the Mindoro Strait and Lagonoy Gulf, and tuna processors. The PTHP also includes around 2,000 fishers in these productive fishing areas.

The WWF-Philippines Yellowfin Tuna Fishery Improvement Project (FIP) has contributed to improving PTHP's performance towards achieving the goal of meeting the MSC Fisheries Standard. Under the FIP, the artisanal fishers register their boats and get a fishing license in return.

The assessment of the fishery to the MSC Fisheries Standard was conducted by an independent assessment team from SCS Global Services. The assessors found that while the PTHP meets the high standards set by the MSC, there are several areas that need to be improved, resulting in nine conditions to keep its MSC certification: (a) stronger habitat management strategies, (b) policies to identify and protect endangered species, and (c) effective monitoring and enforcement of fishery laws. These are time-dependent goals that PTHP must meet to retain its certification, with progress assessed annually.

Source: MSC 2021.

## *3.6 Outcomes and impacts*

The current pressures and state of production have environmental, economic, and social outcomes and impacts.

### 3.6.1 Environmental outcome: Change in fish biomass and species composition

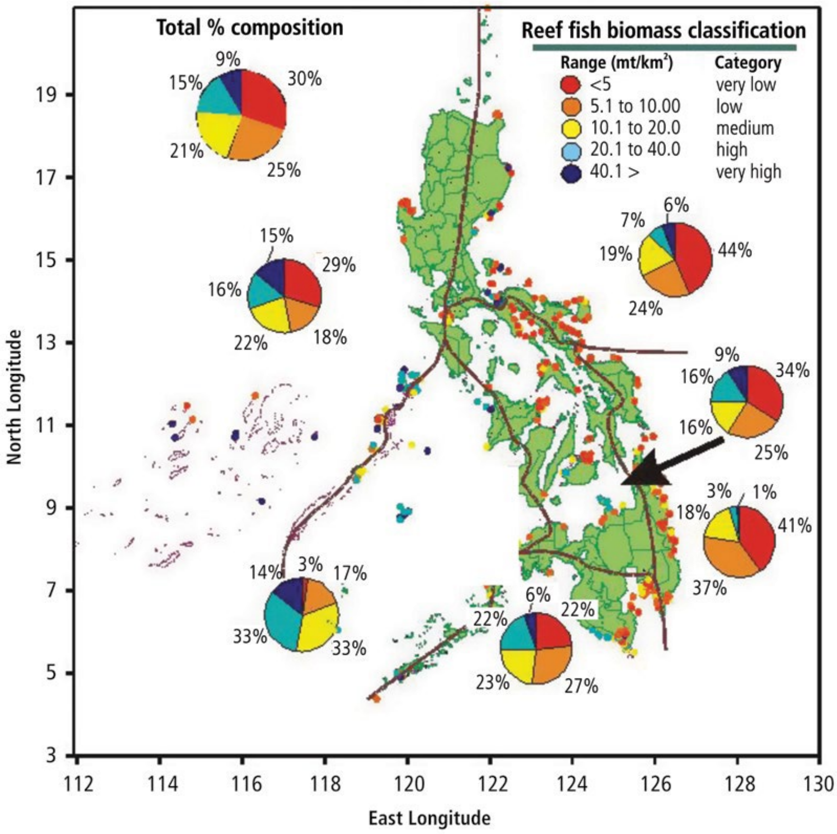
Studies have reported that overfishing is a significant threat in most areas in the country. Low abundance of species at certain regions, especially in the Visayas Region, is characteristic of intense fishing and habitat degradation (Nañola *et al*. 2011). Continuous overfishing has a cumulative effect on fish biomass and species composition. Reef fish biomass ranges from 'low' to 'very low' in most of the biogeographic regions of the country (**Figure 3.19**). This situation is being compounded by climate change. Rising sea temperatures and acidity negatively affect how coral reefs and related ecosystems nurture fisheries. As oceanographic conditions change, so will fish distribution, migration patterns, and the marine food web. Should there be no proactive management interventions put in place soon, fisheries in the country could face dire consequences, such as collapse (Santos *et al*. 2017).

In some areas, not only has the volume of catch been reduced, but also quality of fish. Until the 1970s, Manila Bay was the country's second biggest source of fish catch according to the research made by the Tambuyog Development Center (1990). A major indication of the radical depletion of the bay's resources is the decrease in the stock density or the number of fish per tonne per $km^2$. For Manila Bay, it was established in 1947 that there was a stock density of 4.61 tonnes/$km^2$ or about 8,290 tonnes of demersal biomass, but in 1993, there was only an estimated 0.48 tonnes/$km^2$ or an equivalent of 840 tonnes (**Table 3.16**).

Likewise, there was also a decline in terms of the quality of fish yield in Manila Bay, particularly in the composition of species caught (**Table 3.17** and **Figure 3.20**). The population of finfish decreased which led to a corresponding increase in the relative abundance of demersal invertebrates. Major changes were noted in catch composition include the disappearance of turbots and lactarids. Large number of commercial fish species, such as snappers, sea catfish and mackerels, were previously abundant in these waters (Martinez-Goss 1999). Their decline ushered in the appearance of squid, shrimp, and small pelagic species, such as herrings and anchovies (Jacinto, *et al*. 2006).

Similarly, in Central Visayas, a major change in composition of catch took place in the 1980s when the coastal pelagic fish replaced the demersal fish as the most abundant catch, and invertebrate species shifted from shrimp-dominant to squid-dominant, reflecting a change in ecosystem due to fishing pressure (FAO 2005; Green et al. 2004).

**Figure 3.19. Percentage of Reef Fish Biomass Categories of the Biogeographic Regions**




Source: Nañola *et al*., 2002

**Table 3.16. Historical information on the demersal stock density of Manila Bay**

| Year | Stock Density (tonne/km$^2$) | Relative Density (% of Baseline) | Source |
|---|---|---|---|
| 1947 | 4.61 | 100.0 | Warfel and Mañacop 1950 |
| 1968-72 | 1.71 | 37.1 | Silvestre *et al*. 1986. |
| 1993 | 0.47 | 10.2 | MADECOR and National Museum 1995 |
| 2014 | 0.32 | 6.9 | Bendaño *et al*. 2017 |
| 2015 | 0.48 | 10.4 | Bendaño *et al*. 2017 |

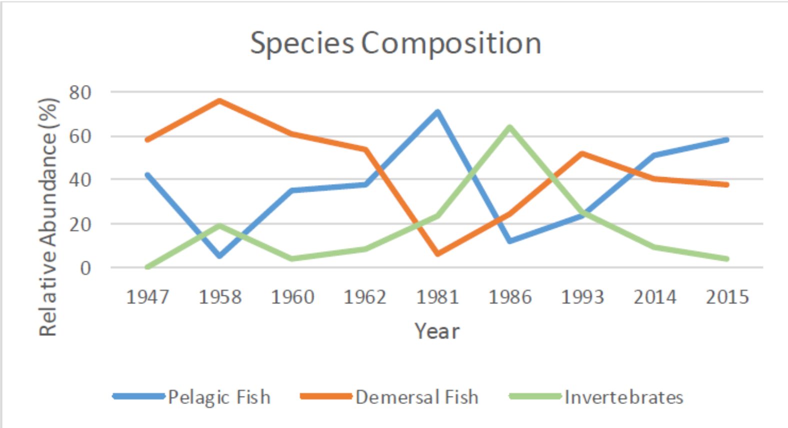
Source: Bendaño *et al*. 2017

**Table 3.17. Historical information on species composition from trawl fishing surveys in Manila Bay**

| Year | Relative Abundance (%) | | | Source of information |
|---|---|---|---|---|
| | Small Pelagic Fish | Demersal Fish | Invertebrates | |
| 1947 | 42 | 58 | 0 | Warfel and Mañacop 1950 |
| 1958 | 5 | 76 | 19 | Ronquillo *et al*. 1960 |
| 1960 | 35 | 61 | 4 | Cases-Borja *et al*. 1963 |
| 1962 | 38 | 54 | 8 | Cases-Borja 1972 |
| 1981 | 71 | 6 | 23 | Bautista and Rubio 1981 |
| 1986 | 12 | 24 | 64 | Ronquillo *et al*. 1989 |
| 1993 | 23 | 52 | 25 | MADECOR and National Museum 1995 |
| 2014 | 51 | 40 | 9 | Bendaño *et al*. 2017 |
| 2015 | 58 | 38 | 4 | Bendaño *et al*. 2017 |

Source: Bendaño *et al*. 2017; PEMSEA 2006a.

**Figure 3.20. Change in Species Composition in Manila Bay**




Source of data: Bendaño *et al*. 2017; PEMSEA 2006a.

### 3.6.1 Impacts on health

Another key issue is the impact of water pollution on the quality and safety of seafood for human consumption.

***Coliform***. The total and fecal coliform bacteria are used as indicators of microbial contamination or pollution related to the presence of pathogenic bacteria, which pose health risk. *Escherichia coli (E. coli)* bacteria are the most frequent causes of diarrhea and intestinal infections, and their presence in water indicates the presence of fecal waste. Total and fecal coliform have been found in the water column and in fish tissue. Only 39 percent (136/351) of the monitoring stations throughout the country reported water quality in coastal waters that passed the DENR-EMB standards for fecal coliform based on the Class SB water quality parameters (DENR-EMB 2018). Sampling and assessment of fish in Manila Bay for coliform contamination had been conducted in 2005 (PEMSEA 2006a) and 2015 (Raña *et al.* 2017). According to these studies, farmed fishery resources had higher concentration of *E. coli* during the dry season. The following are the percentage of samples that exceeded the FDA standard limits: 25 percent of mussels; 24.44 percent of shrimps; 16 percent of tilapia; 14.67 percent of oysters; 8.89 percent of crabs, and 6.67 percent of milkfish (Raña *et al.* 2017).

***Harmful algal blooms***. HABs have been associated with fish and shellfish kills, human health impacts, and ecosystem damage. Fish and shellfish caught during Red Tide can cause paralytic shellfish poisoning. Of the world's 3,800 human Paralytic Shellfish Poisonings from 1985 to 2018, the largest number (2,555 from 1983 to 2013, including 165 fatalities) occurred in the Philippines, which depends strongly on aquaculture for human food protein (UNESCO/IOC 2021). Red Tide incidents also impact the livelihood and income of fisherfolk.

### 3.6.3 Economic cost

Based on a report of BFAR (2019), the economic cost of fishery losses was estimated to be around USD101.88 billion (PHP5 trillion) annually, due to the following factors:

- Overfishing: USD 0.189 billion
- Destructive fishing: USD 99.22 billion
- Environmental (e.g., pollution): USD 0.109 billion
- Poaching: USD 1.22 billion
- Post-harvest losses: USD 1.146 billion

In addition to morbidity and mortality costs due to PSPs, Red Tide incidents also impact the livelihood and income of fisherfolk. Displacement costs of fisherfolk happen because the common policy response of the government has been to ban the harvesting and selling of selected bivalves and crustaceans, e.g., mussel, oyster, sea crab (*alimasag*), small shrimps, and *alamang.* (BFAR monitors HABs and issue Red Tide warnings.) Furthermore, consumers usually inhibit buying and consuming even other marine products that are not affected by the Red Tide. There is also an effect on export earnings. Japan and Singapore banned shrimp imports from the Philippines during the 1988, 1992 and 1993 outbreaks (BFAR 2014). Additional costs are related to monitoring and the expenditure of the government in its relief operations during Red Tide outbreaks. For example, the damage cost in Manila Bay due to Red Tide in 1988-1998 consists of the following (PEMSEA 2006b):

- Mortality cost (pre-mature deaths): PHP10.6 million
- Morbidity cost: PHP 1.9 million
- Loss in export earnings: $176.2 million (or PHP 9.7 billion)
- Number of displaced fisherfolk: 38,500 (1992)
- Foregone earnings of fisherfolk: PHP 1.92 billion (in 1992)
- Government cost: PHP3.5 billion (in 1992)

### 3.6.4 Social impact

Low productivity and low incomes from fisheries are consistent with the prevalence of rural poverty. The situation is further aggravated by low farm gate prices of produce and high retail prices of food, which are among the highest in the Southeast Asian region. The declining fish production also has implications to food security and nutrition.

Poverty among the fisherfolk has fallen over time, but it remains far higher than the national average. The poverty incidence of fisherfolk in 2018 was 26.2 percent while the national poverty incidence in 16.6 percent (PSA 2019; see also Figure 1.2).

## *3.7 Policy reforms and other measures*

Supporting policies and a set of comprehensive mechanisms for modernized fisheries will provide a strong, reliable backbone of a more productive and resilient sector. There were laws that have been adopted but need to be enforced. The **Philippine Fisheries Code of 1998** (RA

8550), **Amended Fisheries Code** of 2015 (RA 10654) and its Implementing Rules and Regulations (IRR) as well as the CNFIDPs (2006-2010, 2011-2016, 2016-2020) mandated the implementation of science-based conservation and management measures for the fisheries sector. Essential measures that have been put in place to secure sustainable and inclusive growth in the fisheries industry, where the poorest among the basic sectors—the artisanal fisherfolk—belong. These measures need to be continued, sustained, enhanced, and scaled up, while gaps and disparities need to be addressed through additional or alternative strategies and programs.

Key international fisheries agreements have also been adopted. The **1995 UN Fish Stocks Agreement** (UNFSA) has entered into force for the Philippines in October 2014. On 11 February 2015, the Department of Foreign Affairs (DFA) finalized and prepared the documents for Philippines' accession to the **2009 Agreement on Port State Measures** (PSMA). The country has also formalized the acceptance of the **1993 FAO Compliance Agreement** in 2015.

### 3.7.1 Fisheries Code (RA 8550 and RA 10654)

***Regulation of fishing***

The regulation of fishing effort is provided in the Section 2 of the *Fisheries Code of 1998*, which states that government has the duty "to protect the rights of fisherfolk, especially of the local communities with priority to municipal fisherfolk, in the preferential use of the municipal waters. Such preferential use, shall be based on, but not limited to the maximum sustainable yield (MSY) or total allowable catch (TAC) on the basis of resources and ecological conditions, and shall be consistent with our commitments under international treaties and agreements."

The **Reference Points** (RPs) and corresponding **Harvest Control Rules** (HCRs) have been identified as key strategies to achieve the goals stated in the Fisheries Code (Santos *et al*. 2017). With the *Amended Fisheries Code of 2015*, BFAR was tasked to determine the **Target Reference Points** (TRP) and **Limit Reference Points** (LRP), and develop the Harvest Control Rules (HCR) to achieve TRP and to avoid LRP in all fishing grounds or fishery management areas, based on the results of NSAP and the precautionary principle.[17] The NFRDI has been tasked to determine the LRPs, TRPs, and Trigger RPs. Among the possible RPs, the **Exploitation Rate** I has been selected by NSAP as one of the RPs to be used in assessing, monitoring and evaluation of the status of fish stocks in the country relative to fishing pressure.

The national fish stock assessment program should be continued and regularly done to monitor and regulate fishing activities and ensure the sustainability of this important resource.

***Stakeholder participation in governance***

The DA has engaged the fisherfolk to craft and implement policies and programs for the sustainable use and management of aquatic resources, so that these could continue to provide a stable supply of food, livelihood, and ecosystem services. BFAR has similarly encouraged coastal communities and local government units (LGUs) to protect their municipal waters up to 15 km from the shore for the exclusive use of artisanal fisherfolk. *Bantay-Dagat* teams have been organized in many LGUs to help in the monitoring of coastal waters against illegal and destructive fishing.

[17] Department of Agriculture Administrative Oder 10, series of 2015. Implementing Rules and Regulations of RA 8550 as Amended by RA 10654.

Emphasis on empowering the fisherfolk was highlighted through the creation of the *Fisheries and Aquatic Resources Management Councils* (FARMCs) at the local and national levels. The FARMCs are involved in planning, policy and decision-making, and monitoring of fisheries-related government programs. This initiative ensures that the interests of the fisherfolk and their organizations are covered and appropriately considered in the policy- and decision-making process and in program/project identification and implementation.

#### 3.7.2 Comprehensive National Fisheries Industry Development Plan (CNFIDP) 2006-2025.

This is a two-part plan that focuses on (1) development of appropriate structures (e.g., physical infrastructure, system for marketing, etc.), and (2) conservation (e.g., restoration of habitats and rehabilitation of fisheries). The framework also identifies six (6) critical actions that need to be prioritized for the sustainable development for the country's fisheries industry, namely: (a) reduction and rationalization of fishing effort; (b) protection and rehabilitation of fishing habitats; (c) improved utilization of harvests; (d) improved local stewardship and management of resources; I provision of supplemental and/or alternative livelihoods for fishers; and (f) capacity building and institutional strengthening.

#### 3.7.3 2011-2016: Shift of policy "focus" from volume-based production to value and conservation.[18]

Since 2011, fisheries management shifted its focus from increasing production, which has led to overexploited resources, to protection and conservation though the adoption of the Ecosystems Approach to Fisheries Management (EAFM). With the reforms and measures undertaken by the government, especially in addressing IUU fishing, the 'yellow card' was lifted by the European Union (EU) on Philippine fishery exports.

***Amended Fisheries Code of 2015***

According to the DA, the implementation of RA 10654 or the Amended Philippine Fisheries Code of 2015 will help catalyze the modernization and sustainability of the fisheries sector.

The revised law would help in addressing IUU fishing and ensuring that the access of small fishers to the municipal waters is guarded from encroachment by large-scale commercial fishers. Section 130 of RA 10654 empowered BFAR to impose administrative fines and penalties provided under the law. The penalties imposed for violation of the Fisheries Code were raised from the old law's PHP10,000-500,000 range to PHP 500,000-10 million range. For this purpose, the Adjudication Committee was created following the creation of the Rules of Procedure for the Adjudication of Fisheries Laws Cases.

***Monitoring, control, and surveillance***

According to **Section 14 of the Fisheries Code of 1998**: "*A monitoring, control, and surveillance (MCS) system shall be established by the Department in coordination with LGUs, FARMCs, the private sector and other agencies concerned to ensure that the fisheries and aquatic resources in Philippine waters are judiciously and wisely utilized and managed on a sustainable basis and conserved for the benefit and enjoyment exclusively of Filipino citizens.*"

[18] The outcomes of the policy shift in 2011-2016 were pointed in PEMSEA and DENR, 2019.

The MCS system supports the initiatives against IUU fishing. "*Monitoring* involves the collection, measurement and analysis of data and information on fishing activities on a regular and continuous basis. *Control* refers to specifying the terms and conditions under which resources can be harvested. *Surveillance* involves checking and supervising fishing activities to ensure all applicable laws and regulations are being observed by the participants in the fishery" (FAO 1997a, p.44).

The **Amended Fisheries Code of 2015, Section 7,** takes a further step by calling for the installation of a **vessel monitoring system** (e.g., Automatic Identification System or AIS) on "*all Philippine flagged fishing vessels regardless of fishing area and final destination of catch*." This will help identify commercial vessels operating illegally in Philippine waters. According to this law, it is unlawful to intentionally tamper with, switch off or disable the vessel monitoring system. By passing the Amended Fisheries Code, the Philippines avoided penalties by the European Union for failing to meet its standards on sustainable fishing practices.

***More fishery law enforcers trained and deployed***

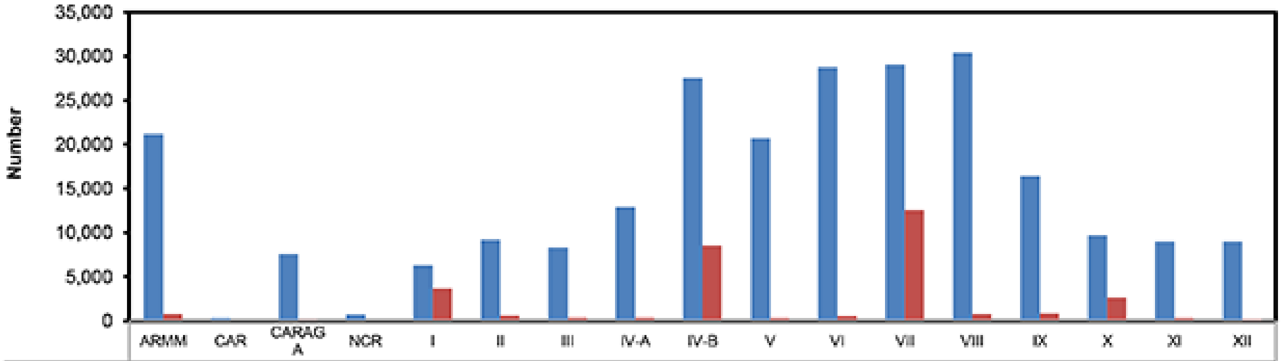
With only 10 fishery law enforcers in 2010, BFAR proposed for the training and deployment of additional fishery regulatory officers to support the implementation of the fishery laws (DA 2015). By 2015, the 188 graduates of the intensive training course have been deployed as professional fishery law enforcers (DA 2015). The Department of Budget and Management (DBM) released authorization for 778 Fishery Regulatory Officers plantilla items (DA-BFAR 2016).

***Registration of fisherfolk and fishing vessels***

The *National Program for Municipal Fisherfolk Registration* (**FishR**) and *National Program for Municipal Fishing Vessels and Gears Registration* (**BoatR**) programs of BFAR were created to help enhance and fast track the registration of fishers and fishing boats under the *Municipal Fisherfolk Registry of the Local Government Units* for detailed and more accurate monitoring and management purposes.

The FishR has been able to register over 1.6 million fishers by 2015 (DA 2015). An offshoot of the FishR program, the BoatR has registered over 138,000 municipal fishing vessels by 2016 (SEAFDEC 2017). **Figure 3.21** shows the number of registered municipal fishing vessels and fishing gears by region.

**Figure 3.21. Number of registered municipal fishing vessels (2017) and fishing gears (2016)**




| | ARMM | CAR | CARAGA | NCR | I | II | III | IV-A | IV-B | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fishing vessels | 21,191 | 308 | 7,621 | 718 | 6,295 | 9,176 | 8,287 | 12,909 | 27,533 | 20,709 | 28,765 | 29,025 | 30,419 | 16,433 | 9,724 | 9,017 | 9,016 |
| Fishing gears | 763 | 12 | 139 | 2 | 3,680 | 598 | 328 | 339 | 8,541 | 305 | 508 | 12,552 | 769 | 825 | 2,628 | 296 | 197 |

Source: SEAFDEC 2017.

### *Closed fishing seasons*

To facilitate the natural progression of fish breeding cycle, BFAR has successfully enforced closed fishing seasons. An example of conservation effort is focused on sardines and small pelagic fish, with the regulations on closed fishing season in certain areas of the country. According to BFAR, a 30 percent increase in fish catch was reported after three years of implementing this policy. The closed fishing seasons in 2011 to 2015 have also led to the resurgence of tamban and galunggong, attracting more tuna that feed on them. The total production of yellow fin tuna has consequently increased significantly. The success of the closed season has also led to the Philippines being allowed by the Western and Central Pacific Fisheries Commission (WCPFC) to fish in tuna-rich High Seas Pocket 1 (HSP1)[19] of the Pacific Ocean.

### *Fish sanctuaries and marine protected areas* (MPAs)

Establishing MPAs as part of ocean and fisheries management has already been "shown to work, and displaced fishing effort is often offset by "spillover" of adult and larval target species from populations inside MPAs as they recover from fishing pressure" (Ceccarelli and Fernandes. 2017, p.vii). One study in the Philippines saw a significant increase in fish density outside of an MPA between 9 and 11 years after the no-take area was established (Russ and Alcala 1996). No-take MPAs can export target species into adjacent fisheries (Ceccarelli and Fernandes. 2017, p.21). As of 2017, MPAs comprised around eight percent of the country's territorial waters (PEMSEA and DENR 2019).

### *Securing fisherfolk welfare*

The government has implemented programs to ensure improved access of small fishers to social services and to reduce poverty incidence in this sector. The FishR national registry was used in expediting free insurance coverage for the fisherfolk by the Philippine Crops Insurance Corporation (DA 2015). The FishR database was also crossmatched with the *National Household Targeting System for Poverty Reduction* for the conditional cash transfers program of the Department of Social Welfare and Development (DSWD) (DA-BFAR 2016). Fisherfolk

[19] HSP1 or the high seas is bounded by the EEZs of the Federated States of Micronesia to the north and east, Palau to the west, and Indonesia and Papua New Guinea to the south. The Filipino fishers are allowed to fish in this area subject to CMMs issued by the WCPFC.

listed on both registries were automatically given a PhilHealth number to access free health care insurance (DA 2015).

The *Targeted Actions to Reduce Poverty and Generate Economic Transformation in the Fishery Sector Program* aims to provide the necessary livelihood interventions across the value chain of specific commodities to targeted 33,206 fisherfolk from an initial 100 targeted poorest-of-the-poor coastal communities. This program is grounded on the following:

- Ensuring sustainability by maintaining the carrying capacity of the fisheries resources.
- Improving productivity through appropriate and environment-friendly technologies.
- Optimizing product utilization to enhance product value.
- Instituting autonomy and sufficiency in all aspects of production operations.
- Assuring equal distribution of economic benefits within the primary production sector.
- Linking with institutions and other government agencies, including the LGUs, to institutionalize the program.

***Fish ports and community landing centers***

The *Community Fish Landing Center Program* aimed for the establishment of one CFLC with two units of freezer and eight stainless steel fish stalls per coastal municipality. Around 500 community fish landing centers (CFLCs) in strategic areas nationwide helped in reducing fisheries post-harvest losses from 25 percent to 18 percent or even lower in 2015-2016 (DA-BFAR 2016). These CFLCs serve the subsistence and artisanal fishers and help them in the marketing of their fish catch. The program established 252 CFLCs in 2015, 271 CFLCs in 2016, and 126 CFLCs in 2017. BFAR carefully identified the sites where the facilities would be established using the FishR database, among other data sources. The National Anti-Poverty Commission (NAPC) likewise assisted in identifying target areas based on poverty incidence and volume of production, among other criteria. The CFLCs provide a proper and hygienic hub for the fisherfolk to land their catch; serve as a monitoring site; and, in part (via its roof deck), serve as a facility for sun drying and smoking of fish. However, more needs to be done in improving the facilities and operation of the community fish landing centers, such as additional cold storage facilities, ice plants, equipment and machinery, dependable electricity, and waste management (collection and disposal of discarded parts of fish, and composting).

***Research and development (R&D) support***

The *National R&D Program on Blue Swimming Crabs* is paving the way for its conservation and sustainable use. This program is funded by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development of the Department of Science and Technology (PCAARRD), in partnership with Southeast Asian Fisheries Development Center (SEAFDEC), and in collaboration with the University of the Philippines Visayas (UPV) and Mindanao State University (MSU). The program aims to increase production of this commercially important commodity by refining existing technologies on hatchery and grow-out culture, and by developing nursery culture of blue swimming crabs for sustainability and industry competitiveness.

***Partnership with private sector***

Partnership with the private sector is crucial for the e-CDTS to address IUU fishing in the tuna industry. Another key initiative is the partnership with seafood producers and processors for the conservation of blue crabs and swordfish.

### 3.7.4 Plans and projects: 2016 – present

***AFMP 2018-2023***

The *AFMP 2018-2023* noted some of the challenges in the fisheries sector, such as the downward trend of the fisheries output over the period 2011 to 2017. This is a result of overfishing and other compounding factors, which have affected fish stocks, fishing effort, and fish catch. Closed fishing season and no-take zones in marine protected areas have affected volume of fish catch, but these initiatives have long-term positive impacts. In aquaculture, some underutilized and underdeveloped fishponds are converted back to mangroves as part of the aquaculture and fisheries restoration program, which may result in the decline of milkfish production. Actions like closed fishing seasons, fish sanctuaries, and mangrove protection will eventually allow fish stocks to recover and enable a more sustainable and resilient fisheries industry in the long run. Moreover, although the fisheries output is declining, the value is increasing.

Hence, the paradigm shift – from volume-based to value-based and ecosystem-based – adopted in the Comprehensive National Fisheries Industry Development Plan (CNFIDP) is commendable. There should also be more consistency and integration between the CNFIDP, AFMP, and other policies and programs.

***Comprehensive National Fisheries Industry Development Plan (CNFIDP) 2016-2020***

The *Comprehensive National Fisheries Industry Development Plan (CNFIDP) 2016-2020***,** launched in February 2016, was crafted by more than 500 stakeholders through consensus-building via a three-part series of consultations and workshops held in October to December 2015 in capture fisheries, aquaculture, post-harvest, and marketing subsectors. The CNFIDP 2016-2020 focuses on the enhanced marketing strategies in the regions with low fish sufficiency.

Through BFAR, the government focuses on the five-year Fisheries Development Plan 2016-2020, which ensures that all interventions are holistic and coordinated to achieve food security and inclusive growth. The plan also aims to enhance the governance of marine resources and strengthen law enforcement, particularly for the LGUs to guarantee resource sustainability (SEAFDEC 2017).

***Comprehensive Post-harvest, Marketing and Ancillary Industries Plan (CPHMAIP) 2018-2022***

To tackle the issues concerning post-harvest losses and the volume and value of traded fish, the *Comprehensive Post-harvest, Marketing and Ancillary Industries Plan (CPHMAIP) 2018-2022* aligned its goals with those of the *CNFIDP 2016-2020,* which provides strategic directions for the optimal development and long-term sustainability of the fisheries sector.

This requires improving the quality and packaging of fishery products, compliance to international standards on food safety, strengthening the traceability system, improving fishery data collection and knowledge sharing, developing the capacity of fishery-based micro, small, and medium enterprises (MSMEs), and promoting the participation in locally held and international trade fairs. Such initiatives can lead to increased fisheries trade in domestic and international markets (Viron 2019).

***National Sardines Management Plan***

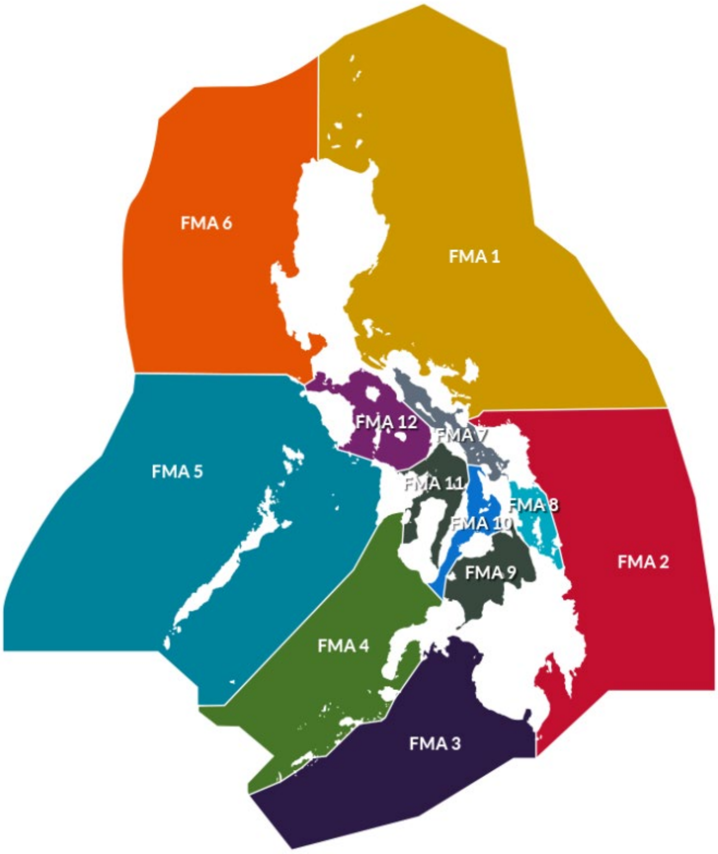
BFAR approved the *National Sardines Management Plan* in May 2020. The closed fishing season approach is not enough to ensure the sustainability of sardines. This sardine fisheries management plan includes science-based indicators for the sustainable management of sardine stocks, and focuses on the equitable distribution of benefits, especially among sardine fisherfolk communities (Oceana 2020). In particular, the plan involves:

- determining reference points, in coordination with the NSAP
- establishing harvest control rules and measures based on the reference points
- reducing juvenile catch
- reducing post-harvest losses and developing livelihood programs
- collaborative data collection and accessible fishery information
- establishing electronic catch documentation and traceability system (e-CDTS)
- increasing awareness and capacity development to enhance the implementation of fisheries and environmental laws and policies, and the National Sardines Management Plan
- instituting program on seal of good governance on fisheries management

***Fisheries Management Areas***

In 2019, a total of 12 fisheries management areas (FMAs) were established (**Figure 3.22**) through the *Fisheries Administrative Order 263 Series of 2019* to ensure sustainable fishery resources by promoting management based on the status and capacity of stocks, stocks boundary and range, distribution of fisheries, and administrative subdivisions as well as promote co-management among BFAR and LGUs. The policy regulation directs all coastal LGUs, municipal fisherfolk, civil society organizations, academe, and other key stakeholders to take on shared responsibilities for the conservation and sustainable management of fishery resources. In the FMAs, the members of the Management Body are mandated to draw up **Management Plans** that are science-based and participatory by considering the advice of the Scientific Advisory Group, and results of consultations with the key stakeholders. The new system aims to improve governance of each FMA at an ecosystem-wide scale to curb the illegal fishing trade. A major hurdle is the lack of a clear mechanism for the reporting of violations, corresponding response by the authorities, and enforcement.

**Figure 3.22. Location of fisheries management areas (FMAs)**




Source: BFAR 2019.

To further ensure the effective management of the 12 FMAs, the **FMA Scorecard** system was designed as an assessment and monitoring tool to determine compliance status using key indicators based on good governance principles of transparency, accountability, and public participation. This Scorecard serves as: (1) Monitoring and evaluation tool in the FMA implementation, (2) Self-assessment tool, (3) Outline in the yearly report by the FMA Management Body, and (4) Venue for the participatory process in the FMA implementation across all sectors (Oceana *et al*. 2020, p.2). Another outcome of the collaborative process is the **FMA Scorecard Evaluator's Guide**, which provides the steps and process on how the FMA Scorecard can be used (Oceana *et al*. 2020b).

***Livelihood support***

The *CNFIDP 2016 – 2020* includes the *Sustainable Fisheries Livelihoods Support program*, which has a goal of increasing the income of small fisherfolk families and organizations through engagement in resource and non-resource-based livelihood initiatives. It identified potential livelihood projects (e.g., seaweed culture, fish cage culture, agri-ecotourism, MPA and tourism, etc.), and aims to establish fisherfolk livelihood centers, and build partnerships between the government and private entities to give fishing communities access and long-term support for alternative livelihood. It was recognized that fisherfolk will lose income in the areas where closed fishing seasons have been implemented, thus, alternative livelihood programs have been identified and consulted with affected stakeholders, with support from donors and NGOs.

### 3.7.5 Major plans and projects on IUU fishing and sustainable tuna fisheries

The **Executive Order No 154 in 2013** establishes the Philippines' ***National Plan of Action (NPOA) to prevent, deter and eliminate IUU fishing***. This EO also formally establishes a committee composed of duly authorized representatives from various government agencies, private sector, and stakeholders whose task is to ensure the implementation of the NPOA-IUU.

The **Philippine IUU Fishing Index and Threat Assessment Toolkit**, or I-FIT, developed by USAID Fish Right project, is a key tool in assessing IUU fishing in the FMAs. The toolkit can be used by fisheries managers and community members to evaluate the prevalence and magnitude of IUU fishing in their communities and assess the progress and gaps in their enforcement efforts. DENR will use this toolkit to address IUU fishing in the marine protected areas (MPAs) established under the National Integrated Protected Area Systems (NIPAS) Act.

The ***National Tuna Management Plan*** (NTMP) ***2010*** provides the framework for the sustainable management and equitable use of tuna fisheries in the country, promotion of responsible fishing practices by Philippine-flagged vessels fishing for tuna in areas beyond national jurisdiction, and the development of the fishing industry through responsible trade of tuna products.

The ***NTMP 2018*** was launched by BFAR with the aim of *establishing a sustainably-managed and equitably-allocated tuna fisheries by 2026* by promoting responsible fishing practices and trade of tuna products. The plan further stated that increasing catch levels in Western and Central Pacific Ocean have led the WCPFC to adopt, for implementation by member-countries, the Philippines included, a growing number of *Conservation and Management Measures* (CMMs). These measures apply to the catching, processing, and marketing of Skipjack, Yellowfin Tuna, Bigeye Tuna, Albacore Tuna, and Pacific Bluefin Tuna.

The NTMP 2018 covers both municipal and commercial fishing employing purse seine, ring net, long line, handline (hook and line), and other fishing methods and gears that are operated in Philippine waters including the EEZ. Likewise, it covers certain operations of Philippine-flagged vessels fishing in areas beyond national jurisdiction (ABNJ). Philippine-flagged purse seine/ring vessels (not more than 250 GT), currently limited to 36 tuna catchers, operate in High Seas Pocket 1 (HSP1) in consonance with WCPFC policy.

The NTMP 2018 intends to address the following issues discussed at the 18$^{th}$ National Tuna Congress in 2016 and the regional cluster consultations conducted in 2017 and 2018:

- Sustainability of oceanic tuna resources
- Resource use conflict (between commercial and municipal fisheries)
- Limited post-harvest facilities resulting in high post-harvest losses
- Limited socio-economic benefits and alternative livelihood opportunities to tuna fishers
- Limited market and stringent trade/market/credit requirements (including EU and US market standards)
- Need to strengthen governance on tuna fisheries management
- IUU fishing

***Electronic catch documentation and traceability system***

One tool that can be used to address IUU fishing and support sustainable tuna fisheries is the *Electronic Catch Documentation and Traceability System* (e-CDTS), which uses modern technologies, allows networking of national information systems, and provides interface that will let system users to input traceability data throughout the supply chain (PEMSEA and DENR 2019; Silvestre 2017). The e-CDTS was pilot tested in General Santos City. USAID Oceans, SEAFDEC and BFAR unveiled the e-CDTS in September 2017 after months of coding and development. The electronic system will document and store key information about the harvest, processing, and transportation of a fisheries product to enable traceability of the seafood product at each step of its journey— from point of catch to the consumer's plate—and facilitate accessibility, and quick sharing of the data. SEAFDEC and Silvestre (2017) pointed out that the e-CDTS provides a practical way to:

- Ensure fisheries resources are legally caught and properly labelled
- Collect, manage, and share ecological and economic data throughout the seafood supply chain
- Strengthen monitoring, control and surveillance system
- Comply with national, regional, and international seafood regulations and import requirements.

#### 3.7.6 Measures for sustainable aquaculture

***Climate-smart aquaculture*** (PEMSEA and DENR 2019)

The *Philippine National Aquasilviculture Program* (PNAP) implemented by BFAR, together with the Commission on Higher Education (CHEd) is a program focused primarily on mangrove resource rehabilitation and livelihood provision to help address climate change, food security and poverty among municipal/artisanal coastal fisherfolks (Dieta and Dieta, 2015). Its goal and objectives are: (1) replanting of destroyed mangrove resources; (2) establishment of community-based multi-species hatcheries (CBMSH), and (3) provision of aquasilviculture livelihood projects to fisherfolk beneficiaries covering 61 provinces and 71 state universities and colleges (SUCs) all throughout the country (PEMSEA and DENR 2019). As of September 2013, 85 percent of the mangrove target for the said year—around 31,000,000 out of 36,000,000 mangrove propagules have been planted. For aquasilviculture, 76 percent has been attained in 2013, thereby benefitting almost 1,900 fisherfolk throughout the country, while the establishment of CBMSHs has been completed by almost 20 percent of participating SUCs and the others are still in the process of construction (Dieta and Dieta, 2015). The ecosystems services of mangroves, such as habitat for diverse marine species, nutrient cycling, and waste assimilation, are benefiting the aquaculture farms, and in addition, provide shoreline protection and carbon sequestration services. Moreover, the multi-species farms will diversify and increase the income of fisher-beneficiaries.

DA-BFAR and SEAFDEC/AQD are currently working towards the establishment of multi-species hatcheries along with the repair and rehabilitation of abandoned hatcheries around the country to boost aquaculture production and support fry sufficiency (The Fish Site 2021). This will also contribute to the adaptation measures as availability of broodstock and fry are affected by changes in ocean parameters brought about by climate change.

***Bangus Fry Sufficiency Program***

DA-BFAR (2020b) reported the following: In 2019, only 860.75 million fry were produced by registered bangus hatcheries in the country while 19.5 million of were caught in the wild, however, this only accounts for 24 percent of the total annual fry requirement. To compensate, bangus fish farmers are forced to import fry to sustain annual production. About half of the

400,000 tonnes of milkfish consumed by Filipinos were sourced as fry from hatcheries in Indonesia and Taiwan before being imported for grow-out in the Philippines (SEAFDEC Aquaculture Department 2021).

In response, DA-BFAR initiated the *Bangus Fry Sufficiency Program*, which aims to produce more milkfish to supply domestic demand by establishing various hatcheries across the country. Milkfish production is hampered by the lack of fry.

There are currently five hatcheries in the country producing milkfish fry under the program: two are located in Region I while the other three are found in Bohol province in Region 7. All hatcheries were turned over and are now being managed by identified fisherfolk groups and associations. DA plans to also establish 299 community-based hatcheries (Satellite Community-Based Larval Rearing Facility or SCBLRF) across the country under the *Bangus Fry Sufficiency Program*. This will add an estimated 1.5 billion locally-sourced fry to the existing fry production of 1.1 billion fry. With more hatcheries, harvesting from the wild will be reduced; thus, protecting and conserving the wild bangus stock. In addition to the establishment of SCBLRFs, the *Bangus Fry Sufficiency Program 2020-2025* also includes development of milkfish broodstock, establishment of fry holding facilities and fry nursery areas as well as provision of fry collecting gears in the regions to maximize the country's wild fry resource.

***Thermal manipulation*** (;

Thermal manipulation can be used to ensure that the expected fry to be produced under the *Bangus Fry Sufficiency Program* are achieved and available throughout the year, including the offseason months. According to SEAFDEC Aquaculture Department's chief Dan Baliao (The Fish Site 2021): "The shortage of milkfish seeds is more pronounced in the Philippines between November and February when the weather becomes too cold for breeders to lay eggs. Thermal manipulation is necessary to help milkfish hatcheries stay productive during the four-month off-season by ensuring a continuous supply of seed." SEAFDEC/AQD installed water heaters with temperature of at least 29°C in a 500-tonne tank housing over 100 milkfish to induce the spawning of the broodstock, and was able to collect about 2.9 million good eggs, from which almost 1.7 million normal larvae were hatched, (The Fish Site 2021). SEAFDEC/AQD was able to donate 1.1 million milkfish larvae to a satellite hatchery in Batan, Aklan, one of the central hubs for quality, locally-produced milkfish fry in Western Visayas.

***Biotechnology programs to improve mudfish and catfish production***

The DA Biotech Program has partnered with NFRDI and BFAR in 2020 to improve mudfish and catfish production using biotechnology approaches. These projects target a continuous supply of good quality mudfish or '*dalag*' and catfish or *'hito'* fingerlings by improving induced spawning techniques and rearing protocols (DA Biotechnology Program Office 2021).

### 3.7.7 Supporting environmental policies

***Pollution management***

**RA 9275**, An Act Providing for a Comprehensive Water Quality Management and for other Purposes, or more widely known as the ***Philippine Clean Water Act of 2004*** is the primary legislation in the Philippines that protects the country's water bodies from pollution.

DENR issued ***DAO 2016-08***, which defines the water bodies classification, water quality criteria for each class of freshwater and coastal and marine water bodies, and the effluent standards to be followed to maintain and improve water quality. This DAO updated *DENR DAO 1990-34*, which provides the water usage and classification and ambient water quality criteria for each use, and *DAO 1990-35*, which provides the effluent standards or the limits in terms of concentration and/or volume that any wastewater discharge coming from a point source, i.e., industrial plants and municipal sewerage systems, shall meet. DENR has classified 942 out of 1060 (89 percent) water bodies in the Philippines.

On 30 June 2021, DENR published the ***DAO 2021-19*** on the "Updated Water Quality Guidelines (WQG) and General Effluent Standards (GES) for Selected Parameters". The main amendments in *DAO 2021-19* include raising the standard values for six parameters ($NH_3$-N, boron, copper, fecal coliform, phosphorus, and sulfate). It also stipulates the obligation to submit data on influent values of BOD for establishments with influent BOD equal to or greater than 3000 mg/L.

**RA 9003,** also known as the **Ecological Solid Waste Management Act of 2000,** adopts a more systematic and comprehensive solid waste management program for the purpose of ensuring public safety. The law calls for the use of environmentally-sound methods in the utilization of the country's natural resources and encourage resource conservation and recovery; set guidelines for solid waste reduction; ensure proper disposal, segregation, collection, treatment, and disposal, encourage greater private sector involvement in proper solid waste disposal and promoting national research and development programs to improve solid waste management and conservation of resources.

**RA 6969,** also known as the **Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990,** highlights the State's responsibility in regulating, restricting, and prohibiting the importation, manufacture processing, sale, distribution, use and disposal of any chemical substance or mixtures that pose a threat to the environment. The act also covers the provision of resources for the advancement of research work on the proper management and handling of toxic chemicals.

**RA 8749**, otherwise known as the **Philippine Clean Air Act**, is a comprehensive air quality management policy and program, which aims to control air pollution from all potential sources (mobile, point and area sources) and ensure that all emissions and ambient air quality would be within the air quality standards.

***Mainstreaming climate change***

**RA 9729** or "An Act **Mainstreaming Climate Change** into Government Policy Formulations, Establishing the Framework Strategy and Program on Climate Change, creating for this purpose the Climate Change Commission, and for other purposes." It calls for the State to

integrate the concept of climate change in various phases of policy formulation, development plans, poverty reduction strategies, and other government development tools and technique.
***Protection of habitats and biodiversity***

The following are key legislation, policies, and plans for the protection of terrestrial and coastal and marine habitats and biodiversity:

- **Republic Act (RA) no. 7161** (s. 1991): Revised Forestry Code of the Philippines (contains anti-mangrove cutting provision)
- **Republic Act No. 7586** (s. 1992): "National Integrated Protected Areas System Act or NIPAS Act"
- **Republic Act No. 9147** (s. 2001): Wildlife Resources Conservation and Protection Act – "An Act providing for the conservation and protection of wildlife resources and other habitats, appropriating funds therefor and for other purposes"
- **Proclamation No. 128** in 1997: "Declaring the entire Sulu and Celebes Seas as an Integrated Conservation and Development Zone (ICD) and creating Presidential Commission for ICD of the area and providing funds therefor".
- **Executive Order (EO) No. 578** (s. 2006): "Establishing the National Policy on Biological Diversity and Prescribes its implementation throughout the country, particularly in the Sulu-Sulawesi Marine Ecosystem and Verde Island Passage Marine Corridor"
- **Executive Order (EO) No. 797** (s. 2009): "Adopting the Coral Triangle Initiative (CTI) National Plan of Action (NPOA)"

***Integrated environmental planning and management***

**Integrated coastal management**

- President Arroyo signed the **Executive Order (EO) No. 533** in 2006: "Adopting Integrated Coastal Management (ICM) as a National Strategy to Ensure the Sustainable Development of Country's Coastal and Marine Environment and Resources and Establishing Supporting Mechanisms for its Implementation"
- **DENR DAO 2016-26** provides the Guidelines for the Implementation of the *Coastal and Marine Ecosystem Management Program* (CMEMP), which aims to comprehensively manage, address, and effectively reduce the drivers and threats of degradation of the coastal and marine ecosystems; and achieve and promote sustainability of ecosystem services, food security and climate change resiliency. The CMEMP includes ICM; sustainable tourism/ecotourism; partnership building; protection, management, and law enforcement; communication, education, and public awareness; valuation of ecosystem services; and biodiversity-friendly enterprises.

**Integrated river basin management**

- **Executive Order (EO) No. 816** (s. 2009): declares the River Basin Control Office under the DENR as the lead government agency for integrated planning, management, rehabilitation, and development of country's river basins.

***Fisheries conservation***

- **Executive Order (EO) No. 154, series of 2013:** adopts the *National Plan of Action to Prevent, Deter, and Eliminate Illegal, Unreported, and Unregulated Fishing* (NPOA-IUUF). It creates an inter-agency Philippine Committee, headed by the Secretary of Agriculture, to ensure the implementation of the NPOA-IUUF), provide policy guidance, and develop capacity-building programs that will strengthen the Philippines fisheries control system at the national and local levels.

- The *Malinis at Masaganang Karagatan* (MMK) program of DA-BFAR awards coastal municipalities for their efforts in protecting and conserving marine environments. MMK has four general criteria: (1) absence of illegal fishing and observance of fishing closed season, (2) establishment of protected marine sanctuary, (3) clean coastal waters without domestic and industrial wastes and, (4) effective mangrove protection and rehabilitation program. Awardees will receive prize money in the form of fisheries livelihoods.
- BASIL: *Balik Sigla sa Ilog at Lawa* program of restocking inland water bodies with native aquatic species.
- BFAR *law enforcement quick response team* (LEQRT) patrol
- **BFAR Administrative Orders on closed fishing seasons** in various fishing grounds:
  - BFAR Administrative Circular No.247 Amending FAO 31, Series of 1952: Regulation for the conservation of *banak* or *ludong* in Northern Luzon.
  - FAO No. 167-3 s.2013 Amending FAO No. 167, Series of 1989: Establishing a closed season for the conservation of sardines, herrings and mackerels in the Visayan Sea.
  - DA-DILG Joint Administrative Order No.1 Series of 2014: Regulation for the conservation of Blue Swimming Crab (*Portunas pelagicus*)
  - DA-DILG Joint Administrative Order No. 2 Series of 2014: Establishing a Closed Season for the Conservation of Small Pelagic Fishes in Davao Gulf.
  - BFAR Administrative Circular No. 255 Series of 2014: Establishing a Closed Season for the Conservation of Sardines in East Sulu Sea, Basilan Strait and Sibugay Bay
  - DA-DILG Joint Administrative Order No.1 Series of 2015: Establishment of a closed season for the conservation and management of galunggong (roundscad; *Decapterus* spp.) in Northern Palawan.
- National regulations compatible with WCPFC measures have been passed:
  - Prohibition on the use of large-scale driftnets
  - Conservation and Management Measures (e.g., Daily Catch Effort Reporting, VMS, Fisheries Observers, Silky Sharks, Pacific Bluefin Tuna, etc.)

## 4.0 Sustainable development and modernization of agriculture

### *4.1 Status and Performance*

The Philippines has a total land area of 298,170 $km^2$ or about 30 million hectares (ha), of which 14.2 million ha are classified as alienable and disposable land, and 15.8 million ha as forestland (DENR 2020). All lands with a slope equal to or greater than 18 percent compose the Philippine uplands. Hilly or mountainous lands (uplands) in the Philippines are estimated at 9.4 million ha, or about 31 percent of the total land area.

Agriculture plays a vital role in the Philippine economy. The main agricultural enterprise is crop cultivation. About a third of the country's 30 million ha is used for agriculture, of which 52 percent is planted to food crops; 31 percent for food grains; and 17 percent for non-food (e.g., pasture and cut flowers).

Agricultural production in 2019 (PSA 2020, p.1):

- The GVA in Agriculture, Forestry and Fishery sector was PHP1.78 trillion (**Table 4.1**). It grew by 1.2 percent in 2019. The AFF sector comprised 9.2 percent of the GDP in 2019.
- The gross output in agriculture increased by only 0.3 percent in 2019.
- Crop production decreased by 1.0 percent. Production of palay was down by 1.3 percent while corn recorded a 2.7 percent increment in output. Banana production contracted by 2.1 percent. Coconut had a 0.3 percent output gain. Increases in production were exhibited in the other crops such as mango, pineapple, calamansi, rubber, sweet potato, eggplant, onion, tobacco, abaca, tomato, ampalaya, cabbage, and cacao. Meanwhile, output decreases were reported in sugarcane, cassava, coffee, potato, and mongo.
- Livestock registered a 1.0 percent decline in production in 2019. Except for dairy, all livestock components exhibited output losses. Hog production dropped by 1.0 percent. Meanwhile, production of poultry went up by 5.9 percent. Chicken registered an output growth of 4.9 percent, but duck had a 2.3 percent reduction in production. Uptrend continued in chicken egg and duck egg production.
- There were 9.72 million people employed in the agricultural sector. This is 23 percent of total employment (**Table 4.2**).

Despite the difficulties brought about by the COVID-19 pandemic, the agriculture and fisheries sector grew by 1.6 percent in the second quarter and 1.2 percent of the third quarter of 2020 (**Figure 4.1**). However, the AFF sector contracted by 2.5 percent in the fourth quarter of 2020, and again in the third quarter of 2021.

Timely actions are crucial to ensure that farmers have access to farm inputs and services and more efforts are needed to avoid major supply disruptions and keeping the transport of agricultural products and food open.

***Mechanization*** is a multi-dimensional concept and widely used in agriculture. In the Philippines, power tillers are gradually replacing the carabao through increasing availability of custom hire services, but not as rapidly as desired because of high prices of imported engines, meanwhile, imported four-wheel tractors, rice transplanters, and combines started getting popular (Lantin 2016). The use of mechanization in Philippine agriculture has been low. The mechanization level of the sector increased from 0.52 horsepower (hp)/ha to 1.68 hp/ha in 2009, to 1.23 hp/ha for all crops and 2.31 hp/ha for rice and corn in 2011 (Dela Cruz, and Bobier 2013). This is still far below other Asian countries, such as Korea (4.11 hp/ha) and China (3.88 hp/ha), Japan, and Thailand, but at par with Vietnam, Pakistan, and India (DA 2013). In 2009, among rice and corn farmers, only 21.7 percent have mechanized while the rest continue to use manual labor and farm animals in production activities (PDP, 2011-2016).

**Table 4.1. Macroeconomic growth indicators, 2015-2019**

(Value at constant 2018 prices)

| Item | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| GNI (million pesos) | 16,722,293 | 17,862,678 | 19,084,224 | 20,212,349 | 21,272,666 |
| Growth Rate (%) | 6.1 | 6.8 | 6.8 | 5.9 | 5.2 |
| GDP (million pesos) | 14,990,907 | 16,062,676 | 17,175,978 | 18,265,190 | 19,368,513 |
| Growth Rate (%) | 6.3 | 7.1 | 6.9 | 6.3 | 6.0 |
| GVA in Agriculture Forestry and Fishing (million pesos) | 1,688,344 | 1,672,086 | 1,743,134 | 1,762,616 | 1,783,855 |
| Growth Rates (%): | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Agriculture, Forestry, and Fishing | 0.7 | -1.0 | 4.2 | 1.1 | 1.2 |
| Crops | -20 | -3.2 | 4.7 | -0.7 | -2.0 |
| Livestock | 3.6 | 3.0 | 3.4 | 3.7 | -0.8 |
| Poultry and Egg Production | 8.7 | 1.8 | 5.0 | 5.3 | 5.8 |
| Other Animal production | 3.6 | 5.3 | 6.4 | 9.3 | 31.8 |
| Forestry and Logging | -24.4 | -4.3 | -1.4 | 22.9 | 5.0 |
| Fishing and Aquaculture | 1.4 | -1.0 | 2.1 | -0.6 | 2.5 |
| Support activities to forestry and fishing | 5.4 | 2.9 | 4.7 | 3.4 | 5.8 |

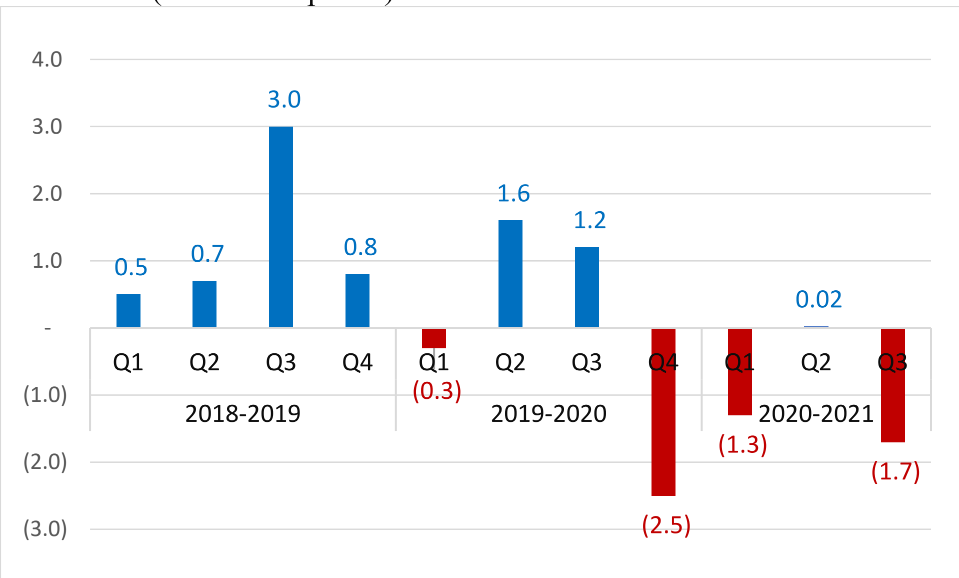
Source: PSA 2020.

**Table 4.2. Population, Labor Force, Employment, and Wage Rate, 2015-2019.**

| Item | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| Population (million persons) [1/] | 100.98 | 102.53 | 104.17 | 105.76 | 107.29 |
| Labor Force (million persons) [2/] | 41.34 | 43.36 | 42.78 | 43.46 | 44.69 |
| Employment (million persons) | 38.74 | 41.00 | 40.33 | 41.16 | 42.43 |
| Agriculture (million persons) | 11.29 | 11.06 | 10.26 | 10.00 | 9.72 |
| Unemployment (million persons) | 2.60 | 2.36 | 2.44 | 2.30 | 2.26 |
| Wage rate in Agriculture (pesos per day) | | | | | |
| Nominal | 267.88 | 276.03 | 280.37 | 306.28 | 331.10 |
| Real | 189.32 | 191.69 | 251.45 | 261.55 | 275.46 |

[1/] 2015 Census of Population; 2016 to 2109 projected mid-year population based on 2015 POPCEN.
[2/] Starting April 2016, Labor Force Survey adopted the 2013 Master Sample Design as well as the population projections based on the 2010 CPH while previous rounds used the 2000 CPH population projections.
Source: PSA 2020.

**Figure 4.1. Agriculture, forestry, and fishing, Quarterly growth rate, Q1 2019 to Q3 2021 (at constant prices)**




Source: PSA 2021.

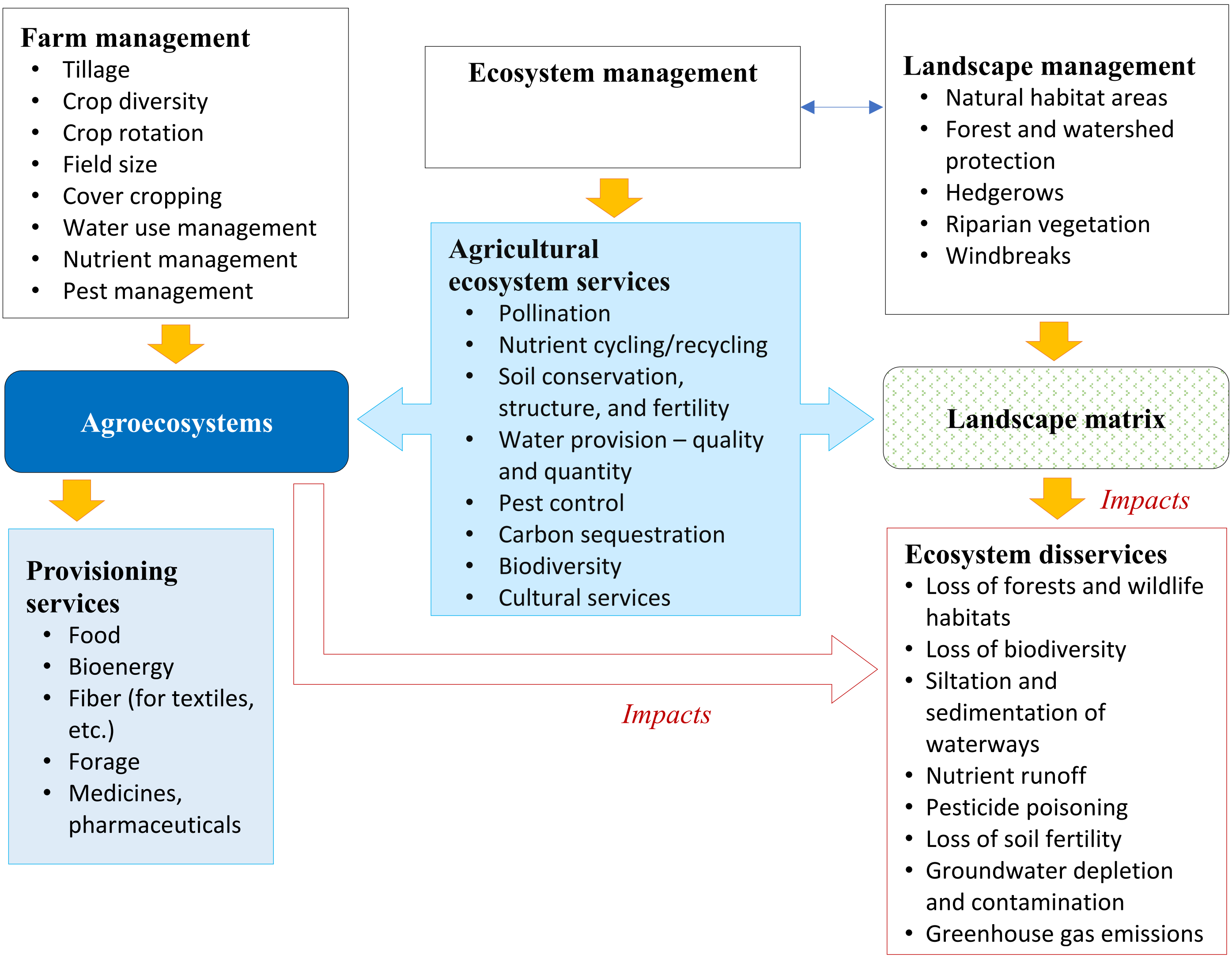
### *4.2 Ecosystem services to agriculture and disservices from agriculture*

Ecosystem services – the multitude of benefits that nature provides to society – underpin agricultural production. Agroecosystems are both providers and consumers of ecosystem services (**Figure 4.2**). The management of agricultural landscapes jointly for conservation and production is relevant to the implementation of the Convention on Biological Diversity (CBD) and the SDGs. Agricultural ecosystems provide humans with food, fiber, forage, bioenergy, and medicines and are essential to human wellbeing.

On one hand, these agroecosystems rely on ecosystem services provided by natural ecosystems, including pollination, nutrient cycling, hydrological services, maintenance of soil structure and fertility, and biological pest control. There are myriad elements of biodiversity in agricultural landscapes: crops, grass, and tree species and varieties; pollinators and soil microorganisms that support production; livestock species; and wild species that use farming areas as their main or supplemental habitat. Fertile soil and available water are a must for long-term, productive, and sustainable agriculture, and is intrinsically connected to the wellbeing of people, the environment and biodiversity.

On the other hand, agroecosystems also produce a variety of ecosystem services, such as regulation of soil and water quality, carbon sequestration, support for biodiversity and cultural services (Power 2010, p.2959). However, there are management practices that can induce ecosystem disservices from agriculture, such as habitat and biodiversity loss, nutrient runoff, sedimentation and agrochemical contamination of waterways, pesticide poisoning, groundwater depletion and contamination, and GHG emissions (Power 2010). These disservices, potential conflicts between the provisioning services and other ecosystem services (market versus nonmarket values), tradeoffs, as well as areas for possible synergies should be evaluated when designing policy and management response measures. Such evaluation would require identification and valuation of ecosystem services and disservices to assess the extent of tradeoffs at spatial and temporal scales, and information on institutional issues, access to markets, trade patterns, and other factors, including potential irreversible damage. There are examples of appropriate and sustainable agricultural management practices that can address the potential tradeoffs and increase food production while reducing the ecosystem disservices, and impacts on biodiversity and climate.

**Figure 4.2. Impacts of farm management and landscape management on the flow of ecosystem services and disservices to and from agroecosystems**




Source: Modified from Power 2010.

## *4.3 Environmental impacts of agriculture*

Agricultural systems are amended ecosystems with a variety of properties. **Agricultural intensification** can be technically defined as "an increase in agricultural production per unit of inputs (which may be labor, land, time, fertilizer, seed, feed, or cash). For practical purposes, intensification occurs when there is an increase in the total volume of agricultural production that results from a higher productivity of inputs, or agricultural production is maintained while certain inputs are decreased (such as by more effective delivery of smaller amounts of fertilizer, better targeting of plant or animal protection, and mixed or relay cropping on smaller fields)" (FAO 2004). Tradeoffs exist between ecosystem health and resilience and agriculture expansion and intensification.

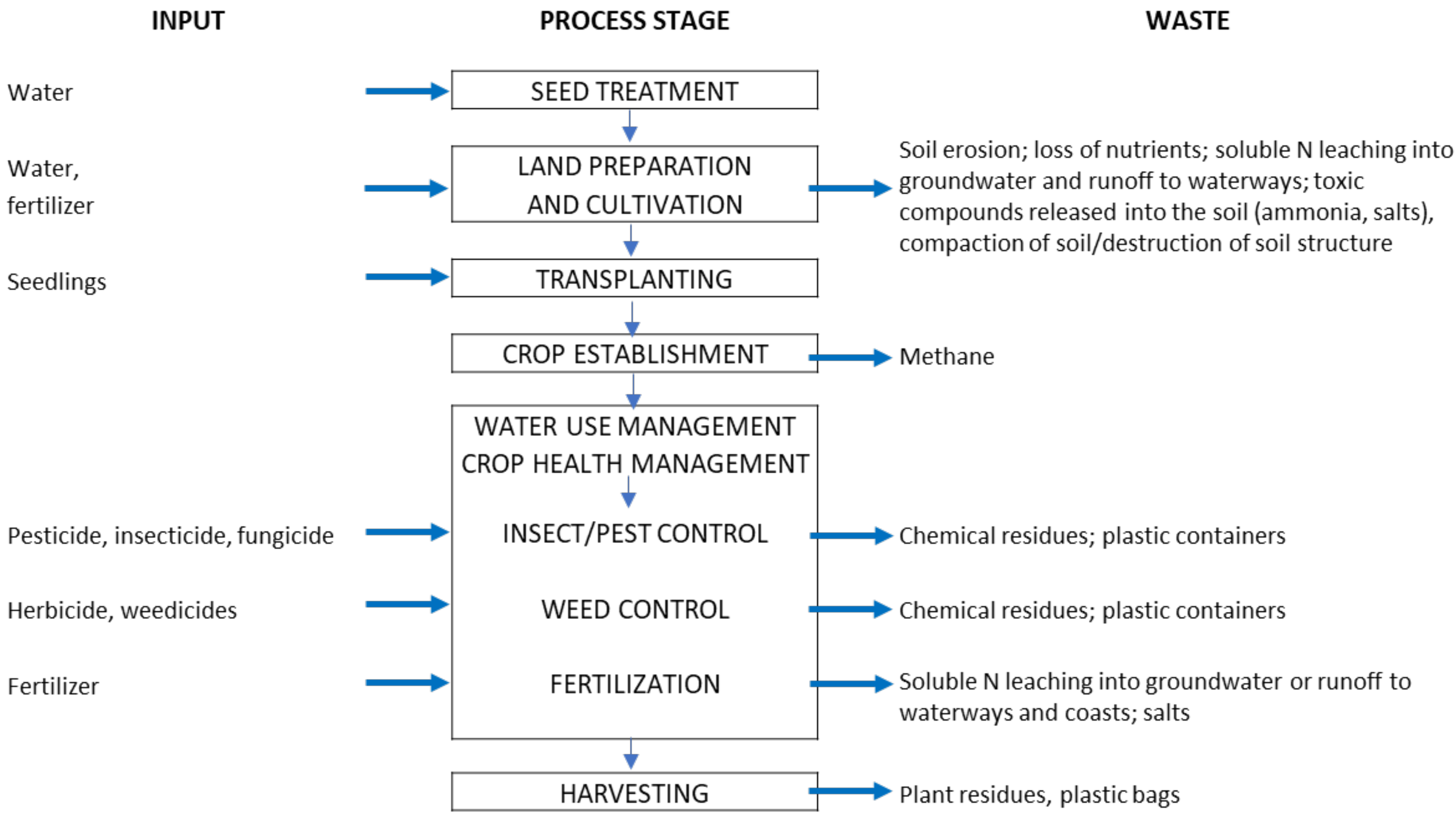
In the Philippines, intensification of cropping systems to optimize production of various major crops involve increased cropping frequency (2-3 crops per year for the annual crops), increased cropping intensity (more trees or plants per unit area), increased fertilizer application to boost growth and crop yield, increased pesticide application to control pests and diseases, irrigation systems to augment precipitation, adoption of technologies (new cultivars, hybrid varieties), and farm mechanization (Magcale-Macandog *et al*. 2016).

To meet a growing population's demands for food and agricultural products, agriculture will need to be further intensified. However, depending on management practices, intensive farming and livestock raising can result in ecosystem disservices and bring about food safety, equity, animal welfare, pollution, and biovdiversity issues. Damage to soil and water has repercussions on yield. Intensification efforts may lead to environmental degradation, such as depletion of soil nutrients; leaching of excess fertilizers into the environment; pesticide residues in crops, soil and water resources; volatilization of GHG into the air; soil erosion; sedimentation and eutrophication in adjacent water bodies (Magcale-Macandog *et al*. 2016).

In the lowlands, the continued use of unsustainable production practices, such as the extensive use of chemical inputs, have degraded the soil resource, and contributed to loading of nutrients and persistent organic pollutants (POPs) to waterways and coastal waters. **Figure 4.3** illustrates the wastes generated from rice production.

In the upland ecosystem, climatic drivers and human-induced activities have resulted, not only in land degradation, but also in the loss of biodiversity (BSWM, 2004).

**Figure 4.3. Wastes from rice production**




Previous decades saw the conversion of forests to farmlands and ranches. In the uplands, the expansion of grazing lands, slash-and-burn agriculture, and deforestation, especially in watershed areas, have resulted in land degradation (i.e., erosion and declining soil fertility) and problems of water quality and availability (due to siltation and sedimentation resulting from deforestation). In addition to erosion, soil quality is affected by other aspects of agriculture. These impacts include compaction, loss of soil structure, nutrient degradation, and soil salinity.

Deforestation is one of the major issues of the livestock industry. Farm animals require considerably more land than crops to produce a given amount of food energy.

Cattle pastures can cause soil erosion, siltation, and pollution of waterways and downstream coastal waters, contribute to the degradation of riparian ecosystems, soil and water resources, and produce GHG emissions.

According to FAO (2013), the global livestock industry produces 7.1 gigatons of $CO_2$-equivalent per year of all human-induced GHG emissions, which is 14.5 percent of all *global* anthropogenic GHG emissions. Cattle is responsible for 65 percent of the livestock emissions, while GHG emissions from pig and chicken supply chains are relatively low (FAO 2013; Gerber *et al*. 2013.

Pig and chicken waste contributes to pollution of soil, groundwater and waterways if not properly collected and treated before disposal. Waste from pig farms carry nutrients, pathogens, antibiotic-resistant bacteria, and heavy metals like copper and zinc, which are used in feeds to promote growth. Thus, proper waste disposal is crucial as copper and zinc can be toxic to plants and microorganisms in the soil, and the runoff with nutrients contributes to eutrophication in downstream water bodies.

In making policy decisions to achieve sustainable agricultural intensification, it is essential to identify and evaluate alternative strategies, in terms of both their immediate and longer-term environmental impacts, socioeconomic consequences, and their implications for all social groups concerned (FAO 2004). A better understanding of conservation of ecosystem services in agricultural food systems, integrated water resource management (IWRM), nutrient management, integrated pest management, GHG emission reduction, and air, water, and soil pollution management are needed for sustainable agriculture, and protection of livelihoods and health of people and ecosystems.

### 4.2.1 Soil erosion

Soil is the result of gradual weathering of plants, rock, and minerals. Its formation is a very slow process, taking millions of years, but half of the topsoil on the planet has been lost in the last 150 years. Soil erosion is the displacement of the upper layer of soil, also known as topsoil, which is rich and fertile because of its organic matter content. Plants and animals die, decay, and are incorporated into the soil. Fungi, bacteria, and other microorganisms in the topsoil break down organic matter and make the soil richer. The nutrients in topsoil are crucial, as they are the food of plants. Soil erosion affects the nutrient and carbon cycling processes, causing impacts on ecosystems as well as agricultural production. A farmer cannot get a good harvest from the land when the topsoil is eroded, unless expensive commercial fertilizers are used to replace the lost nutrients. Poor soil can make a farmer poor. While soil erosion is a natural process, numerous human activities are increasing the rate at which soil is being lost, such as deforestation, mining, and Unsustainable agricultural practices.

Many anthropogenic activities that are used in various cropping systems, such as intensive tillage, monoculture system, draining of wetlands, adaptation of heavy equipment in farming practices, and incorrect fertilization and pesticide use, are factors that cause soil degradation in agriculture. Grazing animals also expose soil to the elements. Over-grazed lands are one of the major causes of soil erosion.

Another cause of soil erosion is the tillage system used in preparing land for seeding and growing crops. One study showed that **intensive tillage** is associated with greater levels of topsoil loss, while no tillage can lead to a 60 percent reduction in soil loss and 56 percent reduction in sediment concentration compared to conventional tillage, although the potential for no tillage is greater in steep slopes, and not so much in clayey soils that are aggregated and less erodible (Mhazo, Chivenge and Chaplot 2016). Another study demonstrates the effectiveness of no-till systems, combined with an intensified crop rotation, in improving residue cover of the soil surface thereby increasing water infiltration into the soil, and decreasing runoff and soil erosion (Rust and Williams 2009). **Conservation tillage** involves either (a) minimum tillage, which is a tillage method that leaves 30 percent or more residue coverage after planting and involves the use of chisel plows or disks; and (b) no till, which leaves 50 percent or more ground cover because the soil surface is left undisturbed from harvest to planting and involves no more than one-fourth of the row width be disturbed (Rust and Williams 2009). Contour tillage also reduces runoff and sediment yield compared to conventional tillage. Various studies show that switching from conventional intensive tillage systems to conservation systems would result in greater water infiltration and reduced soil erosion due to increased crop residue coverage.

**Intensive rice monoculture**, that is, planting two to three crops of rice within a year, became the practice when irrigation facilities were developed, and continuous supply of water was made available to the farms. The downside of intensive cultivation is the rapid depletion of the soil fertility level and degradation of the paddy resource base, which resulted in the decline of rice yields in the 1980s despite the introduction of high-yield varieties, and increased fertilizer application rates during the Green Revolution (IRRI 1998; Magcale-Macandog *et al*. 2016).

### 4.3.2 Water pollution

***Biochemical oxygen demand*** (BOD). BOD determines the concentration of oxygen required for the decomposition of organic matter from a pollution source. A higher BOD value indicates a greater degree of organic pollution. Most aquatic organisms cannot survive if the BOD level is above 7 mg/L. In the Philippines, the agriculture sector contributes 45% of the total BOD loading from **point** sources, and 61% of BOD from **non-point** sources through agricultural run-off (DENR-EMB 2015).

***Nutrient loading***. Agriculture can contribute to nutrient pollution when fertilizer use, animal manure, and soil erosion are not managed responsibly.

***Siltation and sedimentation***. Soil erosion has led to loss of soil fertility, and increased pollution and sedimentation in streams and rivers, affecting water supply used for agriculture, domestic and industrial uses. Reduced quantity and quality of water affect aquatic life and cause changes in species composition, distribution, and abundance. Clogged waterways due to siltation also worsens flooding. Siltation and sedimentation also affect marine water quality, seagrass beds, seaweeds, and coral reefs.

The results of sediment monitoring and source identification In Manila Bay and pollution loading from Pampanga River, one of the main tributaries of the bay, show the contribution of agriculture (**Box 4.1**).

**Box 4.1 Monitoring and source identification**

a. **Sediment monitoring in Manila Bay** (PEMSEA 2006a; PNRI 2015)[20]

***Pesticides in sediments***. The pesticide levels in the sediment samples were all below the limit of detection. The detection of the environmental samples were limited to the following fifteen (15) organochlorine pesticides, namely: 4,4-DDD; 2,4-DDT; 4,4-DDE; 4,4-DDT; Aldrin; alpha-Endosulfan; alpha-HCH; beta-Endosulfan; beta-HCH; Dieldrin; Endosulfan sulfate; Endrin; gamma-HCH; Heptachlor; Heptachlor epoxide, and twelve (12) organophosphate pesticides, namely, Mevinphos, Dimethoate, Diazinon, Isazophos, Methyl Parathion, Chlorpyrifos Methyl, Fenitrothion, Malathion, Chlorpyrifos, Phenthoate, Profenofos and Triazophos to represent the major chemical classes. The limit of determination (LOD) for organophosphate and organochlorine is 0.005 mg/kg.

***Heavy metals***. Chromium levels were higher in stations 1, 2 and 3 (107-140 ppm) compared with the other stations (50-71 ppm). Copper levels ranged from 56 to 90 ppm. Zinc levels varied from 75 to 124 ppm, with stations 1, 2 and 6 exhibiting >100ppm level. Lead level ranged from 13-18 ppm. Sites 1, 2, and 3 (northern part of the bay, coastal areas of Bulacan and Pampanga) exceeded the Predicted No Effect Concentration (PNEC) values for chromium (based on the low limit of Hong Kong Interim Sediment Quality Value (ISQV)). For copper, all sites generally exceeded the PNEC, while the level of lead in all sites is acceptable. Nickel concentrations are all below the criteria values.

***Source identification***

The level of cesium-137 (Cs-137)[21] in Manila Bay ranges from 0.33 to 1.4 Becquerel per kg (Bq/kg) with an average value of 1.0 ± 0.3 Bq/kg. This is within the level of observed values in the Asia-Pacific Region of 1.4 Bq/kg dry. **Soil erosion from agricultural areas surrounding Manila Bay (Pampanga, Bulacan and Bataan) contributed to the relatively higher level of Cs-137 in the coastlines of these areas.** Cs-137 has been shown to be held immobile in soil particles such that Cs-137 can be a tracer for soil movement. Thus, the areas exhibiting relatively higher Cs-137 concentrations may be prone to contamination from agricultural inputs, such as nutrients and pesticides.

[20] From the report on the pilot activities of the Integrated Environmental Monitoring Plan of the Manila Bay Environmental Management Project (MBEMP), funded by GEF/UNDP/IMO Regional Programme on Partnerships in Environmental Management for the Seas of East Asia (PEMSEA). The Philippine Nuclear Research Institute (PNRI) conducted a follow up study in 2015 (unpublished).

[21] "Cs-137 is a fall-out radionuclide introduced into the atmosphere during the nuclear bomb testing conducted in the past. It can be an indicator of radioactive pollution from nuclear waste dumping in the bay, leakage of radioactive materials from nuclear powered vessels and any other nuclear accidents in the area. Coastal marine sediments, aside from atmospheric fallout, may have additional inputs from the transport of Cs-137 bearing soil from uplands to rivers and onto the coast. Thus Cs-137 values may also be used to pinpoint sites which are more likely to be contaminated with pesticides, sediments, and other land-based sources of pollutants." (PEMSEA, 2006).

The distribution of lead ($^{210}Pb$)[22] activity in the bay shows that areas with higher level of Cs-137 have lower level of Pb-210. In an ideal situation wherein, there is a constant rate of sediment accumulation and very low sediment reworking by physical or biological activities, the level of Pb-210 activity in the entire bay should nearly be constant. Thus, areas with lower level of Pb-210 activity may either be experiencing higher rate of sediment accumulation or higher physical/biological level of activity resulting in sediment mixing. This may be the case in the coastal areas of Pampanga, Bulacan and Bataan.

**b. Pampanga River** (BSWM 2013):

Pampanga River obtained a 'failed' rating, with values for some chemical and biological parameters exceeding the criteria, particularly nitrates, phosphorus and coliform.

Around 0.8 km from the river mouth, the water draining into Manila Bay passed the criteria for pH, DO and TSS, but contained nitrates and phosphates beyond the allowable levels set by DAO 90-34 and ASEAN marine water quality criteria. Values of fecal coliform exceeded the safe level of 200 MPN/100ml during the dry season. Concentrations of heavy metals near the bay were within the criteria, although high concentrations were observed in some sites in the upstream of the Pampanga River basin.

Daily and annual loading of nitrates into the water at different sampling sites were monitored along the Pampanga River. About 8.9 km from Manila Bay (Barangay Sagrada, Masantol, Pampanga), the annual nitrate loading was estimated at 2,849 metric tons, exceeding the allowable loading for Class SB water based on the ASEAN water quality criteria. The top five major contributors of nitrate loading were from the following locations:

- Apalit, Pampanga (Site 16)
- Arayat, Pampanga (Site 10)
- Jaen, Nueva Ecija (Site 6)
- San Isidro, Nueva Ecija (Site 7)
- Mayapyap, Cabanatuan City, Nueva Ecija (Site 4)

The phosphorus concentrations near the river mouth were 0.67 and 0.09 ppm during the wet and dry seasons, respectively. This shows that the ASEAN marine water quality criterion of 0.015 mg/L for organophosphate has been exceeded. Concentration of more than 0.02 ppm would accelerate algal growth (Bloom, n.d.). Total phosphorus loading into Manila Bay was estimated at 358 tonnes, which is also above the criteria. The leading contributors were from the following locations:

- Apalit, Pampanga (Site 16)
- San Luis, Pampanga (Site 12)
- San Pedro, Sasmuan, Pampanga (Site 25)

***Source identification.*** The pollution of Manila Bay is associated with loadings from agriculture, industry, and services sectors. Nuclear analytical techniques are tools that could identify the sources or origins of nutrient loading and contributions through spectral signature. The use of multiple stable isotopes was applied in the study conducted

[22] Lead-210 ($^{210}Pb$) is a radionuclide produced from the decay of naturally-occurring uranium-238. It is a useful tracer for sediment mixing processes and sediment flux in the area (PEMSEA 2006a).

by BSWM in 2012-2013. The analysis obtained from dual isotope approach yielded the following signatures for the different sources:

- Livestock and fishery → inorganic fertilizer
- Croplands → soil N
- Domestic → soil N and sewage/septage
- Non-point sources: mixing of cropland and domestic sources of N

Using the two-tracer isotope mixing model, the relative contribution of these activities to the total nutrient load from the Pampanga River basin was assessed. Cropland sources contributed the most to pollutant loading during the wet season (22% to 98%) while domestic waste has higher contribution during the dry season (55% to 65%).

***Terrestrial and marine contribution to pollution loading.*** Carbon I stable isotope ratios in surface sediments served as proxy of land use change in the Pampanga River basin, and in combination with C/N concentrations provided an insight on how terrestrial anthropogenic sources affect and contribute to the nutrient loading in Manila Bay. Using the mixing model, terrestrial contribution from the different sources is as follows: cropland: 27%-100%; forestry: 12%; livestock: 37%-93%; and fisheries: 55%-79%. The relative contribution of these terrestrial inputs into Manila Bay was estimated from the isotopic composition of the offshore sediments. The model showed that 17%-30% of the organic matter deposited in Manila Bay came from terrestrial activities, mainly agriculture, in the Pampanga River basin.

Source: PEMSEA 2006; PNRI 2015; BSWM 2013.

### 4.3.3 Greenhouse gas emissions

The agriculture of the future will need to diminish its own GHG emissions if we are to be successful in controlling climate change. Although the biggest source of GHG emissions is from use of fossil fuels (by power plants and transport sector), agriculture is also a big contributor. Next to the energy sector, which contributes 55 percent of the total GHG emissions in the Philippines, the agriculture sector is the second major source, contributing 29 percent in 2012 (Magcale-Macandog *et al*. 2016; Calub *et al* 2016). In 2018, 29 percent of GHG emissions was from the energy sector (electricity and heat), followed by the agriculture sector, with 26 percent share (**Figure 4.4**). GHG emissions in the agriculture sector are due to:

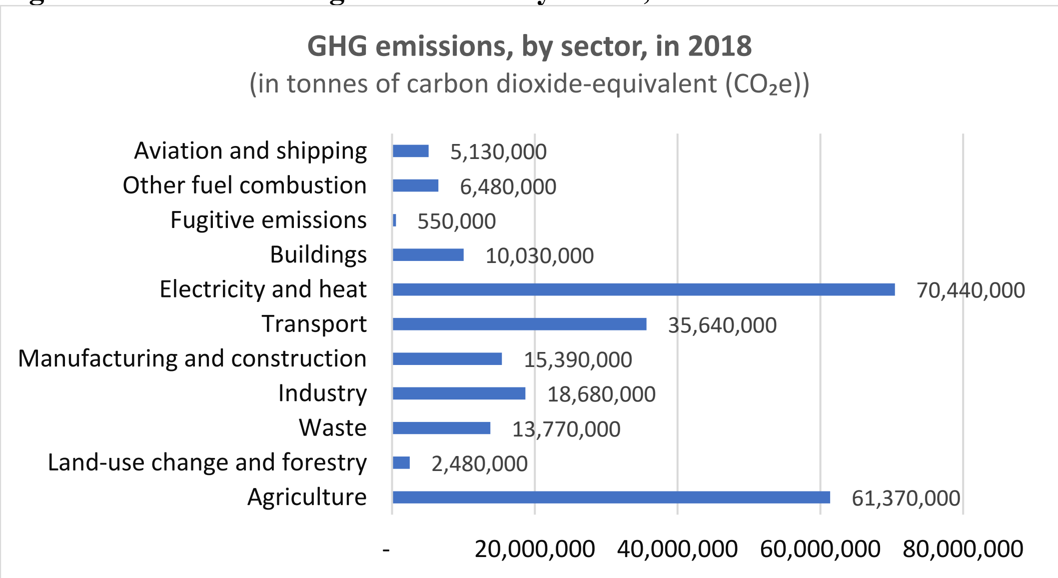
- Methane ($CH_4$) gas emitted by growing rice plants in irrigated paddy fields and enteric fermentation of livestock animals
- Nitrous oxide ($N_2O$) emissions from inorganic fertilizer application, crop residues, and manure
- $CH_4$ and $N_2O$ gases emitted by burning crop residues, and on-farm energy use.

In 2000, rice cultivation contributed 64 percent – the biggest share – of the national GHG emissions. Livestock is also a major contributor, with emissions from enteric fermentation accounting for 16 percent, and manure management and manure left on pasture contributing six percent, and three percent, respectively (**Figure 4.5**). In 2019, the share of rice cultivation in the $CO_2$-e emissions increased to 66 percent while the share of enteric fermentation decreased to 13 percent. The total $CO_2$-e emissions from the Philippine agricultural sector increased by 12 percent between 2000 and 2019 (FAOSTAT 2021).

The production of rice in flooded paddies produces methane because the water blocks oxygen from penetrating the soil, and this anaerobic condition is conducive for growth of bacteria that produce methane (Adhya *et al*. 2014; Jain *et al*. 2004).

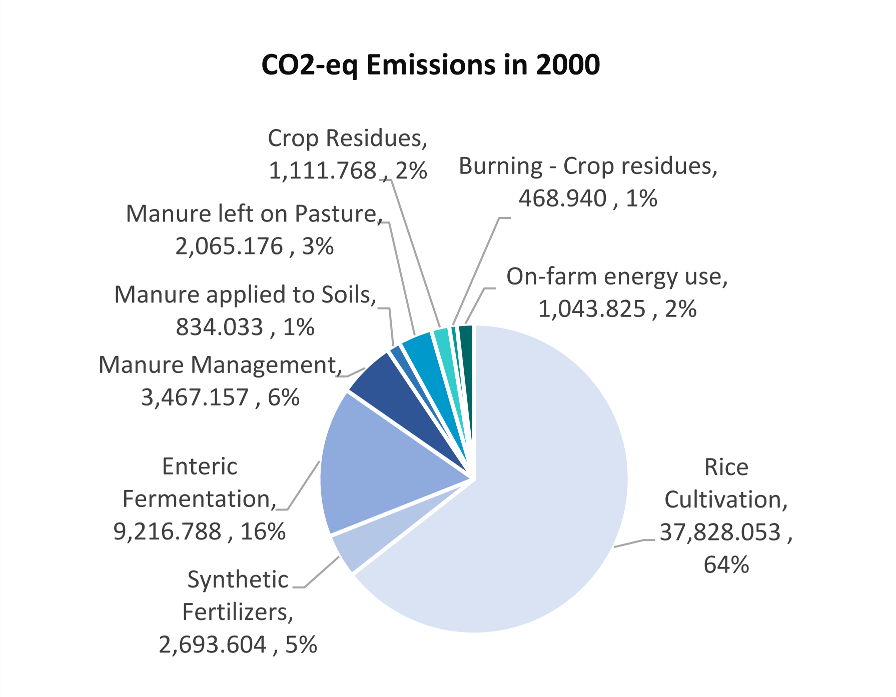
Land use changes also cause the introduction of GHG emissions to the atmosphere. The slash-and-burn technique of deforestation to clear the uplands for farming contribute to significant volumes of $CO_2$ emissions. The destruction of mangroves (due to conversion to aquaculture farms and other developments) and seagrass beds releases the carbon sequestered and stored by mangroves and seagrass in their biomass, roots, and underlying sediments.

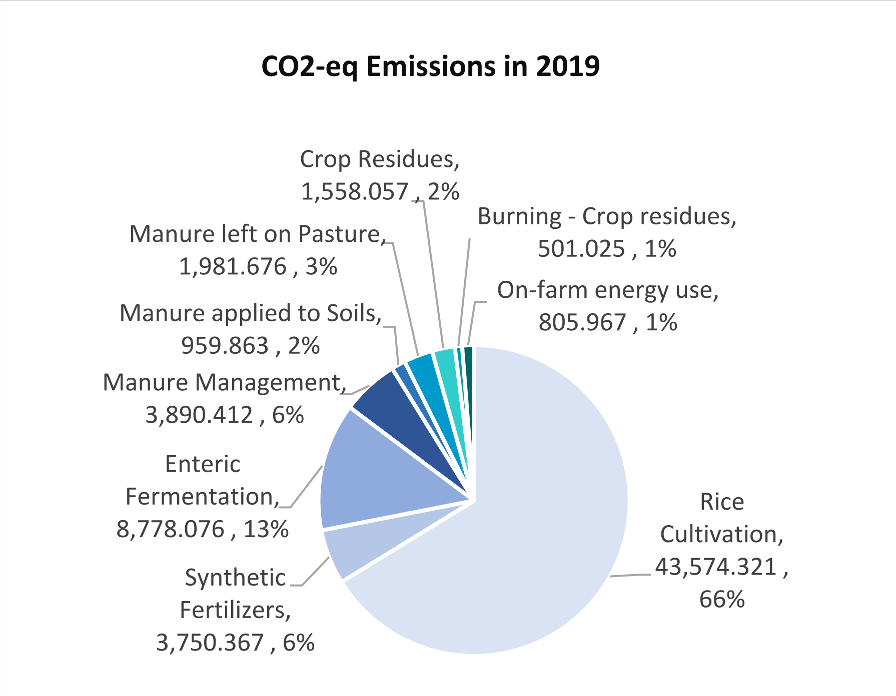
**Figure 4.4: Greenhouse gas emissions by sector, in 2018**




Source of data: Ritcher and Roser 2020.

**Figure 4.5: Greenhouse Gas Emissions from Agricultural Sector, 2000 and 2019**




Source of data: FAOSTAT 2021.

*GHG emissions from livestock*

Methane and nitrous oxide are the major GHGs emitted from livestock production. **Box 4.2** provides key facts and figures on GHG emissions by livestock. In 2000, GHG emissions due to enteric fermentation and manure management contributed 30 percent of the total GHG emissions from the Philippine agricultural sector, while in 2012, enteric fermentation, manure management, manure applied in soils, and manure left on pasture accounted for 26 percent (**Figure 4.5**).

**Box 4.2. By the numbers: GHG emissions by livestock**

The following information is from FAO (2013) – Key Facts and Findings:

- Total emissions from global livestock: 7.1 Gigatonnes (Gt) of $CO_2$-equivalent per year, representing 14.5 percent of all anthropogenic GHG emissions.
- Cattle (raised for both beef and milk, as well as for inedible outputs like manure and draft power) are the animal species responsible for the most emissions, representing about 65 percent of the livestock sector's emissions.
- In terms of activities, feed production and processing (this includes land use change) and enteric fermentation from ruminants are the two main sources of emissions, representing 45 and 39 percent of total emissions, respectively. Manure storage and processing represent 10 percent. The remainder is attributable to the processing and transportation of animal products.
- Cutting across all activities and all species, the consumption of fossil fuel along supply chains accounts for about 20 percent of the livestock sector's emissions.
- On a commodity-basis, beef and cattle milk are responsible for the most emissions, respectively, contributing 41 percent and 20 percent of the sector's overall GHG outputs. (This figure excludes emissions from cow manure and cattle used as draught power).
- They are followed by pig meat, (9 percent of emissions), buffalo milk and meat (8 percent), chicken meat and eggs (8 percent), and small ruminant milk and meat (6 percent). The remaining emissions are sourced to other poultry species and non-edible products.
- Emission intensities (i.e., emissions per unit of product) vary by commodity type. They are highest for beef (almost 300 kg $CO_2$-eq per kilogram of protein produced), followed by meat and milk from small ruminants (165 and 112kg $CO_2$-eq.kg respectively). Cow milk, chicken products, and pork have lower global average emission intensities (below 100 $CO_2$-eq/kg.)
- Enteric emissions and feed production (including manure deposition on pasture) dominate emissions from ruminant production. In pig supply chains, the bulk of emissions are related to the feed supply and manure storage in processing, while feed supply represents the bulk of emissions in poultry production, followed by energy consumption.
- About 44 percent of livestock emissions are in the form of methane. The remaining part is almost equally shared between nitrous oxide (29 percent) and carbon dioxide (27 percent). This means that livestock supply chains emit:
  - → 7.1 Gt $CO_2$-eq of $CO_2$ per annum, or 5 percent of anthropogenic $CO_2$ emissions (IPCC 2007)
  - → 3.1 Gt $CO_2$-eq of $CH_4$ per annum, or 44 percent of anthropogenic $CH_4$ emissions (IPCC 2007)
  - → 2 Gt $CO_2$-eq of $N_2O$ per annum, or 53 percent of anthropogenic N2O emissions (IPCC 2007)

- Improved manure management, adoption of energy efficient technologies, sourcing of low carbon energy, and upgrading of feed, health and animal management in commercial systems can reduce emissions of pig production by 28 to 36 percent in **East and Southeast Asia**.
- Key policy areas for action: extension and agricultural support services; research and development on mitigation interventions, technologies and practices; financial incentives; advocacy; development of Nationally Appropriate Mitigation Actions for livestock

Source: FAO 2013; Gerber *et al*. 2013.

### 4.3.4 Open field burning

Biomass and crop residues that are left on the field to decompose, and those that are burned both contribute to GHG emissions (**Figure 4.5**).

In the Philippines, farmers turn to open-field burning to drive away pests and to avoid the labor-intensive, manual gathering of rice straw, although this is prohibited under the Clean Air Act of 1999 (RA 8749) and Ecological Solid Waste Management Act of 2000 (RA 9003). Open-field burning causes the emission of toxic greenhouse gases – methane ($CH_4$) and nitrogen oxide ($NO_2$).

Although the burning of agricultural waste (crop residues) contributes only one percent of GHG emissions from the agriculture sector in 2000 and 2019 (**Figure 4.5**), this practice however damages the soil. Open-field burning results in up to 100% nitrogen (N) loss, 25% phosphorous (P) loss, 20% potassium (K) loss, and 5–60% sulphur (S) loss (Migo-Sumagang *et al*. 2020; Romasanta *et al*. 2017). With each successive burn, soils lose more nutrients – not only nitrogen (N) and phosphorus (P), but also carbon – increasing the need for more fertilizers, which can again increase GHG emissions.

There are also health impacts resulting from the burning of agricultural waste. Open burning is the fourth largest source of black carbon after energy, transport, and industrial production. Black carbon is the component of particulate matter (PM). PM is a common proxy indicator for air pollution. There are epidemiological studies linking $PM_{10}$ (particulate matter less than or equal to 10 µm or microns in diameter) to chronic bronchitis (Hooper *et al*. 2018; Sung *et al*. 2020; Medina-Ramón *et al*. 2006; MacNee and Donaldson 2003) while $PM_{2.5}$ (particulate matter less than or equal to 2.5 µm in diameter) increases the risk of heart and lung diseases, stroke, and some cancer (WHO 2021). In children, $PM_{2.5}$ causes psychological and behavioral problems, while in older people, it causes dementia, Alzheimer's, and Parkinson's diseases (WHO 2021).

Instead of burning agricultural waste, there are alternative uses for them, which can also generate additional income. Composting, biochar production, and mechanization are a few effective sustainable techniques that can help to curtail the crop residue burning while retaining the nutrients present in the crop residue in the soil.

### 4.3.5 Agricultural plastic waste

Ocean litter has been making the headlines, but plastic pollution is also pervasive in our agricultural soils. According to FAO (2021b), the land we use to grow our food is contaminated with far larger quantities of plastic pollution, posing an even greater threat to food security, people's health, and the environment. The main types of agricultural plastics are surface mulching films, pesticide and fertilizer containers, plastic bags, plant pots, polymer-coated controlled release fertilizers, and crates for harvesting. The FAO report identifies several solutions based on the 6R model (Refuse, Redesign, Reduce, Reuse, Recycle, and Recover). Agricultural plastic products identified as having a high potential for environmental harm include non-biodegradable polymer coated fertilizers and mulching films, and these should be targeted as a matter of priority. Open burning of agricultural plastic waste should be avoided due to its potential generation of GHGs, POPs, and other harmful emissions. The report also recommends developing a comprehensive voluntary *code of conduct* to cover all aspects of plastics throughout the agri-food value chains and calls for more research, especially on the health impact of micro- and nanoplastics.

## *4.4 Pressures and issues affecting agriculture*

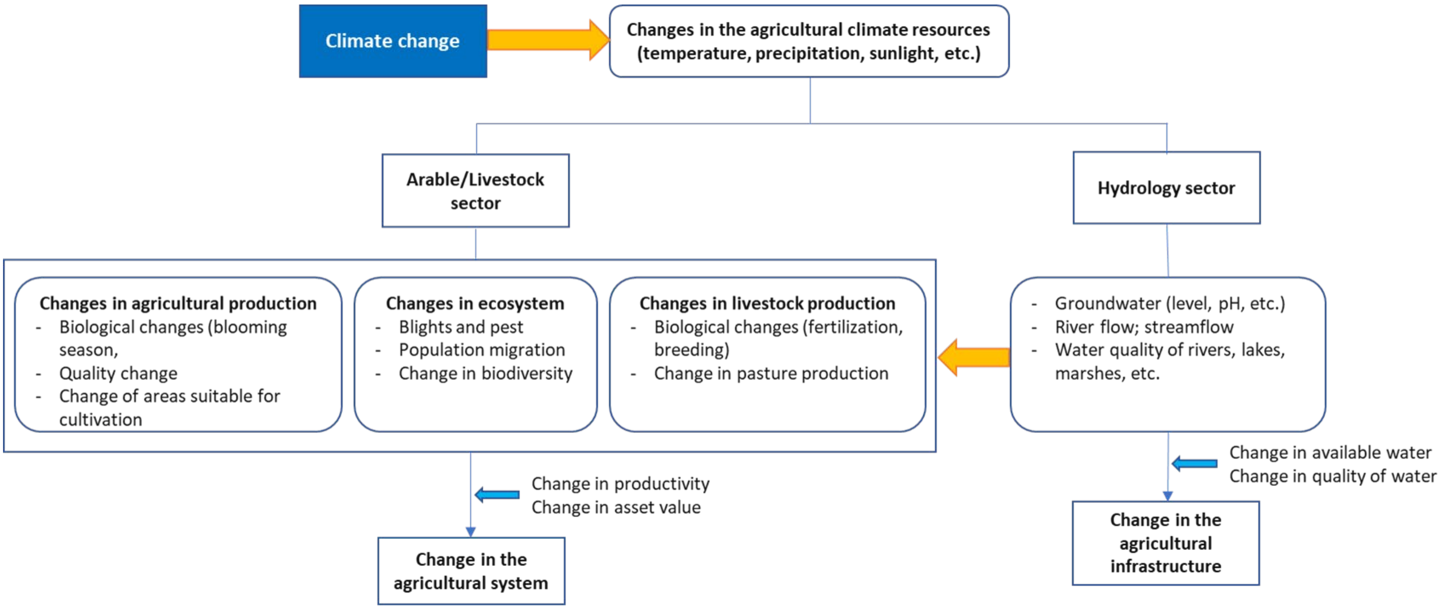
Of the country's total land area, 5.2 million ha (about 17 percent) are severely eroded, and another 8.34 million ha (27.3 percent) are vulnerable to drought, alternating with floods and typhoons, annually (Philippine Development Plan, 2011-2016; AFMP, 2011-2016).

### 4.4.1 Climate change and natural disasters

Agricultural production is climate-dependent since it is carried out through the selection of crops and farming methods suitable for the climate of a specific region .

Agriculture is a major source of GHG emissions, which contribute to the greenhouse effect and global warming, but the changing climate is affecting agricultural production, which is likely to impact food security in the future. Global warming increases the intensity of typhoons, and frequency of typhoons, extreme monsoon rainfall, floods, droughts, and heat waves. Typhoons, flooding, and droughts disrupt crop production and cause extensive damage to agricultural areas. Extreme temperatures and heat waves can cause heat stress in both animals and plants. "Quantity and quality of crops are reduced due to the reduced growth period following high levels of temperature rise; reduced sugar content, bad coloration, and reduced storage stability in fruits; increase of weeds, blights, and harmful insects in agricultural crops; reduced land fertility due to the accelerated decomposition of organic substances; and increased soil erosion due the increased rainfall" (Kim, *et al*. 2009, p.11). **Figure 4.6** shows the pathways of climate change impacts on agricultural system and infrastructure.

**Figure 4.6. Climate Change Impact on the Agricultural Sector**




Source: Kim, *et al*. 2009.

Natural hazards are severe or extreme events, such as a flood, storm, or heatwave, which are natural phenomena. These hazards only become disasters when human lives are lost, and livelihoods, physical assets, infrastructure, and environment are damaged or destroyed. Disaster is defined as “a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.” (United Nations Office for Disaster Risk Reduction, n.d.; United Nations International Strategy for Disaster Reduction 2009).

The Centre for Research on the Epidemiology of Disasters (CRED) recorded 187 significant damaging natural disasters in the Philippines in 2007-2016, causing the death of 16,262 people injury to 168,114 persons, affected more than 100 million individuals, and resulted in socio-economic damages estimated at USD19.16 billion.[23] According to the Climate Change Commission (CCC), from 1990 to 2006, the estimated cost of damages to agriculture and fisheries, on average annually, is around PHP12.43 billion, of which 70.3 percent was caused by typhoons, 17.9 percent by droughts, and 5 percent by floods (PEMSEA and DENR 2019).
From 2010 to 2016, the cost of damage due to natural extreme events and disasters amounted to PHP 463 billion (USD9 billion), and 62.7 percent of this value comprised damage to agriculture (PSA 2020b). The damages to agriculture are mainly caused by hydrological disasters like flooding, meteorological disasters due to tropical cyclones and extreme monsoon rainfall, and climatological disasters due to El Niño and droughts.
Records of the cost of flooding have also been increasing in recent years as typhoons and monsoon rains become stronger and more devastating due to climate change (e.g., Typhoon Haiyan or Yolanda, Ondoy, etc.). Unplanned urbanization, inadequate infrastructure, pollution, deforestation, and habitat destruction aggravate the flooding problem.

[23] CRED (cited in Senate Economic Planning Office, 2017. Policy Brief: Examining the Philippines Disaster Risk Reduction and Management System.)

The El Niño phenomenon in 2015-2016 lasted for 18 months (February 2015 to July 2016) and affected both agriculture and fisheries. FAO (2017) reported the following impacts on agriculture[24]:

- USD 325 million worth of damage and total production losses in crops
- 1.48 million tonnes of crops lost, including rice, corn, cassava, and high value crops, such as banana and rubber
- 413,456 affected farming households, in need of support to recommence farming activities in the next cropping season
- 16 of the country's 18 regions were affected, with the strongest impact on 27 provinces in Mindanao.

It is therefore crucial for the government to work with the scientific community in climate modeling and monitoring of the onset of El Niño and La Niña as well as increase collaboration with stakeholders in planning for early response, shifting to climate-smart agriculture, and implementing adaptation measures.

It is also important to recognize the role of soils in climate change mitigation. **Soils constitute the biggest terrestrial carbon sink on the planet** and hold huge power to mitigate non-$CO_2$ GHG emissions (FAO *et al*. 2020). Sustainable soil management can stop the release of carbon stored in the soils.

### 4.2.2 Soil degradation

Soil is an extremely complex ecosystem and a highly valuable resource due to its many crucial functions, such as: (a) provision of food, fiber, and fuel; (b) decomposition of organic matter (e.g., dead plant and animal material); (c) recycling of essential nutrients; (d) detoxification of organic contaminants; (e) carbon sequestration; (f) regulation of water quality and supply; (g) habitat provision for myriad of animals and microorganisms (soil is an important biodiversity reservoir); and (h) source of raw materials (clay, sand, gravel) (Yang, Siddique and Liu 2020). Soil was formed at a geological scale (over millions of years), but unfortunately, soil has been and is currently being rapidly degraded at a human temporal scale (i.e., soil loss and degradation are not recoverable within a human lifespan). Soil is an important resource that is being lost due to the range of anthropic activities, with associated adverse effects on human and ecosystem health.

The health of soil is a primary concern to farmers whose livelihoods depend on it and well managed agriculture and water resources. The goal of soil health maintenance is to ensure long-term stable high productivity and environmental sustainability of cropping systems in terms of five essential functions: nutrient cycling, water relations, biodiversity and habitat, filtering and buffering, and physical stability and support (Hatfield *et al*. 2017).

Soil erosion is also a form of soil degradation. Erosion leads to a reduction in organic matter and nutrients from the land, and subsequently to a decline in crop production, unless nutrients are replaced in the soil. Severe soil erosion removes the potential energy source for soil microbes, resulting in the death of the microbial population, and the loss of ecosystem services provided by the soil. In the Philippines, erosion rates are very high for overgrazed lands and

[24] FAO's source of data: Department of Agriculture (DA), Report on Damage Caused by El Niño, July 2016.

lands used for shifting cultivation with no conservation measures in place (**Table 4.3**), and grassland/pastureland (**Table 4.4**).

**Table 4.3. Erosion rates by land use (1994)**

| Land use | Erosion rates (tonnes/ha/year) |
|---|---|
| Undisturbed forest | 0.1 – 0.4 |
| Second growth forest | 1 – 7 |
| Rice paddies | 0.2 – 10 |
| Plantations (depending on age and species) | 2.4 – 75 |
| Grasslands | 1.5 – 3 |
| Overgrazed lands | 90 – 270 |
| Shifting cultivation (no conservation measures) | 90 – 240 |
| Annual cash crops (uplands) | 30 – 180 |

Source: ENRAP-II Main Report (1994); Francisco 1994.

**Table 4.4. Erosion rates by land use (1991)**

| Land use | Average soil loss (tonnes/ha/year) |
|---|---|
| Grassland/pastureland | 267.8 |
| Upland agriculture | 112.8 |
| Open grassland | 79.6 |
| Fruit trees | 22.1 |
| Trees, shrubs, grass | 12.5 |
| Secondary forest | 3.0 |
| Paddy rice, irrigated | 2.3 |
| Gmelina, ipil-ipil, coffee | 1.0 |

Source: IRG, Edgevale Associates and MADECOR 1991.

The following are the major causes of soil erosion (WWF 2020b; Borrelli *et al*. 2013; Moore 2021):

- **Deforestation.** Extensively cutting forest trees without replanting exposes the land to wind and heavy rains, and the topsoil can be easily displaced. Deforestation combined with improper farming of fragile, sloping lands cause soil erosion. Undisturbed forests have the lowest erosion rate (**Table 4.3**).
- **Mining.** By its nature, mining requires the excavation and removal of earth to extract mineral resources below the surface. Mining also removes the trees that are essential to maintaining the soil. In the process, landscapes are destroyed. Removal of soil and trees and excavation contribute to soil erosion.
- **Unsustainable agricultural practices**. Expansion and intensification of farming in the uplands, more often with unsustainable practices, hasten soil erosion.
- **Overgrazing.** This can harm soil microbes and result in reduced ground cover, and loss of topsoil and nutrients.
- **Climate change**. Rising global temperatures are resulting in increased rainfall and more severe storms, which can wash away the topsoil.

There are contributing factors, such as**:**

- **Migration from lowlands to uplands.** Due to the absence of alternative sources of employment in the lowlands, landless agricultural people are compelled to cultivate the highly erodible uplands in order to survive. Soil erosion is not only caused by poverty; it also contributes to poverty.

- **Land tenure**. Since most farmers do not own the land, there is no motivating factor to implement any land improvements and soil conservation practices.
- **Mismanagement of upland resources**. Because of the government's inadequate capacity in managing upland resources, people view upland resources as available on a 'first come, first served' basis. Weak administrative capability to monitor activities and enforce laws, lack of coordinating mechanism among concerned government agencies and LGUs, and lack of resources hamper inter-agency cooperation.
- **Road construction and real estate development**. An increasing number of housing developments is taking place in the uplands adjacent to urban areas.

**Cost of soil degradation**

The study by Cruz *et al.* (1988) reported that in the Magat watershed, where sheet erosion was in the order of 88 tonnes/ha/yr., the fertilizer equivalent of nutrients loss through soil erosion was PHP15/tonne or PHP1,320/ha/yr. For the Pantabangan watershed, the on-site cost of soil erosion (using 1977 prices) was about PHP7/tonne from the topsoil layers to about PHP4/tonne for the lower soil layers. The study also estimated the offsite cost of soil erosion. For Magat, the loss was estimated at PHP18/tonne of sediment while it was PHP30/tonne for Pantabangan watershed.

There are also offsite costs of soil erosion, such as siltation and sedimentation of reservoirs, irrigation canals, rivers and waterways, and coastal and marine habitats.

#### 4.2.3 Inadequate water supply

The most common water supply problem is water shortage during the dry season. Siltation and sedimentation in water supply systems (e.g., reservoirs and irrigation canals) aggravate the problem. Meanwhile, flooding during the wet season also reduces cropping intensity. There are also issues on wasteful irrigation practices.

***Siltation***

The downstream economic impact of erosion centers on the siltation and sedimentation, which reduces the potential water supply benefits of irrigation canals, and multi-purpose benefits (e.g., water supply, hydroelectricity, flood control) of water reservoirs.

Although erosion rates have been considered in the design of water reservoirs, a higher erosion rate caused by deforestation and/or mining in the upstream of the reservoirs results in higher siltation rates, which can lead to the shortening of the lifespan of these reservoirs, necessitating rehabilitation plans and additional costs. For example, the Magat Dam was constructed to last for 50 years, but the siltation and sedimentation in the reservoir resulted in reduced lifespan and productivity and damage cost (Francisco 1994; Ebarvia 1994), necessitating rehabilitation. Under the *Electric Power Industry Reform Act* (EPIRA), the hydroelectric power plant component of the multi-purpose dam was privatized and thereafter rehabilitated by the private company that won the bid (SN-Aboitiz Power Group 2016).

Water quality is an often-neglected issue in irrigation. Irrigation canals are also affected by siltation, which causes flow capacity reduction and poor water delivery. According to Clemente *et al*. (2021):

- The primary source of siltation is the rivers that supply water for the irrigation systems. Excessive siltation of the dams and canals was observed in Ambayoan-Dipalo River Irrigation System (RIS), Nueva Era RIS, TASMORIS, Caguray RIS, Jalaur-Suague RIS, Padada RIS, M'lang RIS, and Manupali RIS.
- Mapping of erosion maps of NIS watersheds reveals that most of the uplands of the downstream service areas have moderate to severe erosion.
- Siltation is also part of the headwork problems of all pump irrigation systems (PIS) covered in the study, including the Bonga Pump #2, Banaoang, Libmanan-Cabusao, Solana, and Magapit. Siltation could not be minimized in these systems because all of them were drawing water from major rivers (e.g., Cagayan River for Solana and Magapit PIS, and Libmanan River for Libmanan-Cabusao PIS), which were already heavily silted.

Many communal irrigation systems (CIS) were rated by their irrigation associations (Ias) as being heavily silted. The Ias from Pangasinan, Camarines Sur, Bohol, North Cotabato, South Cotabato, and Bukidnon rated their silt level as high (Luyun and Elazegui 2021).

The most effective way to control erosion and siltation is to maintain a permanent surface cover on the soil surface, protect forests, ensure sustainable agricultural practices, and regularly maintain irrigation systems. DENR-FMB has identified the critical watersheds that support the irrigation systems, and where efforts on forest protection and soil erosion mitigation should be focused on (**Table 4.5**). Hydrologists are also crucial in monitoring water availability and managing the water resource systems. Streamflow records are available for several stations along major rivers from the Bureau of Research and Standards (BRS) of the DPWH, which also operate gauging stations for its flood control management program.

**Table 4.5. Priority critical watersheds supporting national irrigation system (NIS) in 2020**

| | |
|---|---|
| Number | 131 |
| Area (ha) | 14,220,828.67 |

Source: DENR-FMB 2020. Philippine Forestry Statistics 2020.

### *Multiple resource use conflicts*

Increasing population and economic expansion are giving rise to water security issues and conflicts over the rights to access water resources (**Box 4.3**). Constraints on the availability of water supplies should lead to more focus on protecting water resources, improving water use efficiency, eliminating wasteful uses of water, and rationalizing water allocation. While we can usually identify solutions to water security challenges, "they are often difficult to implement for a number of reasons, including political and economic trade-offs inherent in the proposed solutions, problems associated with collective action, such as the issue of *free riders* who use services without paying for them, scarce financial resources and/or technical capacity, social or cultural barriers, and widespread and entrenched corruption" (Iceland 2020).

**Box 4.3. Multiple use conflicts and water rights**

It is important to note that the absence of clearly-defined property (water) rights has been identified as a major factor in the failure of sustainable watershed development, as it discourages smallholders to adopt conservation practices, such as contour farming and invest in land improvements, such as planting trees (Reddy *et al*. 2007; Swallow *et al*. 2001). In the Philippines, many cases of water competition and conflict have been reported. Piñon *et al*. (2010) discussed the following issues on multiple water uses, water allocation, and rights:

One case is the reallocation of upstream water use from agriculture to municipal or domestic use in San Pablo City, Laguna. This change in allocation of water triggered the conflict between the users as it resulted in the reduction of available water for irrigation, and hence, the number of annual cropping cycle for rice (Ordoñez 2010).

Another case is Laguna de Bay, where its environmental and economic significance has made it a source of conflict over property rights and open access (capture fishing versus aquaculture), multiple uses (fisheries, hydropower, water supply), and externalities in resource utilization (Nepomuceno 2004). Discharges of untreated wastewater from domestic and industrial sources and agricultural runoff have affected the water quality of the lake, and this has consequent effects on fisheries and cost of treatment of water used by the water concessionaires.

Other water disputes include arguments over the compensation for changing water allocations in the multi-purpose Angat Dam.

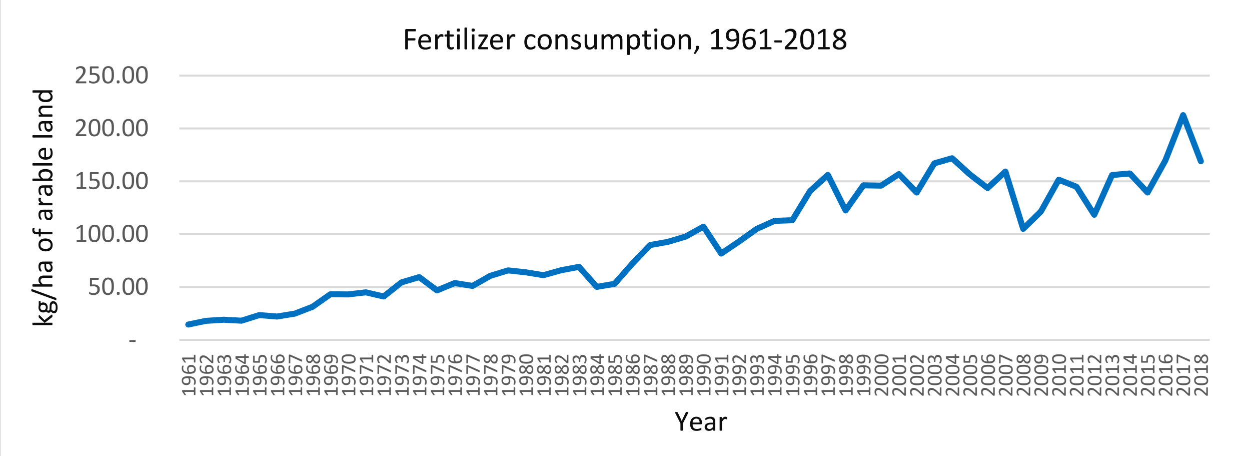
Similarly, conflicts often arise between indigenous peoples (IPs) and other users since large portions of watersheds are commonly claimed by IPs as ancestral domains. In the Philippines, two major national laws define water use and control rights: (a) Water Code (Presidential Decree or P.D. 1067) on statutory rights, and (b) Indigenous People Rights Act (IPRA – RA 8371) for customary rights. However, these laws have often created conflict (Ramazzotti 2008; Kho and Agsaoay-Saño 2005). The Water Code grants water rights as a privilege to allocate and use water, while customary rights, recognized under IPRA, do not acknowledge private ownership but assume traditional collective ownership: water cannot be privately owned, sold, or leased. This difference in principles and perspectives has led to conflict between the government, IPs, and other water users. The proliferation of agribusiness of multi-national companies in watershed areas often poses conflict with local residents and IPs. Water can thus be both a rights issue and a resource use issue, and both are central to water resource management.

Source: Piñon *et al*. 2010.

### 4.4.4 Fertilizer use

From 1961, the national consumption of fertilizers increased continuously from 14.53 kg/ha of arable land in 1961 to 169 kg/ha in 2018 (**Figure 4.7**). However, evidence suggests that farmers are under-applying fertilizer (Briones 2014). Cultivators continue to apply sub-optimal amounts of fertilizer, whether for the main nutrients (nitrogen, phosphorus, and potassium) as well as for micronutrients (Mamaril *et al*. 2009; Briones 2014). In Southeast Asia, the Philippines has relatively low application of N, P, and K for rice, but relatively high application rates of N for corn and sugarcane (Magcale-Macandog *et al*. 2016).

**Figure 4.7. Fertilizer consumption, 1961-2018** (kg/ha of arable land)




Source: World Bank 2021.

***Environmental impact***

Chemical fertilizers have been used to supplement nutrient needs and increase crop production since the 1930s. However, there are also several harmful effects of chemical fertilizers. These include waterway pollution caused by runoff of the excess fertilizer; chemical burn to crops; release of GHGs, such as $CO_2$ and $N_2O$ into the atmosphere; acidification of the soil; mineral depletion of the soil; damage to topsoil due to excessive nitrogen applied to fields.

#### 4.4.5 Multiple land use conflicts

Agricultural intensification may not be sufficient to meet various demands of a growing population with increasing income (Sayer *et al.* 2013). Demands for nonfood land-based commodities, including biofuels, vegetable oils, forage, pharmaceuticals, fiber, and wood products will also compete for space with food crops and livestock. Agricultural landscapes are no longer just farmed entities: they are now recognized as providing multiple values and services to diverse interest groups (Van Ittersum *et al*. 2008). Environmental outcomes can be driven by the intensification of land use and the expansion of agricultural land for both food and non-food purposes. Competing demands on land for agriculture, real estate and commercial development, mining, ecosystem and biodiversity conservation, and climate change mitigation (e.g., Reducing Emissions from Deforestation and Forest Degradation (REDD) and REDD+[25]) imply tradeoffs. Sectoral management approaches, despite still being predominant, have long been recognized as inadequate. The means by which conflicting objectives are resolved will be subject to changing societal desires and political choices. Interactions among these challenges require that they be addressed in a coordinated and collaborative way.

### *4.5 Response: Actions taken and key results*

While there have been laws passed to modernize the country's agriculture sector, progress has been very slow. Among these laws are the AFMA, Agricultural and Fisheries Mechanization

[25] REDD+ refers to Reducing Emissions from Deforestation and forest Degradation, plus the sustainable management of forests, and the conservation and enhancement of forest carbon stocks (REDD+), is an essential part of the global efforts to mitigate climate change.

Act (RA 10601), Cooperative Code of the Philippines (RA 9520), Credit Surety Fund Cooperative Act (RA 10744), etc.

The lead agency for agricultural development is the DA, supported by DAR for agrarian reform beneficiaries and communities, the DENR for community-based upland management areas, and the DOST for science and technology.

The Philippine Development Plan 2011-2016 (NEDA 2011, p.102) pointed out: "Unsustainable practices employed to improve yields have resulted in land degradation, and problems of water availability and water pollution. Climate change has exacerbated the inherent vulnerabilities of the sector. Development efforts need to focus on transforming the sector into one that is not only highly productive, but also climate-resilient, environment-friendly, and sustainable."

In 2019, the Agriculture Secretary advocated for the eight paradigms that make up the "New Thinking for Agriculture": modernization of agriculture, industrialization of agriculture, promotion of exports, farm consolidation, roadmap development, infrastructure development, higher budget and investment for agriculture, and legislative support (Dar 2019). There is no explicit paradigm for environmentally sound, sustainable, and resilient agriculture ***and*** fisheries, except for calling for the stronger implementation of climate change and disaster risk reduction programs and institutionalizing early warning systems and protocols.

More attention should also be given to soils and the biodiversity beneath our feet—soil biodiversity—which drives many processes that produce food and nutrients, purify soil and water, and store carbon (FAO *et al*. 2020). It takes thousands of years for soils to form, thus, protecting them is pivotal to our very existence.

### 4.5.1 Sustainable agroecosystems and mitigating soil erosion

According to Pretty and Bharucha (2014, p.1571):

- ***Sustainable agroecosystems*** are those tending to have a positive impact on natural, social, and human capital, while unsustainable systems tend to deplete these assets, leaving fewer for the future ().
- ***Sustainable intensification*** is defined as a process or system where agricultural yields are increased without adverse environmental impact and without the conversion of additional non-agricultural land. It aims to achieve both more food and improved environmental goods and services.

Some strategies to increase production with consideration of environmental sustainability are identified in the AFMPs. Integrated pest management (IPM) is an example of sustainable intensification.

***Agroforestry***

Climate-smart agriculture and agroecology both incorporate a wide array of practices, and among them is agroforestry. In the agroforestry system, trees are integrated into the crops and livestock production area. It involves land-use systems and technologies and deals with the production, management, and utilization of woody perennials (trees, shrubs, palms, bamboos, etc.), which are deliberately used on the same land-management units as agricultural crops, animals, aquatic and/or other resources in some form of spatial arrangement, temporal sequence, or mixed simultaneously for the twin purpose of conservation and socioeconomic productivity. Through the integration of trees on farms and grazing areas, agroforestry diversifies and sustains production and food supply for increased economic, sociocultural, and environmental benefits for the various land users, especially for smallholder farmers.

There are three main types of agroforestry systems (FAO 2015):

- *Agrisilvicultural system*: This is a combination of agricultural crops with woody perennials. Alley cropping is simplest and most widespread agroforestry practice in sloping lands.
- *Silvopastoral system*: This system combines woody perennials with livestock production. (Trees are planted around the perimeter of the ranch or grazing area, and in scattered locations in the grazing area.)
- *Agrosilvopastoral system*: This is a combination of agricultural crops, livestock, and woody perennials.

The Ifugao rice terraces are an agroforestry system that has existed for more than 2000 years. A forest is maintained at the top of the mountain, which is the source of water that irrigates the rice paddies. It also prevents land slippage. This is accompanied by a cooperative approach to planning and zoning, extensive soil conservation, and complex pest control regime using a variety of herbs, based on traditional knowledge of the rich diversity of biological resources existing in the Ifugao agroecosystem.

Since 1995, the Philippine government has been using agroforestry as a key technology for the community-based forest management (CBFM). Government agroforestry-related projects are being implemented by the communal tree farm and social forestry programs under the technical supervision of DENR – Forest Management Bureau (FMB). Together with DA and other government agencies, NGOs have also been active in the development and implementation of agroforestry practices. Promising agroforestry systems and technologies for the uplands have been developed.

***Sloping Agricultural Land Technology*** (SALT) is a technique introduced in the Philippines to sustain fertility and reduce erosion of soil in cultivated inclined lands. It is a form of alley farming in which crops are grown in four- to five-meter-wide columns between rows of leguminous trees. Although SALT is not the panacea for upland farming, it is a proven system with certain good qualities over both slash-and-burn and conventional terrace farming (**Box 4.4**). There are four variants developed by the Mindanao Baptist Rural Life Center (MBRLC):

- SALT1: Sloping Agricultural Land Technology
- SALT2: Simple Agro-Livestock Technology
- SALT3: Sustainable Agroforest Land Technology
- SALT4: Small Agro-fruit Livelihood Technology

**Box 4.4. Sloping Agricultural Land Technology (SALT)**

In the 1970s, the Mindanao Baptist Rural Life Center (MBRLC), an NGO began working with *Leucaena leucocephala* in the Mount Apo area as hedgerow plant in alleycropping system.

According to Tacio (1992): "In designing and testing SALT, field and permanent crops are grown in 4-5 meter-bands between contoured rows of nitrogen-fixing trees and shrubs, which are thickly planted in double rows to form hedgerows. Examples of hedgerow species are *Flemingia macrophylla, Desmodium rensonii, Calliandra calothyrsus, Leucaena diversifolia, L. leucocephala, Gliricidia sepium,* and *Sesbania sesban.* Farmers can also use any leguminous trees and shrubs found on their respective farms. When a hedge is 1.5 to 2 m tall, it is cut back to a height of 40 cm and the cut branches are placed in the bands between the hedgerows, also called alleys, to serve as mulch for conserving moisture and as organic fertilizer (green manure). Rows of permanent crops, such as coffee, cacao, citrus and banana, are dispersed throughout the farm plot. The bands or alleys not occupied by permanent crops are planted on a rotating basis with cereals (e.g., maize, upland rice, sorghum) or other crops (e.g., sweet potato, melon, pineapple) and legumes (e.g., mung bean, bush bean, soybean, peanut). This cyclical cropping helps maintain soil fertility and provides the farmer with several harvests throughout the year. Moreover, if a farmer leaves the land untended for one or two cropping seasons, the leguminous trees and shrubs will continue to grow and may later be harvested for firewood and charcoal."

After testing different intercropping schemes and observing *Leucaena*-based farming systems, the SALT prototype was finalized in 1978. SALT recommended that every third alleyway between the double hedgerows of *L. leucocephala* be planted with perennial woody crops, such as coffee trees, with the majority of the alleys maintained by continuous cropping with annual food crops (MBRLC 2012). The "standard" SALT farm, as originally recommended by the MBRLC, allocates sloping farmland as follows: about 20 percent contour hedgerows, 25 percent permanent crops, and 55 percent annual crops (Tacio 1992).

"Judging by the tests, SALT has proven to be very effective in controlling erosion, reducing soil losses from more than 194 tonnes/ha/year to 3.4 tonnes/ha/year" (Tacio 1992).

Source: Tacio 1992; Medina 2019; Mindanao Baptist Rural Life Center (MBRLC) Editorial Staff 2012.

***Conservation farming in the uplands***

To reduce surface runoff and soil loss, the DA-Bureau of Soils and Water Management (BSWM) promotes conservation-guided farms in the sloping watershed areas. Farmers are trained to prepare and use *A frame* to establish the contour, and plant suitable crops on the hedgerows. Natural vegetative strips and hedgerow crops reduce surface runoff and soil loss.

For example, technology demonstration (technodemo) projects on conservation farming were conducted in the watershed areas draining into the Manila Bay in 2012-2013. In Bataan, upland rice was planted along the contours. In Rizal, lemongrass was used as soil barriers. Bamboo was also used for riverbank stabilization. The technodemo on conservation farming in 2012 covered 168 ha in the following areas: (a) San Roque, San Jose de Monte in Bulacan – 17 ha; (b) Tanay, Rizal – 3 ha; (c) Brgy. Ariendo, Bongabon, Nueva Ecija – 139 ha; (d) San Miguel, Bulacan – 6 ha; and I Payagan, Dinalupihan, Bataan – 3 ha. In 2013, the technodemo on conservation farming covered the following areas: (a) Tanay, Rizal; (b) Puray, Rodriquez, Rizal; and (c) San Jose City, Nueva Ecija; and continuing maintenance in: (a) Limay, Bataan; (b) San Isidro, Rodriquez, Rizal; and (c) Dinalupihan, Bataan.

***Sustainable Corn Production on Sloping Areas*** is targeted under the DA's *Agri-Pinoy* Program. It aims to educate farmers on appropriate ways of tilling maize-planted sloped lands by practicing contour farming and planting permanent trees and leguminous plants. A total of six technodemo sites had been established located in CAR, Cayagan Valley, CALABARZON, MIMAROPA, and Western Visayas in 2014 (DA, 2015). The DA is also encouraging farmers to stop the indiscriminate use of glyphosate herbicide on lands with slope that is greater than 18 degrees.

### 4.5.2 Integrated river basin management

The River Basin Control Office (RBCO) of the Department of Environment and Natural Resources (DENR) was created and mandated under the Executive Orders No. 510 and 816 to rationalize and integrate all national plans, programs and projects within the country's river basins. The integration of all these national plans comes up through the formulation of the *Climate Change Responsive Integrated River Basin Management and Development Master Plans* (CCR-IRBMDMPs).

Sustainable development will not be achieved without water security. **Integrated water resource management** (IWRM) is one of the major frameworks in the formulation of IRBMDMPs. IWRM has been defined by the Technical Committee of the Global Water Partnership (GWP) as "a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment." (Hassing *et al*. 2009, p.3).

The IWRM program comprises water collection and storage projects, irrigation and drainage, water supply development, sanitation and wastewater management, solid waste management programs, etc. The conventional change model for IWRM has been based on four practical elements: policies, laws and plans; an institutional framework; use of management and technical instruments; and investments in water infrastructure.

The *Integrated River Basin Management and Development Framework Plan* basically consists of the Water Resource Management, Watershed Management, Flood Mitigation (Disaster Reduction and Mitigation), and the Wetlands Management Frameworks. Recognizing the country's vulnerability to adverse climate change impacts, climate change adaptation and mitigation were also integrated and aligned in the river basin master plans. Under Climate Change Adaptation and Disaster Risk Reduction thematic area of each IRBMDMPs, related projects comprised of *structural* (e.g., slope protection and rehabilitation, flood control of infrastructures, evacuation centers, etc.), and *non-structural* (e.g., weather monitoring, early warning systems, research and development and community and public awareness).

### 4.5.3 Watershed and forest restoration

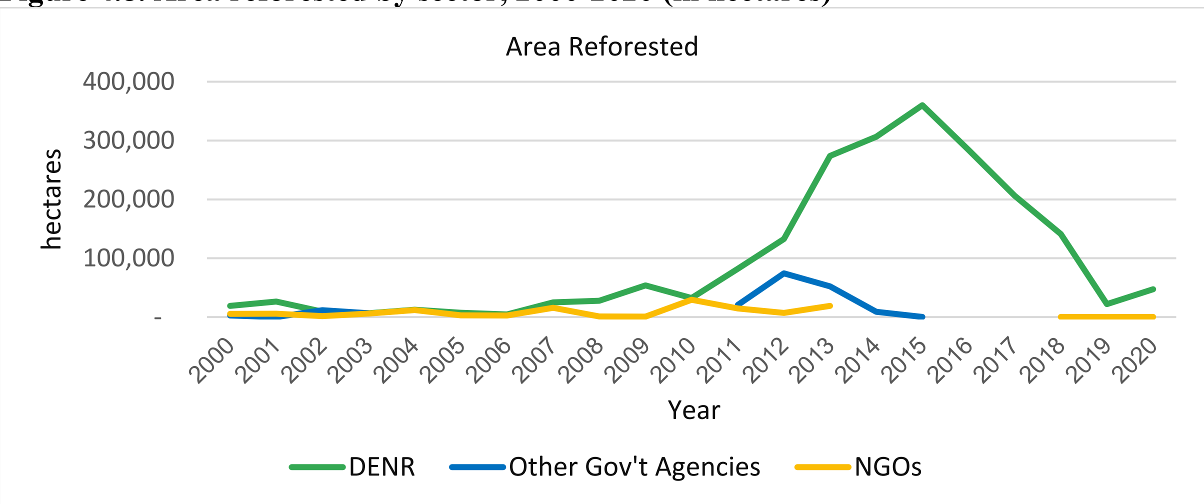
***Rehabilitation of micro-watersheds***. Topographic mapping of the watershed is prepared and sites for technodemo projects are identified. The micro-watersheds of existing small water impounding systems are rehabilitated to improve vegetation cover and thus reduce siltation in the reservoirs. Denuded watersheds are given priority in partnership with the concerned LGUs, irrigation associations (IAs), and the Provincial Environment and Natural Resource Office (PENRO), Municipal or City Environment and Natural Resource Office (MENRO/CENRO) where the watersheds are located. Replanting of suitable plants is made along the contour to minimize soil loss.

***Reforestation.*** The forest area of the Philippines has been declining since the 1950s until 2010. The National Greening Program (NGP) was launched in 2011 as a priority of President B. Aquino in an effort to bring back the lost forest cover of the country, reduce poverty in the countryside, ensure food security and biodiversity conservation, and address climate change. Reforested area increased in 2011 to 2015 (**Figure 4.8**). Due to reforestation programs and logging ban, the forest area has been increasing since 2011 (**Figure 4.9**).

***Agroforestry tools*** developed by multidisciplinary teams to attain productivity and sustainability of the land, improve the economic wellbeing of the farmers, and at the same time conserve the forests resources include: (a) Agroforestry Land Capability Assessment and Mapping Scheme (ALCAMS) by the Institute of Agroforestry, UP Los Baños (IAF-UPLB); (b) Methodology for Evaluating Agroforestry Systems (MEAS) by the International Centre for Research in Agroforestry (ICRAF) (Medina 2019).

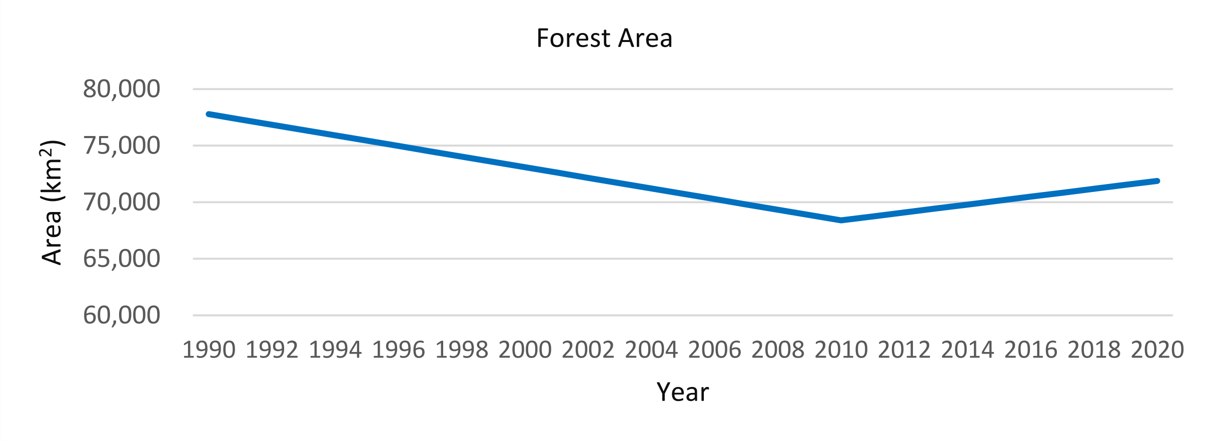
***Supporting policies***. DENR has issued administrative orders to support watershed management: DAO 99-01 on the "Adoption of Watershed and Ecosystem Planning Framework"; DAO 2005-23 on the "Adoption and Implementation of Collaborative Approach to Watershed Management"; DAO 2008-05 on "Guidelines in the Preparation of Integrated Watershed Management Plans"; and DAO 2021-41 on "Guidelines in the Creation of Watershed Management Councils".

**Figure 4.8. Area reforested by sector, 2000-2020 (in hectares)**




Source: DENR-FMB 2020.

**Figure 4.9. Forest area** (in square kilometers)




Source: World Bank 2021.

### 4.5.4 Water supply and irrigation systems

Rainwater harvesting, irrigation systems, small impounding dams, and watershed management are included in the strategies of the Food Security Development Framework of DA.

For irrigation, AFMA included the (a) rehabilitation of existing irrigation systems, (b) promotion of the development of effective, affordable, and efficient irrigation systems, and (c) allocation of additional funds for agriculture modernization, of which 30 percent is for irrigation. From 2011 to 2018, budgetary appropriations for irrigation have more than tripled, from PHP 13.3 billion to PHP 44.3 billion (Inocencio and Briones 2021). **Table 4.6** shows the irrigation development in 2015-2019. However, siltation has been pointed as a major problem plaguing reservoirs and irrigation systems. More effort and resources are needed to rehabilitate denuded watersheds, monitor water flows, and maintain irrigation systems.

**Table 4.6. Irrigation Development, 2015-2019**

| | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| **Total Service Area** (million ha) | 1.73 | 1.86 | 1.89 | 1.92 | 1.97 |
| **Irrigation Development** (%) | 57.3 | 59.3 | 60.4 | 61.4 | 63.0 |

Source: NIA; PSA 2020.

### 4.5.5 Crop diversification

An important paradigm shift in agricultural policy involved moving away from a heavy focus on rice and specific crops towards improving the overall competitiveness, resilience, and sustainability of the sector. This shift typically leads to more diversified sectors with stronger food value chains, affordable and nutritious food, alternative sources of income, rural employment opportunities, and an enhanced rural economy. Crop diversification also helps in reducing risk factors as it ensures that the farmers do not lose all of their resources if the weather does not favor the crop production. In addition, crop substitution and shift to intercropping, crop rotation, and crop diversification can help in the areas with distinct soil problems. Such practices have shown to be effective in increasing soil fertility, controlling pest incidences, and enhancing biodiversity. The DA is allocating part of the revenues collected from the rice tariffs to support the crop diversification and crop insurance programs.

#### 4.5.6 Organic farming

Developing the organic food sector in the Philippines is seen as a potential path to enhance high-value agricultural exports. The *Philippine Organic Agriculture Act of 2010* (RA 10068), signed in 2010, is geared towards ecologically sustainable, environmentally friendly, and safer production systems, and aims to expand the availability of safer and more nutritious staple foods and to increase farm productivity and income opportunities for farmers (DA, 2015).[26]

In 2011, new rules and regulations obliged the DA to direct two percent (2%) of its annual expenditure towards supporting policies and programs to promote organic agriculture (Oxford Business Group, 2012). In the *National Organic Agriculture Program 2012-16* of the Bureau of Soils and Water Management (BSWM), it was targeted that at least five percent (5%) of Philippine agricultural farm areas will practice organic farming by 2016 (DA, 2015).

The law was amended by Republic Act No. 11511, which introduced these provisions:

- Nationwide educational and awareness campaign on the benefits of consuming organic products
- Adoption of the **Participatory Guarantee System** (PGS) as a community of group-based certification process, other than third party certification of organic products
- Protection of organic resources against contamination by genetically engineered organisms including crops, livestock and poultry and marine products
- Access to marketing by organic producers to ensure decent prices which would ensure organic ventures are profitable and sustainable

Due to the Green Revolution from the mid-1960s to late 1980s, yield of rice increased primarily as a result of the introduction of high-yield varieties coupled with commercial fertilizer application, irrigation, and pesticide application ((Magcale-Macandog *et al*. 2016). The green revolution was initially a success as it increased rice yields, but it eventually resulted in the negative impacts on the environment and affected longer-term economic unsustainability. Millions of farmers were forced into debt due to the high cost of chemical fertilizers and pesticides, which over time eroded the soil and polluted the waterways, and this in turn, further affected productivity and yields. Due to this experience and through the rise of the international organic food supply movement, **sustainable agriculture** has come to play a role as an alternative form of agricultural development in the country. It has been recommended that the Philippines needs a sustainable agriculture program that allows and promotes a calibrated reduction of hazardous chemical inputs, with adequate funding to support the transition to ecological farming methods and value chain (Montemayor, Villegas, and Mendoza 2021).

Due to the environmental impact of chemical fertilizer, alternative options are called for. Organic agriculture is now being viewed as an option towards sustainable agriculture. ‘Organic’ refers to the particular farming and processing system, based on the *Philippine National Standards for organic agriculture*. The principal methods of organic farming include crop rotation, green manures and compost, biological pest control, and mechanical cultivation.

[26] Even before the Organic Agriculture Act was passed, there was already an organic movement initiated in the 1980s by some non-government organizations (NGOs). In 2006, there were 35,000 organic farms on 14,140 ha under organic management, with a share of total agricultural land of 0.12% (International Trade Centre).

Organic agriculture aims to dramatically reduce external inputs by refraining from the use of chemical fertilizers, pesticides, and pharmaceuticals, and help in the rehabilitation of degraded arable land. However, yields could drop if zero chemical use is immediately adopted, affecting food security, income and livelihoods of farmers, and the food supply chain, thus, a transition period has been proposed.

Nevertheless, there are currently private companies and NGOs involved in the production of organic food, catering to the niche domestic market and exports (**Box 4.4**). Locally grown organic products include rice, fruits, vegetables (both fresh and processed), herbs and spices, soybean, honey, livestock and poultry, dairy products, and fertilizers. The main organic export products include muscovado sugar, fresh bananas, banana chips, and coconut oil. Most of the organic production in the Philippines is exported to international markets, with Japan, Western Europe, and the U.S. as the primary destinations. With increasing awareness and income, a niche domestic market has developed, and domestic demand is increasing.

The national fertilizer application in corn fields increased from 1960 to 2010 but decreased in in 2011-2015. The continuing increase in volume of corn production despite the decreasing trend in commercial fertilizer application may be attributed to the massive campaign of the DA for organic farming (Magcale-Macandog *et al*. 2016). However, more data on the amount of organic fertilizer applied and its management are needed to establish the correlation.

Although it is well accepted that organic agriculture is sustainable on the environmental/ecological aspect, sustainability with regards to financial and social/cultural aspects still need further assistance due to meagre formal support throughout its supply chain, including input supply, production, and R&D on seeds, nutrient management, and pest management (Maghirang, De La Cruz and Villareal 2011). Around 97 to 98 percent of producers, mostly small, still rely on chemical fertilizers and pesticides. Significant investments in R&D on organic conversion technologies, alternative fertilizer, capacity development for their application, and extension services are needed to address the needs and the issues with the transition process to more sustainable agriculture.

**Box 4.4. The network of organic agriculture**

The organic movement in the Philippines was initiated in the 1980s by a series of uncoordinated initiatives promoted by some NGOs. Even with no support from the government, several projects emerged and introduced organic farming in the Philippines. There are currently private companies and NGOs involved in the production of organic food, catering to the niche domestic market and exports.

- The Organic Producers and Traders Association (OPTA) was formed in 1995.
- The Organic Farming Information Network (Phil-Organic) is an information service that provides accessible data/information to various stakeholders in the organic farming industry.
- MASIPAG – Farmer-Scientist Partnership for Development is a farmer-led network of people's organizations, non-government organizations and scientists working towards the sustainable use and management of biodiversity through farmers' control of genetic and biological resources, agricultural production and associated knowledge.
- The Organic Certification Center of the Philippines (OCCP) is an independent, private, membership-based, organic-standard setting and organic certification body.
- Asian NGO Coalition for Agrarian Reform and Rural Development (ANGOC) also supports the organic farming movement.

- The Philippine Development Assistance Programme, Inc. (PDAP) is a national network of Philippine NGOs working on the promotion of rural enterprises for poverty reduction and as tool for peace building in conflict-affected areas and also active in the promotion of organic agriculture.

Source: International Trade Centre

### 4.5.7 Integrated pest management (IPM)

In 1978, DA, through the Bureau of Plant Industry (BPI), formally introduced the integrated pest management (IPM) approach to educate the farmers on the concept and practice of need-based insecticide spraying. Former President Fidel V. Ramos formed the *Philippine National IPM Program* in 1993. It was named 'Kasaganaan ng Sakahan at Kalikasan' (Prosperity of the Farm and Nature) or KASAKALIKASAN. IPM is a core of crop protection policy in Philippine agriculture.

IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques, such as biological control, habitat manipulation, modification of agricultural practices, and use of resistant varieties, with the goal of removing only the target organism (University of California Integrated Pest Management Program[27]). Following established guidelines, it promotes the protection of beneficial and nontarget insectsand contributes to the reduction of the environmental risks associated with the use of pesticides, which include air, soil, and surface and groundwater pollution.

The operationalization of the *National IPM Program* is guided by a series of DA Special Orders (SO), which define the basic organization at different levels of implementation, and suitable technologies and practices. The farmers were trained on the agroecosystem interactions affecting the plant growth and crop management. Bio-fertilizers and bio-pesticides, which are promising alternatives to inorganic fertilizers and chemical pesticide, have also been developed under the BIOTECH[28] research programs (Magcale-Macandog *et al*. 2016).

### 4.5.8 Agricultural waste management: Turning waste into resource

Agricultural wastes can be turned into useful resources, such as biogas, biomass energy, compost fertilizer and soil conditioner, irrigation water from treated wastewater, etc. Agricultural waste can also be applied directly to the soil or composted to serve as fertilizers, following certain guidelines. Biogas is produced through anaerobic digestion of agricultural and livestock waste. It can be used for cooking, heating, and lighting, while the by-product, slurry, can be applied as liquid fertilizer (ADB 2020). Biomass, such as bagasse, is commonly combusted to produce power and heat for factories in some rural areas, but the combustion of bagasse produces many harmful emissions. On the other hand, no combustion and no GHG emissions take place with bio-digestion, i.e., biogas is a clean, renewable source of energy.

[27] 1996–2022 Statewide IPM Program, Agriculture and Natural Resources, University of California (https://www2.ipm.ucanr.edu/What-is-IPM/).

[28] In 1980, the National Institutes of Biotechnology and Applied Microbiology (BIOTECH) was established at the University of the Philippines in Los Baños. In 1997, the UP System organized three other biotechnology research institutes in Diliman, Iloilo, and Manila.

*Waste to energy and fertilizer*

According to an ASEAN Briefing post: "The Philippines has abundant supplies of biomass energy resources in the form of agricultural crop residues, forest residues, animal wastes, agro-industrial wastes, and biodegradable municipal solid wastes. The most common agricultural wastes are rice hull, bagasse, cane trash, coconut shells/husks, and coconut coir. At present, biomass technologies utilized in the country vary from the use of bagasse as boiler fuel for cogeneration, coconut husks dryers for crop drying, biomass gasifiers for mechanical and electrical applications, fuelwood and agricultural wastes for oven, kiln, furnace and cook-stoves for cooking and heating purposes" (Shead 2017). The DA promotes agricultural waste management for conversion of waste into energy and fertilizer, and reduction of water pollution.

Rice hull and rice straw are underdeveloped biomass resources that could be used in power generation. Using the **portable biogas** developed by the BSWM, technodemo projects were set up in rice-producing areas, specifically to recycle rice straw with animal manure to produce liquid fertilizer that can be applied in the farms, and methane that is useful for household cooking. For example, the supplies used for the technodemo sites within the watersheds of Manila Bay are the following:

For 6 set-ups:

- Farm wastes: 720 kg of rice straw and 300 kg of animal manure
- Urea: 6 kg
- water: 6 $m^3$
- PVC drums and pipes, hose, fittings, sealant, and gas burner.

The expected by-products from each set-up are:

- 150-175 $m^3$ of biogas
- 8-10 bags of digested compost (400-500 kg @ 14% MC).

*Vermicomposting biodegradable and organic waste*

In support of the solid waste management of the DENR, the DA also pursued agricultural waste conversion to organic material through **vermicomposting**. Simple set ups at household level were demonstrated using locally available agricultural wastes with African night crawler as decomposer. For instance, a set, which consists of the following items will produce 20 kg of vermicompost that is useful for organic crop production:

- earthworm – 1 kg
- crop wastes – 60 kg
- cow manure – 20 kg
- ipil-ipil trimmings – 10 kg

*Treatment and reuse of wastewater*

The DA is responsible for formulating and enforcing the guidelines for the **re-use of wastewater for irrigation** and other agricultural uses and for the prevention, control, and abatement of pollution from agricultural and aquaculture activities.[29] This should be coordinated on the Department of Health (on health and safety issues), and DENR (on water quality criteria and environmental impact assessment). With the *DA-Administrative Order or AO number 26*, the wastewater must be treated first prior to application to ensure the safety of the farm workers and community and food safety (Mogol *et al*. n.d.). The major crops irrigated with treated wastewater are fruit-bearing plants, such as sugarcane, banana, pineapple, maize, cassava, mango and coconut, rather than green leafy vegetables (**Box 4.5** and **Table 4.7**).

**Box 4.5. Examples of Treated Wastewater Use in Agriculture**

According to the study of Dr. Raul Alamban titled "Environmental assessment of farm household wastewater for vegetable production in Maria Paz, Tanauan City, Batangas, Philippines", the use of wastewater for irrigation has improved the farmers' productivity and income in terms of water saved (Mogol *et al*. n.d.).

The Busco Sugar Milling Co., Inc. located at Brgy. Butong, Quezon, Bukidnon practiced "Zero Discharge Program" or a "Close-Loop System" by employing primary and secondary wastewater treatment, and using the treated effluent for the irrigation of the sugarcane farm—from95 ha to about 400 ha—through a handmove sprinkler system. The value of average nitrogen and phosphorous content in wastewater effluent is 2.5 mg/L and 3.8 mg/L, respectively, thereby reducing fertilizer requirements in the sugarcane farm (Mogol *et al*. n.d.).

Another notable practice for wastewater use is the case of Absolut Distillers, Inc. in Lian, Batangas wherein the high-strength wastewater is treated using sequential batch reactor and reed bed system, and a thermophilic anaerobic digester is used to capture the methane for use in the distillery's boilers, while the liquid fertilizer is given away for free to sugarcane farms (Tan Tee 2009; ADB 2014). The high organic content of the distillery slops has proven to be useful in the production of sugarcane by reducing the cost of fertilizer requirements, with annual savings of PHP23,272,970 or USD541,231.86 (Mogol et al. n.d.), and increasing the yield by 60 percent (Tan Tee 2009; ADB 2014).

Based on the reports of the DA regional offices on the use of treated wastewater with certification from the DA, there are 1,904 ha of farms irrigated with treated wastewater, while 1,424 ha applied wastewater as liquid soil conditioner (**Table 4.7**).

Source: Mogol *et al*. n.d.; Tan Tee 2009; ADB 2014.

[29] Department of Agriculture Administrative Order No. 26 Series of 2007: Guidelines on the Procedures and Technical Requirements for the Issuance of a Certification Allowing the Safe Re-use of Wastewater for Purposes of Irrigation and other Agricultural Uses, Pursuant to Section 22.C of R.A. 9275, Otherwise Known as the Philippine Clean Water Act of 2004."

**Table 4.7. Treated Wastewater Use in Agriculture**

| Region | Irrigation | | Land Application* | | Treatment |
|---|---|---|---|---|---|
| | Area (ha) | Major crops | Area (ha) | Crops | |
| I | 6 | Rice, tomato | | | Mechanically operated treatment lagoon with bio-agents added |
| VI | 85 | Sugarcane | | | Anaerobic digester plant, reverse osmosis, effluent collection pit, pre-discharge lagoon, irrigation lagoon |
| X | 1,813 | Corn, banana, vegetables, cassava, coffee, pineapple, sugarcane, mango, coconut | 1,424 | banana, pineapple | Primary, secondary, tertiary |
| **TOTAL** | **1,904** | | **1,424** | | |

*Note: Treated wastewater is applied to the farm with no growing crops or during fallow period. The application of wastewater intends to improve soil physical structure and water holding capacity.
Source: Mogol *et al*. n.d.

***Agricultural waste as raw material for various products***

Some agricultural residues are upcycled and fabricated into bricks and other usable materials. The 'agricultural residue panels' are plywood-type boards made from agricultural waste materials, such as rice straw and seed husks of sunflowers. Coconut coir is being used by DENR and some LGUs to stabilize riverbanks and sloping areas. Bagasse can be used as an alternative to trees to produce pulp and paper. There are food packaging materials made of bagasse paper instead of Styrofoam.

### 4.5.9 Climate-resilient agriculture

The climate-resilient agriculture (CRA) concept aims to improve the integration of agriculture development and climate responsiveness in order to achieve food security and broader development goals under a changing climate and increasing food demand (Dikitanan *et al*. 2017). **Table 4.8** shows some of the key practices that are considered CRA as they enhance food security and productivity as well as meet at least one of the other objectives of CRA (adaptation and/or mitigation). The Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) has also published a *Compendium of Climate-Resilient Agriculture Technologies and Approaches in the Philippines* (Labios *et al*. 2020) to provide science-based and actionable knowledge on climate-resilient agricultural technologies and practices in different agroecological systems in the Philippines.

**Table 4.8. Ongoing climate-smart agricultural practices, by production system**

| CRA practice | Region and adoption rate (%) | Impact on CRA Pillars |
|---|---|---|
| **1. Rice (32% of total harvested area)** | | |
| **a. Water harvesting technologies**, e.g., Small Water Impounding Project (SWIP), drip irrigation | Western Visayas <30%<br><br>Central Luzon <30% | **Productivity**<br>Increases yield and revenues.<br><br>**Adaptation**<br>Ensures water availability, therefore, increases resilience to drought.<br><br>**Mitigation**<br>Maintains or improves soil carbon stocks and soil organic matter content. |
| **b. Site-Specific Nutrient Management** (SSNM) and **Integrated Pest Management** (IPM) | Western Visayas <30%<br><br>Central Luzon <30% | **Productivity**<br>Reduces economic losses due to pests and diseases. Increases in productivity and food availability<br><br>**Adaptation**<br>Adequate source, timing, amount, and placement of fertilizers can reduce negative effects of excessive fertilization. Reduces soil salinity and nutrient leaching. Reduces incidence of pests and diseases.<br><br>**Mitigation**<br>Reduces emission of methane and other GHG related with rice production and excessive use of pesticides. |
| **2. Integrated farming (27% of total harvested area)** | | |
| **a. Agroforestry systems** (fruit and timber trees along with rice and vegetables) | Southern Luzon including Bicol, and Eastern Visayas <30%<br><br>Southern and Eastern Mindanao <30% | **Productivity**<br>Reduces use of inputs per unit of product.<br>Diversifies sources of income.<br>Enhances food availability and access.<br><br>**Adaptation**<br>Improves soil fertility and water conservation.<br>Enhances above- and below-ground biodiversity.<br>Reduces occurrence of pests and diseases.<br><br>**Mitigation**<br>Enhances above- and below-ground carbon stocks and organic matter content.<br>Minimizes use of inorganic fertilizers and improves energy use efficiency. |
| **b. Soil and water conservation techniques** | Southern Luzon including Bicol, and Eastern Visayas <30% | **Productivity**<br>Enhances food availability and access, due to improved soil fertility.<br><br>**Adaptation**<br>Increases soil moisture conservation and water availability. Prevents erosion. |

| | | |
|---|---|---|
| | Southern and Eastern Mindanao <30% | Builds soil fertility by improving physical and biochemical soil characteristics.<br>**Mitigation**<br>Maintains or improves soil above- and below-ground carbon stocks and organic matter content. |
| **3. Maize (18% of total harvested area)** | | |
| **a. Site-Specific Nutrient Management** (SSNM) and **Integrated Pest Management** (IPM) | Cagayan Valley <30%<br>SOCCSKSARGEN <30% | **Productivity**<br>Reduces economic losses due to pests and diseases. Increases in productivity and food availability.<br>**Adaptation**<br>Adequate source, timing, amount and placement of fertilizers can reduce negative effects of excessive fertilization.<br>Reduces soil salinity and nutrient leaching.<br>Reduces incidence of pests and diseases<br>**Mitigation**<br>Reduces emission of methane and other GHG related with rice production and excessive use of pesticides |
| **b. Use of early maturing and stress-tolerant Varieties** | Cagayan Valley <30%<br>SOCCSKSARGEN <30% | **Productivity**<br>Increases land productivity, produce quality and income.<br>**Adaptation**<br>Increases efficient use of nutrient and water.<br>Increases crop's resilience to climate shocks.<br>**Mitigation**<br>Contributes to reduced GHG emissions, primarily through reduction of energy and agrochemicals. |
| **4. Livestock (5% of total harvested area)** | | |
| **a. Alternative Feeds** (forages) | Central Luzon 30-60 %<br>CALABARZON 30-60 % | **Productivity**<br>Reduces production costs by reducing external inputs.<br>Reduces yield variability.<br>**Adaptation**<br>Increases food availability during extreme weather conditions.<br>**Mitigation**<br>Increases carbon capture.<br>Reduces GHG emissions per unit of product. |
| **b. Biogas and composting** | Central Luzon <30%<br>CALABARZON <30% | **Productivity**<br>Increased land productivity and income.<br>**Adaptation**<br>Increases livestock system's resilience to climate shocks.<br>Reduces electrical cost for cooking or lighting.<br>Facilitates the elimination of pathogens. |

| | | |
|---|---|---|
| | | **Mitigation**<br>Reduces the use of nitrogen fertilizer, and<br>reduces methane and other GHG emissions from manure.<br>Provides an on-farm alternative energy source. |
| **5. Vegetables (5% of total harvested area)** | | |
| **a. Organic farming** | Cordillera Administrative Region (CAR) <30%<br><br>CALABARZON and Northern Mindanao <30% | **Productivity**<br>Reduces costs of production through reduction in input use.<br>Increases in income through high quality an healthy produce.<br><br>**Adaptation**<br>Builds soil fertility by improving physical and bio-chemical soil characteristics.<br>Increases biodiversity.<br>Reduces the occurrence of pests and diseases.<br><br>**Mitigation**<br>Reduces GHG emissions due to reduction energy and in inputs needs.<br>Enhance soil carbon stocks. |
| **5 Use of drought-resistant varieties** | Cordillera Administrative Region (CAR) 30-60 %<br><br>CALABARZON and Northern Mindanao 30-60 % | **Productivity**<br>Increase soil fertility, less cost of inputs, improved product quality.<br><br>**Adaptation**<br>Enhanced food availability and access, enhanced biodiversity, pyramid soil and water conservation, reduced occurrence of pest and diseases<br><br>**Mitigation**<br>Less emissions of release, enhance soil-carbon deposit |

Source: Dikitanan *et al*. 2017.

DA has established the Climate-Resilient Agriculture Office to address climate change vulnerabilities and risks, and craft and implement climate-resilient agriculture and fisheries modernization programs. This office has a systems-wide seven-point program[30]:

1. **Mainstreaming Climate Change Adaptation and Mitigation Initiative in Agriculture** (AMIA): To minimize DA's institutional risks and protect government investments; and adjust development programs/projects and approaches to address Climate Change risks.
2. **Climate Information System**: To have a common database to generate timely and reliable data for disaster risk reduction, planning and management; conduct vulnerability and risk assessments of productive areas; and establish agro-meteorological (Agromet) stations in highly vulnerable areas.
3. **Philippine Adaptation and Mitigation in Agriculture Knowledge Toolbox**: To compile, generate, and disseminate tools, technologies, and practices, which users can readily use through the extension services of the country, while research will pursue new tools and knowledge in partnership with the scientific community.

[30] More details are available on the website of DA (http://amia.da.gov.ph/index.php/da-systems-wide-programs-on-climate-change/).

4. **Climate-Smart Agriculture Infrastructure**: DA will support the development of new designs and construction protocols for agricultural infrastructure, including production and postharvest facilities and fishery infrastructure, to withstand adverse effects of extreme weather events, repair of existing systems to enhance resilience where necessary, and improvement of the design management of irrigation systems to reduce leakage and optimize water use.
5. **Financing and Risk Transfer Instruments on Climate Change**: DA will develop new innovative financing schemes to help the agriculture producers to obtain financing insurance and guarantee for climate change-related events, especially vulnerable stakeholders in the agriculture and fishery sector. A **quick response fund** will be set up to provide emergency support to farmers in affected production areas.
6. **Climate-Smart Agriculture and Fisheries Regulation**: The DA's regulatory agencies will redesign their services to take into consideration new technologies towards the promotion/development of Climate-Smart Agriculture. This is to ensure among others, that new kinds of pesticides, fertilizers and other inputs, as well as genetically modified crops and organisms, that may be created or brought in to address the changing weather patterns will comply with effectiveness and safety standards.
7. **Climate-Smart Agriculture Extension System**: The entire agriculture and fishery extension infrastructure, in partnership with LGUs, State Universities and Colleges (SUCs), NGOs, and the private sector, will be mobilized to develop and implement a national extension system that will educate and equip the stakeholders to deal with climate change including adaptation and mitigation measures available for agriculture and fishery industries.

#### 4.5.10 Financing mechanisms to support disaster and climate resiliency

***People's Survival Fund***

In addition to the **national disaster fund**, the **People's Survival Fund** (PSF) was created by R.A. 10174 in 2012 as an annual fund intended for LGUs and accredited local/community organizations to implement climate change adaptation projects that will better equip vulnerable communities to deal with the impacts of climate change and natural disasters (National Integrated Climate Change Database Information and Exchange System 2022). Projects funded by the program are deliberated by the **People's Survival Fund Board**, which required that projects address the community's climate vulnerabilities based on scientific and historical data. Priority will be given to local government units with high poverty incidence, are exposed to climate risks, and has a key biodiversity area as well as eligible and accredited community organizations. "The objective of PSF projects is to provide an effective combination of engineering and non-engineering interventions, which directly address the area's climate risks, and capacity building programs designed to empower the community and ensure project sustainability" (Department of Finance, DOF 2020). The PSF is intended: (a) for adaptation activities that include water resources management, land management, agriculture and fisheries, health, among others; (b) to serve as guarantee for risk insurance needs for farmers, agricultural workers and other stakeholders; and (c) to be used for establishing regional centers and information networks, setting up forecasting and early warning systems, support contingency planning for droughts and floods, etc. (DOF 2015).

### *Agricultural Insurance*

P.D. 1467 created the Philippine Crop Insurance Corporation (PCIC) in 1978 as the implementing agency of the government's agricultural insurance program. Amended through **RA 8175** in 1995, PCIC is a government-owned and controlled corporation, an attached agency of DA. The PCIC's principal mandate is "to provide insurance protection to farmers against losses arising from natural calamities, plant diseases and pest infestations of their rice and corn crops as well as other crops". The PCIC also provides protection against damage to/loss of non-crop agricultural assets, including, but not limited to, machineries, equipment, transport facilities and other related infrastructures due to peril/s insured against.

The *Registry System for Basic Sectors in Agriculture – Agricultural Insurance Program* (RSBSA-AIP) is an insurance program for all subsistence farmers and fisherfolk listed in the RSBSA. The number of rice and corn farmer enrollees/beneficiaries is around 50,000, which is less than two percent of the estimated 5.2 million smallholder farmers in the Philippines.

Prior to 2009, PCIC was the only public sector crop insurance facility. In 2009, the Malayan Insurance Company underwrote – on a pilot micro level – individual *crop insurance index program* developed by a local financial intermediary, **MicroEnsure**, for typhoon and drought.

The Philippines is pilot-testing a number of index-based insurance schemes. One is the **weather-based insurance scheme** jointly undertaken by the Department of Agriculture, The World Bank and SwissRe in Cagayan Valley and Panay Island. Another modality is the **yield-based insurance scheme**, which was conducted in irrigated farmlands in Leyte and Agusan del Norte (CPBRD Policy Brief 2012).

There are major issues affecting the crop insurance program. First, institutional reforms are needed to correct the market and structural inefficiencies of the system (and PCIC). Second, there is asymmetric information. Studies have shown that adverse selection can occur on the part of farmers who preferred to insure the plots that faced more risk and are most likely to suffer losses (e.g., low-lying, flood-prone plots). Moral hazard can also occur as a result of insured farmers applying less effort in taking care of their farm when aware that it is insured against certain risks. Hence, it was recommended to: (1) fast track the index-based insurance products; (2) pursue legislative reforms to ensure sufficient funding while reducing administrative costs and increase insurance coverage; (3) utilize government support to fund agricultural risk infrastructure (e.g., weather stations and information management systems); and (4) access international reinsurance market of affordable and reliable products.

## 5.0 Conclusion and Recommendations

### *5.1 Enabling environmental governance framework*

Forests, rivers, estuaries, coastal zones, marine environments, and both land-based and sea-based activities are all inherently interlinked. River basins and coastal and marine areas are interconnected through physical, chemical, and biological processes, thus, any modification in a river basin will ultimately affect the coastal and marine areas while changes in the marine areas will affect the coastal area and the people living in the river basin. Economic activities in downstream areas benefit from upland resources, such as water, but will also be affected if that water becomes polluted, if streamflow is reduced, orif there is flooding. Coastal ecosystems that provide shoreline protection, as well as fisheries and other coastal and marine activities (e.g., tourist, ports, shipping, trade, marine renewable energy) have a positive benefit for the broader river basin area. Coastal resources are often threatened due to the pollution generated in upstream areas and coastal zone. Unsustainable agricultural practices can impact the fisheries sector. As such, an integrated approach to the management of river basins, coastal zones and ocean is crucial for sustainable and resilient agriculture and fisheries. It is, therefore, important to pursue the national convergence initiative using the more comprehensive **ridge-to-reef** or **highland-to-ocean** (H2O) approach, control pollution and habitat loss in the uplands and watershed areas down to the coastal and marine areas, mitigate GHG emissions, manage both land use and water use, and strengthen resilience to climate and disaster risks.

First, this calls for a **Whole-of-Government** approach, which puts institutions to the service of sustainable development, i.e., environmentally sound, people-centered, and inclusive economic prosperity. The purpose of the whole-of-government approach is to create a culture that facilitates a shared vision across diverse public administrations and local and national agencies in order to provide collaborative responses and coherent, cost-effective, doable solutions to the growing complexity of problems. Inter- and intra-agency coordination and cooperation strengthens the abilities of various government agencies at the national and local levels to operate as one system rather than as a collection of silos and separate components. Mainstreaming sustainable food, agriculture, and fisheries into national development strategies and action plans requires setting up a process and a functioning institutional structure (FAO 2018).

Secondly, the government cannot do it alone, even if it can marshal enough human and financial resources. The '**Whole-of-Society**' or '**Whole-of-Nation**' is advocated wherein the government engages all relevant stakeholders, such as the private sector, civil society, academe, scientists, communities, and individuals in support of joint efforts to address the various issues and move forward to a more sustainable and resilient development. The whole-of-nation approach promotes partnership between the government and different segments of society.

The interactions between the various land-, water-, and ocean-uses and their impacts to one another must be recognized. River basins and coastal areas host valuable ecosystems and provide space and resources, which are increasingly used more intensively in human activities. Integrated policy approaches, enabled by cohesive institutional arrangements, integrated governance mechanisms, stakeholder engagement, and modern technologies, contribute to the overall objectives of long-term development and environmental and resource management, which will benefit the agriculture and fisheries sector. Overcoming the complex challenges that the country faces would require transformative action that subscribes to the principles of sustainable, resilient, and inclusive development and confronts the root causes of poverty and hunger.

### 5.1.1 Ecosystem-based management approach

When the Convention of Biological Diversity (CBD) was first adopted, it was most strongly focused on protected areas and endangered wildlife; but over time, sustainable use of farmland, agricultural biodiversity, and sustainable fisheries have become increasingly important. FAO also recognizes that production systems generate not just goods (such as food crops, meat, fish and timber) but also multiple services: for example, clean water, cultural values and the ecosystem services that regenerate life, including nutrient cycling, soil fertility, natural pest control, and pollination. The challenge is to achieve food production goals for the growing population in ways that alleviate poverty and hunger, improve nutrition, and conserve the environment. Climate change also threatens fisheries and crop production, and a better understanding of the causes and impacts of climate change is crucial. Interactions among these challenges require that they be addressed in an integrated and coordinated way. **Table 5.1** provides a selection of principles of the ecosystem approach relevant to climate impacts, the corresponding principles of an ecosystem approach to fisheries, and their practical implications on fisheries management.

Agriculture relies on water availability, healthy soil, biodiversity, and good weather conditions. Likewise, fisheries relies on clean water and seas, healthy ecosystems, and biodiversity. Both are affected by other human activities. At the same time, unsustainable agricultural and fishing practices undermine the ecosystems where they exist, consequently affecting future productivity and sustainability. Agriculture and fisheries will therefore benefit from the **ecosystem approach to management**. There are already ongoing good practices on ecosystem-based management that provide evidence of economic viability and environmental performance, although a more structured set of metrics and indicators is still needed to inform policy and choice. It is crucial to continuously engage with both small- and large-scale farmers, agribusinesses, artisanal, subsistence and commercial fishers, food processing and distribution industries as well as consumers, regulatory agencies, and scientists in collaboratively finding solutions and developing sustainability metrics that work across ecosystems, scales, sectors, and the supply chains.

*Ecosystem management* involves "managing areas at various scales in such a way that ecological services and biological resources are conserved while appropriate human uses, and livelihood options are sustained" (Brussard *et al*. 1998, p.9). When it comes to implementation, the choice of approach depends very much on local contexts and specific priorities but in line with the integrated river basin, coastal and marine area context.

"The significance of ecosystem management is that it focuses on ecological systems as a whole rather than on just some of their parts, includes public involvement in the goal-setting process, integrates conservation into economic activity, and represents a paradigm shift from `linear comprehensive' management (managing as if there were comprehensive, quantitative, and continuous knowledge of the system being managed) to `cyclic-incremental' management or `adaptive' management" (Brussard *et al*. 1998, p.9).

Solution options range from green or nature-based solutions, appropriate hard infrastructure (irrigation systems, fish landing centers, post-harvest facilities, etc.) to soft infrastructure (knowledge management, capacity development, public awareness, stakeholder participation, etc.). Upgrading to new and innovative technologies is vital for effective performance both of local and national management as well as the farmers and fishers.

Crafting supporting policies, regulations, and incentives, fostering stakeholder participation and coordination mechanisms, supporting capacity development and knowledge sharing, and ensuring adequate investment and financing are important enabling conditions. Monitoring and evaluation are also essential for ensuring that the policies, plans and management of resources are properly implemented, gaps and needs are identified, and plans and management strategies are adjusted as necessary.

**Table 5.1. A selection of principles of the ecosystem approach relevant to climate impacts and fisheries management.**

<table>
<tr><th>CBD ECOSYSTEM APPROACH PRINCIPLES</th><th>FAO PRINCIPLES ON ECOSYSTEM APPROACH TO FISHERIES</th><th>PRACTICAL IMPLICATIONS TO FISHERIES MANAGEMENT</th></tr>
<tr><td>Principle 3:<br>Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.</td><td rowspan="2">Management measures should be compatible across the entire distribution of the resource.</td><td rowspan="2">Fisheries management goals should be holistic and long term, and management objectives compatible across ecological, social, and governance domains.</td></tr>
<tr><td>Principle 7:<br>The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.</td></tr>
<tr><td rowspan="2">Principle 5:<br>Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.</td><td>Ecological relationships between species should be maintained.</td><td rowspan="2">Ecological resilience is recognized as integral to sustainability, is achieved through institutional and social resilience, and the tradeoffs between ecological and social resilience are made in a transparent manner.</td></tr>
<tr><td>Fisheries should be managed to limit their impact on the ecosystem to an acceptable level.</td></tr>
<tr><td>Principle 9:<br>Management must recognize that change is inevitable.</td><td>Precaution in decision-making and action is needed because the knowledge on ecosystem is incomplete.</td><td>The planning process is based on adaptive management, and the precautionary approach is applied to decision-making.</td></tr>
<tr><td>Principle 12:<br>The ecosystem approach should involve all relevant sectors of society and scientific disciples.</td><td>Governance should ensure both human and ecosystem well-being and equitability.</td><td>Decision-making is participatory. This requires good governance, cooperation, and coordination across institutions and co-management.</td></tr>
</table>

Note: CBD – UN Convention on Biological Diversity
Source: Heenan *et al*. 2015.

### 5.1.2 Integrating the management of river basins, coasts, and ocean

There are important functional relationships between river basins, watershed, coastal areas, and seas, and each one may influence the other. These systems are linked through physical, chemical, and biological processes and human activities (urban development, rural activities, sea-based activities, infrastructure, food-water-energy nexus, waste and pollution, etc.).

A *river basin* encompasses all the land drained by a river and its tributaries to a common outlet (lake, gulf, bay, sea), connecting humans and living and nonliving resources that are interdependent on one another. A river basin can contain smaller watersheds. River basins are important areas for management due to water, and the ecosystems and biodiversity within the area as well as the diversity of human activities, including water and land uses, habitat conversion, and pollution, which impact not only the basin area but also the downstream areas, lakes and seas.

*Coastal areas* are the interface between the land and marine areas. The rich diversity of natural habitats and species and other natural resources in the coastal and marine systems are valuable, comprising 63 percent of the global value of the world's ecosystem services (Costanza et al. 1997). As rivers flow from the uplands to the sea, the coastal zone is an essential part of a river basin. Unlike river basins and watersheds, there are no exact natural boundaries that categorically delineate coastal areas, both on the landward and seaward directions. Both river basin and coastal problems require a holistic management approach that captures the integrated terrestrial−aquatic system, and balances protection and production.

River basin management has frequently been associated with the IWRM, encompassing management of the watershed, water resources, water allocation, water supply, and water use, whereas integrated coastal management (ICM) has been more concerned with coastal and marine resource management and spatial planning.

IWRM is an environmental planning process which promotes the coordinated development and management of water, land, and related natural resources and ecosystems. Understanding the close connection between the river and its catchment area has led to a more integrated approach to river basin and water resource management, taking into account water quality along with quantity.

Similarly, recognition of the importance of integrated management of the various coastal ecosystems and resources, coastal resource uses, and economic activities in the coastal area as a move towards achieving sustainable development has led to the development of the ICM framework. ICM refers to a "*dynamic and continuous process of administering the use, development and protection of the coastal zone and its resources towards common objectives of national and local authorities and the aspiration of different resource user groups*" (Knecht and Archer 1993, p. 186). ICM denotes coastal resource use management and more effective environmental protection, with expansion of the domain in both landward and seaward directions, in a way that recognizes interdependencies and interaction. It involves **inter-agency, multidisciplinary, and intersectoral planning and coordination of activities** in a way that acknowledges the interaction between socio-economic and natural environment; and an **integrated spatial consideration of the coastal area** in a way that recognizes the interdependencies between the watershed, rivers, and seas, and the ecosystems therein.

Since ICM covers coastal areas, the implementation of the ICM policy in the Philippines would fall under the purview of LGUs, with the national government providing technical support. Due to the multisectoral activities and the nature of interactions and interdependencies in the coastal zone, there is a need for coordination with various sectors and users (horizontal integration), between the national agencies and the LGUs (vertical integration), and between land and sea areas (spatial integration), and linkage between policy and science, technology and innovations. Climate change is bringing about a myriad of hazards that threaten the coastal areas, e.g., flooding and fluctuations of water flows from the upstream, and storm surge and rising sea levels from the marine side.

Being an archipelagic country, and with EEZ that extend beyond the municipal waters, and various ongoing activities in the marine areas, (municipal and commercial fisheries, shipping, marine tourism, offshore oil and gas, submarine communications, etc.), there is also a need for an apex body that would set the vision, policy and strategy for integrated coastal and ocean management, and coordinate the various stakeholders for the sustainable and resilient development of the coastal and sea-based activities and the protection of the ecosystems and the marine environment.

### 5.1.3 Local government level

All cities and municipalities are required to prepare Comprehensive Land Use Plans (CLUPs). While most LGUs have CLUPs as well as Local Disaster Risk Reduction and Management Plan (DRRMP), and Local Development Plans as required by law, only a few LGUs have integrated land- and sea-use plans that would facilitate sustainable, ecosystem-based management for agriculture, forestry, fisheries and aquaculture, and reduce multiple-resource use conflicts in the uplands/watershed areas and coastal and marine areas.

The LGUs should also incorporate the Strategic Agricultural and Fisheries Development Zones (SAFDZs), a key component of AFMA, into their CLUPs. The delineation and management of SAFDZs should also follow the ecosystem-based management and integrated approach, recognizing that sustainable economic growth involves environmental sustainability and climate resiliency. Options for land- and sea-use management should be designed in a way that enhance the ecological role of biodiversity in agroecosystems and fisheries.

In agriculture, even though the issues of nutrient and pest management, crop residue burning, pollution, habitat loss, food security, water security, and climate change touch many sectors, such as environment, economy, agriculture, water, energy, social aspects, and education, the government efforts revolved around these sectors **separately**. This silo-approach and sectorial thinking is a barrier that needs to be broken.

Coastal LGUs should also implement integrated coastal management (ICM) programs, which should include integrated land- and sea-use plans encompassing the watershed, coastal, and municipal marine water areas and risk-based marine spatial plans with zoning schemes for prime agricultural lands, aquaculture (inland and coastal), municipal fishing areas, and other uses like tourism, ports and shipping, industries, and commercial areas.

## 5.2 Fisheries

Despite the measures and actions that have been undertaken, the fisheries industry still faces various issues and concerns that adversely impact livelihoods, incomes, and the overall wellbeing of the fisherfolk. Most notably are concerns related to declining fish stocks, multiple resource-use conflicts, habitat loss, pollution, climate change as well as the stringent requirements being imposed by importing countries on fish and fishery products entering their markets. Environmental sustainability should be addressed in each stage of the supply chain of capture fisheries and aquaculture.

The Philippines has good laws and enabling conditions on paper but more needs to be done to improve the implementation of policies and plans, build capacity of fisherfolk and fisheries and coastal managers, and ensure consistent enforcement of laws, continuity of programs, scaling up of best practices, and adoption of sustainable technologies and practices.

The ICM bill is still pending in Congress. Moreover, there is no national law on integrated ocean management. The national marine policy needs to be updated, including establishing the institutional arrangements, coordinating mechanism, and budgetary allocation. The challenge is to make the different sectors and stakeholders work together and resolve diverging objectives to enhance the effectiveness of actions. Fishery resources are managed under BFAR, but the habitats of the fish are under the DENR, with mangroves under the Forest Management Bureau (FMB), corals reefs and seagrass beds under the Biodiversity Management Bureau (BMB), and water quality and pollution management under the Environmental Management Bureau (EMB). Meanwhile, the LGUs also have responsibilities for fisheries management under the current decentralized system of government that were first laid down in the Local Government Code. Moreover, the Fisheries Code of 1998 gave the LGUs broad powers to control fishing activities occurring within its municipal waters and to set conditions for marine resource use by local ordinance.

### 5.2.1 Enhance the ecosystem approach to fisheries management

In complex multi-species, muti-gear fisheries, and in the face of multiple resource uses in the aquatic environment, and threats from habitat degradation, pollution, and climate change, achieving effective, equitable, and inclusive fisheries management is indeed a challenge. The past approach has focused on fish and fishing only. The alternative is the *ecosystem approach to fisheries management* (EAFM), which has been adopted in the fisheries laws and plans.

Implementing an ecosystem approach can also contribute to climate change mitigation and adaptation by protecting ecosystems, improving resilience, and reducing vulnerability to climate change through planning strategies based on precautionary, flexible, and adaptive principles, and using tools to monitor and assess the impacts of climate change on fisheries.

**Box 5.1. What is the ecosystem approach to fisheries management (EAFM)?**

EAFM is an integrated management approach across coastal and marine areas and their natural resources, promoting conservation and sustainable use of the whole ecosystem and balancing ecological and human well-being priorities through effective fisheries governance (USAID and SEAFDEC 2020).

In addition to conserving target species, EAFM also addresses non-target species, endangered species, biodiversity, waste and pollution reduction, and welfare of coastal states involved, including the interests of artisanal or small-scale fisheries and subsistence fishers.

EAFM builds on and improves what is in place (EAFM Consortium 2022):

- Strengthens existing management
- Strengthens agencies through better planning and cooperation
- Builds on and integrates co-management and other participatory approaches
- Uses the traditional and scientific knowledge
- Improves human capacity in skills needed for sustainable management
- Allows the threats to the long-term sustainability of the fishery to be viewed alongside shorter-term economic needs and analysis of tradeoffs

Sources: USAID and SEAFDEC 2020; EAFM Consortium – Collaboration among Bay of Bengal Large Marine Ecosystems, Coral Triangle Initiative, FAO, GEF, NOAA, NORAD, SEAFDEC, SIDA, USAID, etc. (eafmlearn.org)

### 5.2.2 Restore habitats and establish and effectively manage MPAs and fish sanctuaries.

Though numerous marine protected areas (MPAs) have been established to protect fishery resources and habitats, most are considered mere "paper parks" due to lack of effective management, with no plans, monitoring and enforcement. In addition to protecting important ecosystems and habitats, MPAs are necessary for food security. Scientific studies prove that properly managed MPAs result in dramatic increases in spawning stocks, and that fish in MPAs live longer, grow larger and produce more eggs. MPAs also provide coastal communities with protection from coastal erosion and storm surge. Coastal and marine ecosystems, such as mangroves, seagrass, and coral reefs, have to be restored and protected as they are essential in the face of climate change by ensuring resiliency, mitigating disaster risk, and sequestering and storing carbon.

### 5.2.3 Address overfishing, and eliminate, deter, and end IUU fishing.

Overfishing and destructive fishing methods have long contributed to the rapid decline of fish stocks and habitat degradation.

More efforts are needed to make sure that the seafood that we are eating are not illegally caught. These include implementing harvest control rules for commercial fishers to fish within the MSY and within the limits of the commercial fishing area, nationwide ban on modified Danish seine, known as 'hulbot', penalties for dynamite fishing, and strong traceability system. Well-defined flexible and enforceable regulations are critical.

Determining exploitation rates and adoption of reference points and limit reference points are keys tools for fisheries management. This requires continuous or regular fish stock monitoring and assessment. There should be stronger linkage between policy and science, and support for evidence-based planning and decision-making.

Strengthening the monitoring, control, and surveillance (MCS) systems, and enforcement of the laws (RA 8550 and RA10654) are particularly important and can serve as a deterrence to crimes. In addition, limiting access and implementing appropriate systems of access rights are essential for successful and responsible fisheries (FAO, 2003). They must be supported by a sustained campaign to enforce fishery and related laws, rules and regulations, and educate stakeholders and the general public on the objectives and benefits of fisheries management in order to encourage compliance and self-regulation.

#### 5.2.4 Support research and innovative technologies, and link policy and science

In light of climate change, research priorities should include life history and physiology, oceanographic context, movement and migration of pelagic fish species, food webs, ecosystem dynamics, and stock status within the milieu of rising, acidifying, and warming seas.

Technological innovations, such as new information and communication systems can be used to provide more information to consumers about the benefits of sustainable fisheries, and where to access sustainably sourced seafood so they can make more responsible seafood choices. This can create incentives for fishers and processors to change towards more sustainable practices. ‘Apps’ (application software programs) can be developed to support e-commerce and link consumers or markets with sustainable fishery (fishers, fishermen association or cooperative, fish processors) though internet and smartphones. Digitalization can also improve the financial services and make them more accessible to the marginalized fisherfolk and farmers.

Addressing IUU fishing, traceability and transparency along the supply chains are the major concerns that can be fulfilled by the e-CDT system. The pilot e-CDT system should be replicated in other major tuna fishing grounds and for other key species as well. It can be used in informing consumers about sustainably sourced fish and seafood, and in engaging them in reporting illegal and destructive fishing activities.

The e-CDT system can be enhanced by using blockchain technology. Blockchain is a digital record of transactions that is publicly accessible and incorruptible by any single entity. Although it was first used in digital currency transaction processing, there is potential value in using blockchain for tracking and sharing information about a fish’s origin, gears used, harvest, processing, and delivery. Unlike traditional seafood traceability systems where data can be altered easily, Blockchain prevents data tampering.

Data analytics, digitalization, remote sensing, imagery, machine learning models, and computer vision technology can be used for early detection and predicting the probability of potential damage, e.g., declining fish stocks, decreasing DO, onset of HABs (Red Tide), rising sea temperature, etc.

The government can also invest in the *visible infrared imaging radiometer suite* (VIIRS), which typically collects images and radiometric data to provide not only information on the Earth’s clouds, atmosphere, oceans, and land surfaces but also to detect violations, such as illegal logging and illegal fishing during the closed fishing season. Sensors, cameras, and drones are increasingly being used in other countries to gather environmental data, and aid in monitoring and surveillance.

Cost, policymaking delays, and challenges with information-sharing and capacity development are barriers that need to be overcome to ensure that such technologies can be accessed and applied.

#### 5.2.5 Incorporate climate action in fisheries development and management

There are studies showing the climate change impacts on fisheries and coastal areas. To prepare for climate change, the Philippine needs to implement the following actions (Suh and Pomeroy 2020, p.12):

- conduct an assessment of vulnerability to climate change for fisheries at the national level in order to respond to changing economic conditions expected to worsen over time and that the assessment is continuously and periodically carried out;
- carry out a gap analysis on the capability to cope with the impact of climate change on fisheries for the national economy; the gap analysis enables organizations to take the selective and premeditated actions providing the information about whether a sector or area can potentially be associated with the issue or which community is more vulnerable to climate change;
- make effective management plans for fisheries to develop adaptation to climate change with the accumulated information in the process—for an effective plan, it is necessary to establish reliable research materials by collecting climate data and fisheries-related information, and these sources should be open to both organizations and the public to help make more informed fisheries management decision;
- incorporate climate change impacts into national economic development plans and fisheries development plans; and
- incorporate climate adaptation into the fisheries management plan—it should be accompanied by education on climate change that can increase awareness of impacts of climate change and promotion of adaptation strategies that can reduce the effect of climate change on fisheries.

#### 5.2.6 Provide incentives and support certification systems

Certification and labelling of sustainably sourced fish are incentives that can contribute to creating new market opportunities for artisanal fishers. (The experience of the Philippine Tuna Handline Partnership is discussed in Section 3.5.3.) The seafood industry, like all industries, is largely market driven. Increasing consumer awareness about sustainability, fair trade, and climate change coupled with rising incomes can lead to changing consumer preferences for sustainably sourced fishery products, similar to coffee, chocolate and other food and clothing products. .

### *5.3 Aquaculture*

Over the last 35 years, the ranking of the Philippines in world aquaculture production fell steadily from 4th place in 1985 to 11th place in 2019 (FAO 2020). The Philippines now contributes only a little over one percent of world aquaculture production. Since 2004, it has been pointed out that it is essential to develop new markets, enhance market competitiveness, and reduce farming risks to ensure the long-term growth of the Philippine aquaculture industry (Cruz 2004; as cited in FAO n.d.). Moreover, given international trade and competition and climate change impacts, there is a need for the aquaculture industry to adopt a global plan that is sustainable, climate-smart, and resilient.

The CNFIDP includes the following recommendations for the aquaculture industry:

- Have a market-oriented framework of development.
- Develop new markets, both for local and for export.
- Promote technologies that will bring down production cost.
- Develop new species that are cheap to produce.
- Develop the processing and value-adding industries.
- Rationalize fisheries ordinances in support of the CNFIDP.
- Benchmark strategies against other countries.
- Promote and support private sector leadership and initiatives.

### 5.3.1 Support research, development and deployment (RDD)

More support from the national government for research and development in aquaculture and biotechnology centered on polyculture, production of hatchery-bred high value-species, lower feed conversion ratio, disease incidence reduction, safety and quality, and climate resiliency is essential. This should be followed by dissemination of the knowledge gained to planners, managers, and aquaculture operators and workers/fishers, and capacity development.

### 5.3.2 Improve fish farm management

Active and proper fish farm management is essential to maintain maximum and sustainable aquaculture production level, ensure the world demand-based quality aquaculture products, and reduce pollution and other environmental impacts. It starts with proper pond/pen preparation.

***Fish farm mechanization.*** Mechanization of the fish farm is the new concept for enhancing aquaculture production. It involves mainly fish feed delivery system, water distribution and exchange system, aeration system, water quality monitoring system, and other activities, such as electric equipment operation, security camera, office management, etc. Mechanization of a fish farm reduces the fish farm labor and feed cost and increases the fish farm productivity along with reducing the water pollution through effective fish farm management (Asadujjaman and Chowdhury 2019).

***Innovative technologies.*** Sensors and related data-derived services are targeting farm efficiency. Blockchain can be used to exchange information about a fish's origin, history, harvest, processing, delivery and marketing, thereby, producing a transparent and verifiable origin of each aquaculture product. It can, therefore, contribute to resolving the fragmentation of the seafood supply chain, and addressing transparency and accountability necessary for sustainable practices.

***Farm consolidation and entrepreneurship.*** DA-NFRDI is addressing the modernization and diversification of fish food with the introduction of ***agripreneurship*** and ***farm consolidation***, such as mechanization and cooperative farming of the fisheries sector. The projects focus on increasing productivity and breeding of high-quality seafood, such as siganid, tilapia, mudfish, ayungin, milkfish, oyster, and seaweeds, and the application of verified fisheries technologies on production and nursery rearing.

### 5.3.3 Promote integrated aquaculture

***Rice-fish farming*** is an integrated agriculture-aquaculture system and involves the simultaneous culture of rice and fish in rice paddies. In 2019, the Philippines produced a mere 5.3 tonnes of rice-fish, of which 2.8 tonnes were produced in Region I, and 2.5 tonnes in Region VI (BFAR 2020).
According to Guerrero (2018): Rice-fish farming has many environmental and economic benefits. "In rice-fish farming, the fish (mainly the Nile tilapia in the Philippines) helps in fertilizing the rice field through its manure and contributes to mosquito and insect pest control. There is also more aeration of the rice roots and less release of the GHGs from the paddy bottom because of fish agitation." The fish refuge takes up 10 percent of the rice field area. Even with this reduction of rice farming area, the rice yield increased by 14-48 percent while there was 5-174 kg/ha of fish produced.

According to de la Cruz et al. (2001), fish in the rice-fish farms in Nueva Ecijia can contribute to increased rice yield by 10-15 percent by:

- Controlling certain weeds and insects, such as stemborer and brown planthopper
- Producing fish wastes, including uneaten feeds which add fertility to the soil
- Increasing availability of nutrient for increased floodwater productivity and uptake by rice
- Reducing loss of ammonia through volatilization by preventing floodwater pH to rise over 8.5.

The wide-scale adoption of rice-fish is still constrained by continued application of chemical fertilizers and pesticides, which are toxic to the fish. Instead, use of organic fertilizers like vermicompost is recommended or selection of pesticide with low toxicity. IPM and nutrient management strategies should thus be adopted as a necessary complement to fish farming practices in rice fields. Moreover, the rice-fish culture requires abundant water supply.

***Aquaponics*** is one of the sustainable food production technologies being promoted by BFAR, especially in areas with limited space and even in densely populated urban areas.[31] It is a closed system that combines two parts, with the aquaculture part for raising resilient fish like carp, tilapia and catfish, and the hydroponics part for cultivating vegetables in water.[32] Plants like lettuce, basil, tomatoes, bell peppers are suitable in aquaponic system. Aquaponics mimics a natural ecosystem like the rice-fish farming. Water is recycled in this system. The water from the fish tanks contains the waste from fish, and this nutrient-rich water is used as the water media for use by the plants. Aquaponics uses the plants, naturally occurring bacteria, and the water media where the plants grow to clean the water, which is then returned to the fish tanks. Solar panels can be used to power the water pumps.This system lessens water, fertilizer and pesticide use and toxic runoff (compared to traditional aquaculture and hydroponics).

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[31] Start-up units and inputs were distributed by BFAR under the DA's Plant, Plant, Plant Program and BFAR's Food Resiliency and Recovery Program for CoVID-19. The project is in line with one of the eight paradigms – Modernization – of the department's "New Thinking" approach for agriculture. (BFAR News - https://www.bfar.da.gov.ph/BFARnews?id=368)
[32] For more details about the aquaponics system, see:

- Rakocy, James E. (2012-03-23), "Aquaponics-Integrating Fish and Plant Culture", Aquaculture Production Systems, Oxford, UK: Wiley-Blackwell, pp. 344–386, doi:10.1002/9781118250105.ch14, ISBN 978-1-118-25010-5.
- Baganz, Gösta F. M.; Junge, Ranka; Portella, Maria C.; Goddek, Simon; Keesman, Karel J.; Baganz, Daniela; Staaks, Georg; Shaw, Christopher; Lohrberg, Frank; Kloas, Werner (2021-07-26). "The aquaponic principle—It is all about coupling". Reviews in Aquaculture. **14**: 252–264. doi:10.1111/raq.12596. ISSN 1753-5123.

***Aquasilviculture***, which integrates aquaculture with mangrove protection, also shows potential for sustainable production, with the added benefits of ecosystem services from the mangroves. The tidal flats and mangroves are combined with the culture of fish, mud crabs, shrimps/prawns, shellfish, etc.

## *5.4 Agriculture*

### 5.4.1 Adopt the ecosystem approach to agriculture

Adopting the ***ecosystem approach*** to agriculture encompasses several key elements: functional relationships and processes within ecosystems; management at the scale appropriate for the issue being addressed; decentralization to the lowest level appropriate; intersectoral cooperation; equitable distribution of benefits; and use of adaptive management policies that can deal with uncertainties and are modified in the light of experience.[33]

Sustainable agricultural management practices are key to realizing the benefits of ecosystem services and reducing ecosystem disservices from agricultural activities (Power 2010). The ecosystem approach to agriculture builds on the good practices that are already in place. However, there are still challenges associated with costs, profitability, productivity, uptake, and scalability, and the requirement of technical and scientific knowledge and skills, and importance of public support (Oberč and Arroyo Schnell 2020).

It is essential to explore the many interdependencies across sectors and ecosystems, and the issues along the national and global food value chain in order to choose the practical and appropriate action from among the different solution options. Multi-stakeholder processes can mobilize local farming communities as part of a social fabric for achieving sustainable ecosystems, creating bridges between farmer and catchment. Agribusinesses should be brought fully into the process in landscapes where they are key actors. The corporate sector is beginning to recognize the business case for ecosystem conservation for sustainable supply, to meet consumer demand, reduce regulatory costs, and adapt to climate change.

### 5.4.2 Implement sustainable land management and soil conservation practices

***Agroforestry***

Agroforestry recognizes the convergence of initiatives to produce food and restore, rehabilitate, and conserve resources in the uplands. It involves the integration of trees and shrubs in the same land being used for growing crops and/or raising animals. To ensure proper integration of various components involved in agroforestry system and its sustainability, it is necessary to promote multidisciplinary collaboration and bring together people from diverse fields of knowledge: agronomists, animal care specialists, landscape planners, foresters, economists, soil analysts, etc. (FAO 2015).

The following actions need to be considered to further promote and scale up agroforestry systems in the Philippines:

- Incentivize adoption of technologies that promote sustainable sloping land management and farm management.

[33] For details on CBD's Ecosystem Approach, see http://www.cbd.int/programmes/cross-cutting/ecosystem/.

- Monitor and regulate use of glyphosate herbicide and raw/semi-processed chicken dung as fertilizer and soil conditioner.
- Address resource degradation: Agroforestry should be able to assert its significant role in alleviating pressure on soil, water, and biodiversity through proper management of forests, soils and other natural resources, and effective governance.
- Support agroforestry promotion and resource productivity improvement, especially in the following areas:
    - Provision of basic support services for the upland farmers to use appropriate technologies to enhance their productivity, at the same time effectively manage the uplands and reduce risks from disaster and climate change.
    - Input and output markets should be made available to help the upland poor.
    - Make the uplands accessible through roads and adequate transportation facilities.
    - Post-harvest technologies and value-adding enterprises in the whole value chain should be included as well.
    - Incorporate delineation of agroforestry areas in land use plans.

Agroforestry should be able to provide sustainable management systems capable of improving resource productivity in the upland, reducing poverty, increasing farmer's income, and enhancing environmental stability. However, agroforestry technologies and practices are only partial solution to upland problems. Security of tenure is essential and required capacity building and support services must be mobilized, otherwise agroforestry efforts will not truly benefit resource-poor farmers. Increases in productivity as a result of the adoption of agroforestry and post-harvest technologies should be translated into increased incomes to alleviate poverty among households in the uplands. Communities in the uplands are heavily reliant on the land and water and will also need support to become resilient in the face of environmental and climatic pressures.

The passage of the proposed National Land Use Act pending in Congress is important to institutionalize climate-resilient land use planning and development. In the absence of such law, there are no clear parameters on land utilization, including zoning agricultural land for food security, delineating protected areas, such as forest corridors, and prohibiting houses in hazardous areas. The proposed law aims to create a national land use authority that will draft and oversee a national land-use plan that will classify land according to use, such as: protection (for conservation), production (for agriculture and fisheries), settlements development (for residential purposes), and infrastructure development (for transportation, communication, water resources, social infrastructure). It needs to be enacted as a key vehicle to contribute to achieving SDG 15 (Life on Land) and SDG 11 (Sustainable cities and communities).

***Reforestation and soil erosion mitigation***

The following are the priority areas for restoration and conservation (Medina 2019):

a. Vulnerable areas (11.45 million ha)
    - Sloping agricultural areas, which are not practicing soil and water conservation measures.
    - Sloping areas with minimal vegetative cover or those denuded forests, shrubs, and grasslands.

Hotspots (2.6 million ha)
- Areas requiring immediate interventions or priority areas for land conservation measures.
- Agricultural areas, greater than 18% slope with severe erosion.

- Denuded forests, shrubs, and grasslands with slopes of more than 18%.

P.D. 705, known as the Revised Forestry Code of 1975, is the law governing the management and utilization of forest lands. There is a proposed Sustainable Forest Management bill (SFMA) pending in Congress.

***Site-Specific Nutrient Management (SSNM)***

The problem with existing fertilizer application guidelines is the lack of specificity on matching the type and amount of nutrients to various crop types, and timing of application, and this can result in either over-fertilization or under-fertilization. Site-specific nutrient management (SSNM) provides an alternative and systematic approach to increase fertilizer use efficiency and reduce nutrient losses. There are four key principles (4Rs) to ensure the application of the right type/combination and quantity of soil nutrients to crops to optimally match their inherent spatial and temporal requirements:

- **Right product**: Ensure proper balance of nutrients by selecting the type of nutrients that would be suitable to the crop and to the soil properties.
- **Right rate**: Equate nutrient supply and plant demand. This involves assessing the nutrient supply in the soil and from all sources, and the amount needed by the crop. "Too much fertilizer leads to environmental losses, including runoff, leaching and gaseous emissions, as well as wasting money. Too little fertilizer exhausts soils, leading to soil degradation" (Richards *et al*. 2015).
- **Right time**: Apply nutrients when crops need them. This would involve assessing the dynamics of crop uptake of the nutrients, determining the timing of nutrient application – pre-planting, at planting, at flowering, and at fruiting, and adjusting fertilizer inputs accordingly. "This may mean using split applications of mineral fertilizers or combining organic and mineral nutrient sources to provide slow-releasing sources of nutrients" (Richards *et al*. 2015).
- **Right place**: Nutrients should be placed into the soil at the appropriate distance from the crop and appropriate soil depth. "The ideal method depends on the characteristics of the soil, crop, tillage regime, and type of fertilizer" (Richards *et al*. 2015).

The key challenges to the adoption of SSNM are (a) technology and knowledge requirements; and (b) availability of fertilizer. Public financial support should be redirected to encourage farmers to adopt best practices for fertilizer use, including manure management, and towards knowledge dissemination and education of farmers to improve their understanding of how best to use fertilizers (Andersen and Bonnis 2021). Farmers need to know the different nutrient sources (e.g., chemical fertilizer, compost, manure, crop residues), soil properties and crop types as well as be able to monitor and assess the nutrient status and plant demand so that the right amount and type of nutrients are applied at the right time. Innovative tools, such as remote sensing, GPS, GIS systems, yield monitoring, artificial intelligence, etc., can be used in detecting nutrient stresses. Government support is needed to provide farmers with the information produced from these technologies or access to such technologies. The additional benefit from SSNM is that nitrous oxide and methane emissions from agriculture can be reduced by proper nutrient management. Various studies have shown that SSNM increases crop productivity, improves efficiency of fertilizer use, and mitigates GHG emissions from agriculture in areas with high nitrogen fertilizer use.

***Crop diversification, inter-cropping, and crop rotation***

Crop diversification not only can lead to higher incomes but can also contribute to nutrient and pest management. Monoculture system can result in a low diversity of functional soil microbial community, accumulation of some host-specific soil-borne pathogens, and an imbalance of soil nutrient contents (Wang *et al*. 2018).

Plants can no longer be considered as standalone entities since they harbor a wide diversity of microorganisms. The phytobiomes resulting from increased crop diversity are increasingly recognized for their contribution to disease and pest control. Recent advances in the agricultural systems include: (i) a better understanding of the mechanisms of interactions between crop species and genotypes; (ii) ecological progress including a better understanding of the context-dependency of those interactions; and (iii) the role of microtopographic variation in agricultural systems for priming basal resistance to multiple pests and pathogens by intercropped crops (He *et al*. 2019).

### 5.4.3 Advance integrated water resources management to support agriculture

IWRM is based on the understanding that water resources are an integral component of the ecosystem, and that water is a natural resource, and a social and economic good. Managing the water resources is foundational to development. The basis of IWRM is that the many different uses of finite water resources are interdependent. Currently, there is fragmentation in water governance, with several agencies involved, and overlapping mandates. It is essential to bring together the different users and sectors—finance, planning, environment, agriculture, energy, fisheries, tourism, industry, education, health, and public works as well as local governments and private sector to improve integrated planning, water allocation, water resource conservation, and water supply and use management. For agriculture, it is necessary to (a) protect the water sources from upstream to downstream, both quantity and quality, (b) manage water supply systems for agriculture, and (c) balancing water allocation for agriculture, domestic and industrial water usage. Food security is directly linked to water security.

***Integrated watershed management***

AFMA promotes the prevention of further destruction of watersheds. The IWRM is a key strategy to protect and conserve the watershed, control damaging runoff, prevent siltation, and protect water resources. Additional benefits are moderation of floods peaks in downstream areas and increase infiltration of rainwater to hasten groundwater recharge.

***Integrated irrigation development and management***

The poor performance of irrigation systems has been attributed to poor water governance, in particular inadequate database for planning, inadequate institutional capacity and mechanisms for development, design mistakes, poor quality of construction, inadequate and fragmented support services for irrigated agriculture, and complexity of operation, such as socioeconomic and institutional management (Rola *et al*. 2021).

The crafting of an *integrated irrigation development plan* is crucial in capitalizing the long-term benefits of the country's irrigation system to ensure an increase in farm productivity and boost socioeconomic progress (Briones 2021). There is fragmentation in different phases of the irrigation development and management cycle (Rola 2019). The link between NIA and

DENR for watershed management should be strengthened, considering that the main problem of siltation in irrigation canals is caused mostly by soil erosion upstream and denuded forests. Current decision-making in the irrigation sector is done in silo by multiple institutions, and with no integrated irrigation plan to follow. At least 13 national agencies play a part in irrigation water governance: NIA, DA-BSWM, DAR, NWRB, DENR-FMB, DENR-RBCO, National Power Corporation (NPC), Department of Interior and Local Government (DILG), National Economic and Development Authority (NEDA), Governance Commission for Government Owned and Controlled Corporations (GC-GOCC), Department of Budget and Management (DBM), Local Water Utilities Administration (LWUA), and Metropolitan Waterworks and Sewerage System (MWSS). The key national government agencies—NIA and DA-BSWM, and the LGUs have been implementing irrigation projects without coordination with each other, and without coordination with other key agencies. Rola (2019) made the following recommendations:

- Craft an integrated irrigation development plan
- Boost technical capacity of NIA
- Ensure the quality of the irrigation system
- Institutionalize a modern M&E system
- Establish water resource and research centers
- Create an apex body for water to harmonize policies of water sector

### 5.4.4 Reduce pollution and promote circular economy

***Agricultural organic waste management***

The different components of solid waste (including agricultural waste) that are covered under various laws and regulations need to be integrated. With regards to organic waste, the Ecological Solid Waste Management Act (RA 9003, Section 17, Article 5) promotes composting, while the Organic Agriculture Act (RA 10068, Sections 2 and 13) gives directions on applying compost. The Renewable Energy Act (RA 9513, Section 30) promotes waste-to-energy where practicable. "One of the major challenges is the proper planning and implementation by the LGUs on how to divert the organic waste from the waste stream, and monitoring/validation on the actual reduction and diversion of organic wastes" (UNEP 2017, p.33). Active stakeholder involvement, and education and empowerment of farmers along with technical solutions and product manufacturing are other key challenges.

The development of crop waste recovery system, introduction of latest energy conversion technologies, and improvement of the biomass supply chain can play a major role in biomass and biogas energy development in the Philippines.

***Agricultural wastewater management and reuse***

Per review of the DA on the implementation of DA-DAO No. 26, it was found out that some of the assigned staff within the regional field units of DA lack awareness on the effects of untreated wastewater on health and safety of the community; do not have appreciation on the use of wastewater in agriculture; and have inadequate level of knowledge and skills to ensure that provisions in the Guidelines are properly complied with (Mogol *et al*. n.d.). This also holds true for the local government officers and staff who are responsible for the municipal wastewater management. Knowledge sharing and capacity development are needed on the following: (a) collection and different treatments methods for wastewater to ensure safety of people, crops, and aquatic life; (b) different reuse applications, and proper handling and application of treated wastewater and sludge; and (c) interpretation of laboratory analysis. Investments in infrastructure for wastewater collection, treatment, and reuse also need to be ramped up.

***Agricultural plastic waste management***

Although the percentage of agricultural plastic waste is small compared with household and other business waste, it should still be properly collected and recycled because of the negative impacts of plastic on the environment. There are also inadequate studies resulting in uncertainties about the health impact of micro- and nanoplastics. FAO (2021) recommended the development of a comprehensive *Code of Conduct* to cover all aspects of plastics throughout the agri-food value chains.

#### 5.4.5 Apply modern machineries and innovative technologies

The *Rice Competitiveness Enhancement Fund* (Rice Fund) was created by RA 11203 or *Rice Tariffication Act* (Section 13). RA 11203, Section 13.a allocates 50 percent of the Rice Fund on providing eligible rice farmers with machinery and equipment through the Philippine Center for Postharvest Development and Mechanization (PhilMech). The Rice Fund established the *Rice Competitiveness Enhancement Program,* which aims to improve the competitiveness of rice farmers through (a) rice farm mechanization; (b) inbred rice seed development, propagation, and promotion; (c) expanded rice credit assistance; and (d) rice extension services (DA 2020).

Information and communication technology, digitalization, and other innovations can facilitate good stewardship of the ecosystems, which agriculture relies on, and benefit both crop yields and sustainability. Frontier technologies can bring about a new revolution in the agricultural world, and transform resource conservation, forestry, and land management. Using remote sensing, satellite data, drones and aerial imagery can enhance real-time monitoring, which can help in analyzing field-level agricultural practices, deforestation, and water resources.

**Artificial intelligence** and **deep learning** from large image datasets can be used to classify land cover, generate maps of soil moisture to aid water management, identify weeds and non-weeds for more efficient pesticide application, and enable yield estimation through semantic segmentation (Winters 2020). Different **sensors** – optical, electrochemical, mechanical, and dielectric soil moisture sensors – can be combined with AI to enable the selection of plants that can be bred, and detect root growth, a sign of a healthy plant (Winters 2020). **Drone imagery** provides coverage of small areas at very high spatial resolution. It can be applied in plant counting for yield estimation as well as detection of nutrient deficiencies and plant diseases (Winters 2020). **Satellite and aerial imagery** provide large area coverage at lower spatial resolution, but useful where entire fields or large tracts of land require monitoring.

There are technologies that are transferable. For example, Microsoft's BasinScout Platform uses satellite data and machine learning to run possible scenarios for achieving conservation outcomes within budget constraints, and accounting for cost-effectiveness and environmental impact. It can be used to develop an approach that includes both field-scale and watershed-scale data to make recommendations, while also letting land managers set criteria for priority outcomes, e.g., reducing groundwater demand, improving irrigation, reducing nutrient runoff, or building vegetation buffers.

However, it is crucial to ensure access to such technologies and to develop the skills of farmers and agricultural planners. Collaboration with developed counties and technology providers for technical assistance is called for as climate change, biodiversity, and food and water security are shared, global responsibility, and such partnerships are in line with the SDGs (SDG 17 in particular).

#### 5.4.6 Invest in research and knowledge management for climate change adaptation

It is important to invest in research, modeling, and knowledge management to design adaptation strategies. Crops depend on a variety of soil, water, and climate conditions to grow, and climate change is expected to affect both temperature and rainfall in many areas. Studies that provide information about what conditions different crops prefer, combined with maps of current climate data and different soil or land types, and climate models, can help in predicting where conditions would improve and where they would decline. The government, with support from the scientists, can then help smallholder farmers by sharing information on breeding or planting new varieties adapted for higher temperatures, drought, or more frequent and extreme rainfall events.

Development of mathematical models, which process the dynamic relation between plant, weather conditions, soil, and management operations, would assist in farm management and strategy design, monitoring and evaluation. The application of water management models can help in the reduction of water wastage in agriculture by more accurate determination of water requirement by the crop, and in the improvement of the performance of water distribution systems by adoption of precise irrigation techniques.

Modern biotechnology is also one of the tools in modernizing Philippine agriculture, with its application in varietal improvement, crop management, biosecurity, product standards, pest and disease prevention and management, and transformation of biomass and agricultural wastes into food, feed, energy, and chemicals (Padolina 2001). Biotechnology offers a sustainable and practical solution to numerous problems in rice production, specifically on pest protection. It could aid the development of cultivars with higher yields that offer resistance against major pests in the Philippines and adapt to climate change impacts.

### *5.5 Conclusion*

The key policies and plans on sustainable development and climate resiliency of the AF sector are in place as shown by the review done in this report. However, problems remain when it comes to implementation due to competing agendas, limited resources, and lack of awareness of causes, impacts, and costs of environmental degradation, which result in the low priority being given to the environment. We have to hammer home the point that AF management and environmental protection are mutually beneficial. How to forge collaboration between government and various segments of society against the existential threat brought about by environmental and climate changes and biodiversity loss has become a conundrum. Tough decisions must be made to stabilize and reverse the negative trends plaguing the AF sector and the terrestrial and marine ecosystems today. Sustainability is not just about financial sustainability. Environmental and resource management supporting the AF sector must be given higher priority by national and local governments, in coordination with various stakeholders, to ensure food on the table today, and food in the future, continued economic benefits, and flow of ecosystem services, including resiliency to climate change. Modernization without considering the environmental aspects will not be sustainable, and even create more harm.

As difficult as integrated management may seem at first, it will eventually result in more sustainable benefits for farming and fishing communities as multiple resource use conflicts are reduced, and cross-cutting issues are resolved. The lack of integration across the different sectors, agencies, LGUs, disciplines, and even the management across ecosystems is like an orchestra with people playing different instruments, but there is no conductor. The AF sector is affected by various sectors and issues that could undermine its role in food security, exports, and economic progress, and in providing income and livelihood opportunities, not only to the marginalized farmers and fishers, but also to those employed in the food value and supply chains, and even scientists and researchers, who aim to innovate and enhance further the agricultural and fisheries production. Thus, the Whole-of-Government and Whole-of-Nation approaches are essential to support the AF sector. Solving problems at scale requires collaboration and ecosystems that are multidisciplinary, cross-boundary, and inclusionary.

Modernization of agriculture and fisheries in the 21st century is not just about increasing productivity and income; it entails a different process of change, and more focused on sustainable, climate-resilient, and equitable improvements that are made to advance the quality of life for all. There is room to hope as there are good practices and ongoing initiatives that resulted in the desired outcomes, and the lessons learned can be used to refine the policies, strategies, and institutional arrangements, and overcome the barriers. We now have many management practices that are well-accepted among LGUs and AF communities. However, there should be continuity of the programs and projects, and stricter enforcement of laws and regulations. AF conditions also change constantly, so AF managers and institutions must have the flexibility and capacity to respond appropriately and timely to the changes when they occur. Biotechnology, modeling, and innovative technologies, e.g., digitalization, blockchain, IoT, AI, machine learning, satellite data, sensors, drones, imagery, etc., are becoming ubiquitous and show potential uses in ensuring sustainable fisheries, aquaculture, and agriculture. The challenge for policymaking is to facilitate dialogue and knowledge sharing, create the market and/or regulatory conditions to incentivize uptake of sustainable practices, and support research, innovations, and continuous capacity development. It is important to help farmers and fisherfolk access the necessary inputs, financing, and technologies, and acquire the skills that will allow them to follow the economically feasible, environmentally sound, and societally desired path, and ensure that they share in the benefits.

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