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C H A P T E R

23

Socio-economic and environmental impacts of COVID-19 pandemic:
Building resilience of the seven lakes of San Pablo city, Philippines

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23.1 Introduction

In just less than six months, the world has drastically changed into a different place because of the coronavirus disease 2019 or COVID-19 that halted the various sectors of the countries. It has pushed the health systems to the edge and pulled the economy down.

It was in December 2019 when a report was made that there were pneumonia-like cases in Wuhan, China. Then, in January 2020, China officially informed the World Health Organization (WHO) that there was already an outbreak. Wuhan was declared under quarantine. The outbreak immediately spread to other countries. Several countries including the Philippines reported their first cases in the same month. The cases and death rates continued to rise that by the end of February 2020, there are already 56 countries with confirmed cases, more than 84,000 total cases confirmed globally, and almost 3,000 total deaths worldwide. It was only on March 11, 2020 when the coronavirus outbreak was officially declared by WHO as a pandemic (Kantis et al., 2020).

In the Philippines, the COVID-19 pandemic has brought a huge impact not only on the country’s economic status but also primarily on the population, health system, and its environment. At the moment there are very few studies looking at the impacts of this pandemic in the country.

This book chapter aims to present the (1) growth and status of COVID-19 cases in the Philippines and San Pablo City, (2) effects of COVID-19 on climate change, (3) environmental and socio-economic impacts of this pandemic in the seven lakes of San Pablo City, (4) governance of COVID-19 by the national and local governments, and (5) policies and measures to build the resilience of the local communities in the seven lakes.
23.2 COVID-19 cases in the Philippines

The Philippine President initially announced a partial lockdown in Metro Manila beginning at midnight of March 15, 2020. This covered 16 cities and municipalities. There were suspensions of all air, land, and sea travel to and from Metro Manila. The alert level for the coronavirus has been raised to its maximum level. Further, with the rapid increase in the number of COVID-positive cases in nearby provinces, the President placed the entire Luzon island in lockdown on March 16, 2020. The enhanced community quarantine (ECQ) was imposed in all provinces of Luzon. This is equivalent to total lockdown. Only establishments offering basic goods and services were allowed to operate. Strict confinement in all households was imposed, public transportation was suspended, and uniformed personnel such as police and military were designated to enforce stringent isolation measures. Work in all government offices and private companies were strictly operated by skeletal force. Only frontline health workers, authorized government officials, and humanitarian and medical services were allowed movement.

The daily record of COVID-cases in the country is shown in Fig. 23.1. As of August 30, 2020, the reported that the number of cases in the country was already at 217,396. Out of the total confirmed cases, there were 56,473 or 26.0% active cases, 157,403 or 72.4% have recovered, and 3,520 or 1.6% have died. DOH likewise announced 655 recoveries on that day, bringing the total number of recoveries to 135,101. The top regions with cases in the recent two weeks were the National Capital Region (NCR) (16,480 or 54%), Region 4A (CALABARZON) (5,600 or 18%), and Region 3 (2,220 or 7%). The daily record of COVID-19 cases in region 4A (Fig. 23.2) shows increasing number of cases starting from June 2020.

The ECQ was lifted on June 1, 2020. Then, the country was transitioned to a less strict lockdown category, the General Community Quarantine (GCQ). Under GCQ, employees in low-risk and priority industries such as construction were allowed to work. Curfews were still imposed on nonessential workers, but the general populace was allowed to go outside their homes to buy basic necessities. Furthermore, mall stores and shopping plazas that are classified as "non-leisure" were allowed to open partially. Public transportation was permitted, however, with less volume subject to social distancing protocols. With the easing up of lockdown, the number of COVID-positive cases increased in the country. From the average daily cases of 300-500 during the ECQ, the country recorded daily average of 800-2000 cases in June.
23.3 COVID-19 cases in San Pablo city

The first COVID-19 case in San Pablo City was recorded on March 31, 2020. There are only minimal cases in the city. The number of cases remained only 18 from May 5 to June 10, 2020 and only started increasing again on June 12. Fig. 23.3 shows a total of 223 cases as of August 30, 2020. Out of the total number of cases, 102 were active cases, 128 have already recovered, while three have died.

23.4 Effects of COVID-19 pandemic on the environment

23.4.1 Climate change

From 1951 to 2010, the air temperature in the Philippines generally has a warming trend with consistently positive trends for both the mean air temperature (Tmean) and minimum air temperature (Tmin) while a less consistent increasing trend for the maximum temperature (Tmax). This indicates warming nights and closer convergence between diurnal and nocturnal temperatures. The annual average mean temperature has risen by 0.62°C during the last 56 years. With regard to rainfall, there is an increase in both the frequency and intensity of extreme rainfall events in the majority of the weather stations throughout the country (Cinco et al., 2014).

An average of 19.4 tropical cyclones per year enter the Philippine Area of Responsibility (PAR), nine of which made landfall and crossed the Philippine islands (Cinco et al., 2014). Overlapping tropical cyclones and South West Monsoon rains interact resulting in abundant rainfall that may generate landslides and flooding that cause weather-related disasters (Cayanan et al., 2011; Heistermann et al., 2013). These typhoons have caused havoc in the environment and properties that resulted to destructive weather-related losses in many areas of the country.
Warming of air temperature, decrease in cooler nights, increase in the amount and intensity of rainfall, increase in the frequency and intensity of extreme tropical cyclones are evidence of climate change that the Philippines is experiencing in the recent decades.

The agriculture sector, coastal resources, water, and health sectors are affected by climate change. Extreme weather events like drought and flooding have damaged agricultural crops and livestock and impacted the lives and productivity of the farming communities. Coastal communities and resources are also vulnerable to extreme climatic events.

23.4.1.1 Impacts of COVID-19 pandemic on climate change

The immediate action of governments to prevent COVID-19 from spreading rapidly is the containment of people and shutting down of transportation and industries. The shutdown of industries and transportation sharply reduced the consumption of fossil fuels and its accompanying greenhouse gas (GHG) emissions such as carbon dioxide (CO$_2$) and nitrous oxide (N$_2$O), aerosols (Myhre et al., 2013; Jacobson, 2010), and particulate matter. In 2020, it was estimated that global GHG emissions might decrease by 8% or 2.6 GtCO$_2$ (IEA, 2020a). Similarly, it was predicted that there would be between 4.2 to 7.5 percent global reduction in CO$_2$ emissions in 2020 due to quarantines and economic downturns to contain COVID-19 (Le Quéré et al., 2020).

Using the spatio-temporal satellite-based products, the effects of the COVID-19 pandemic on environmental pollution were assessed (Preet et al., 2020). Results of the assessment have shown that in early months of the year 2020 (February to March), there was a significant decrease in nitrogen dioxide (NO$_2$: 0.00002 mol m$^{-2}$) concentration, a less decrease in CO$_2$ (0.03 mol m$^{-2}$), and a low to moderate decrease in Aerosol Optical Depth (AOD: $\sim$0.1–0.2) in the main hotspots of COVID-19 pandemic.

Temporary shutdown measures in industries and transportation have the potential for restoring the global environment (Preet et al., 2020). Vehicular emissions were greatly reduced, resulting to clearer skies in major cities. The ozone layer has recovered and thickened. Pollution in tourist places such as hill areas, forests, and sea beaches has diminished. Thus, generally COVID-19 pandemic has very constructive bearings on the world environment (Chakraborty & Maity, 2020).
Addressing COVID-19 also overlaps with tackling the climate change crisis. Governments and multilateral institutions addressing COVID-19 must also acknowledge that actions and measures should be appropriate to the distinct susceptibilities, needs, and conditions of the affected populations (Phillips et al., 2020).

The long-term impacts of COVID-19 on climate change is on the investments on clean technologies. The sharp decline in energy demands due to the slowing down of the economy will result to steep decline in the progress of wind, solar, and battery capacity in 2020 until 2021 (Hepburn et al., 2020). The collapse of oil prices (IEA, 2020b) will encourage fossil-based consumption during the economic recovery phase after the pandemic, predominantly in emerging economies.

A major lesson that the COVID-19 pandemic has shown us is the fragility of human life and that this pandemic requires immediate firm action from all governments. Similarly, climate change is dealing with the fragility of ecosystems that sustains human life (Prideaux et al., 2020). The probable threat of climate change to humanity and ecosystems is way greater than the impact of COVID-19. However, addressing climate change is not as urgent as addressing the spread of COVID-19 (Hepburn et al., 2020), thus in most cases, actions to address climate change are either slow, being postponed, or not prioritized by governments.

The triumph of swift science-based actions and determination of governments in the battle against COVID-19 (Hepburn et al., 2020) offers lessons for the need for such swift actions and determination in order to succeed in the battle against climate change (Prideaux et al., 2020).

23.4.2 Water quality

23.4.2.1 Impacts of aquaculture and ecotourism towards water quality of the seven lakes

Ecotourism is one of the recreational services that a lake can provide. Various water activities including swimming, boating, and other water sports have negative impacts on water quality. The negative effects of tourism development can progressively damage the environmental resources. On the other hand, ecotourism can also be beneficial to the environment. It can promote environmental protection and conservation. Also, it can raise awareness about different environmental values and serve as a tool for financing natural areas protection and intensifying its economic significance.

The adverse effects of tourism happen when the visitors’ use exceed the environment’s acceptable limits. Unrestrained tourism activities have potential threats (Dokulil, 2013). The ecological issues and problems are primarily from nutrients like nitrogen and phosphorus that come usually from urine (Dokulil, 2013). A swimmer contributes an average of 0.094 g of Phosphorus to the water (Schulz, 1981). Nutrient accumulation would lead to algal growth and blooms that decrease dissolved oxygen level when the algae die-off. Algal blooms could also create aesthetic problems such as greening of the water and ugly smell due to algal decay (Dokulil, 2013).

The Seven Lakes of San Pablo is known to offer both aquaculture and ecotourism services. Lakes Pandin, Yambo, and Mohicap are famous for their ecotourism activities such as touring around the lake using a bamboo raft and swimming activities. On the other hand, Lakes Bunot, Calibato, Palakpakin, and Sampaloc have fish cages for rearing tilapia to supply fish products to San Pablo City and nearby municipalities. Due to these lake uses, the water quality is being compromised particularly in the aquaculture lakes. Based on the historical perception of people residing around the lake, during the 1940s–1960s, water in the lakes are still of pristine condition (Fig. 23.4). But when the aquaculture industry was introduced during the 1970s, there was a decline in the water quality. For ecotourism lakes, based on local community’s perception, water quality is still in good condition until the 2000s. However, due to tourist influx and pressures of development, the water quality started to decline.

This was validated through recent water quality assessment conducted during the rainy season of 2019. Results showed that the dissolved oxygen levels of ecotourism lakes are above 5.0 ppm while aquaculture lakes are slightly below the 5.0 ppm level (Fig. 23.5A). Dissolved oxygen below 5.0 ppm is already stressful for fish and other aquatic organisms as they start to gasp for air on the surface (Pleto et al., 2018). Mortality or fish kill usually occurs at dissolved oxygen levels less than 2.0 ppm. One cause of oxygen depletion in aquaculture lakes is the increase in organic waste due to fish excretions and excess fish feeds (Floyd, 2003). As of 2018, Lakes Bunot, Calibato, Palakpakin, and Sampaloc have fish cage surface area percentages of 18.70%, 22.36%, 17.25%, and 7.68%, respectively. Other critical parameters that differentiate ecotourism and aquaculture lakes are the chlorophyll-a and transparency levels. These two parameters can determine the trophic status of the lakes. Chlorophyll-a concentration is directly related to the abundance of phytoplankton present in water. An excessive chlorophyll-a concentration due to high nutrients (nitrogen and phosphorus) from anthropogenic activities in water can cause detrimental effects to fish. Based on the results obtained, aquaculture lakes have higher chlorophyll-a content (>10 μg/L) than ecotourism lakes (<5 μg/L).
Further, lakes Pandin and Yambo are in the oligotrophic state which means that the level of nutrients is low. Lakes Mohicap and Sampaloc are in the mesotrophic state that indicates nutrients at an intermediate level. While Lakes Calibato and Palakpakin are already at the critical level with high levels of nutrients and classified as eutrophic. Related to this parameter is the transparency of water. The transparency of water is influenced by the dissolved inorganic and organic substances, total suspended solids, algae and other microscopic organisms found in water. The results showed that lakes Pandin and Yambo have clearer water which indicates good water quality while the other lakes have lesser transparency. The current condition of the seven lakes of San Pablo in terms of water quality is being threatened due to various anthropogenic activities. Based on the assessment, some of the aquaculture lakes such as Palakpakin, Bunot, and Calibato are at the critical level in terms of water quality.

**23.4.2.2 Impacts of COVID-19 pandemic on the water quality of aquaculture and ecotourism**

Various anthropogenic activities such as aquaculture and ecotourism contribute to pollution. It contributes to the pollution load in the water as they introduce different pollutants and substances. However, due to the recent COVID-19 pandemic, people’s movement and other industrial activities were stopped for weeks.
There are still very few studies conducted on the immediate environmental effect of lockdown due to the COVID-19 pandemic. There is a current study about the impact of COVID-19 on lake water quality during lockdowns in Vembanad Lake, India using remote sensing images to track suspended particulate matter (SPM) (Yunus et al., 2020). Based on the result obtained, the SPM concentration during the lockdown is lower than the pre-lockdown by 15.9% on average. Also, when they compared it with the preceding years, there was a 34% decrease in SPM concentrations. The pollution from tourism and industrial activities had decreased during the lockdown. However, non-industrial pollution such as domestic wastewater remained to be at the same level during the lockdown period. But when the industrial and tourism activities re-open, the pollutants will eventually return to the lake.

Another study was conducted and observed on the improvement of water quality of the rivers in India. The primary cause of improvement is due to reduction of industrial activities that release effluents to the river due to lockdown situations. Accordingly, the BOD of the rivers decreased to below 3 ppm which ranged between 4.0 ppm–6.5 ppm during the pre-lockdown period. Scientists in India claimed that water quality improved by about 40-50% during the lockdown. A reduction in the use of water for domestic use and bathing in the river resulted in cleaner water with aquatic life moving around (Lokhandwala and Gautam, 2020).

Considering the case of the seven lakes of San Pablo City, the aquaculture and ecotourism industries were shut down due to the threat of COVID-19. According to the San Pablo City Tourism Office, the tourism activities in Lakes Mohicap, Pandin, and Yambo were affected as they opted not to accept tourists to avoid the spread of the virus. Since there will be no recreational activities such as swimming and boating, there could be reduction of pollutants introduced into the lake water. According to the local people residing around the lake, water was relatively clean through visual inspection compared when there are tourists. This is because there was a reduction in the number of people swimming in the lake. In terms of the solid waste, it was evident that there was a decrease in volume since there are no tourists going to the lakes. Also there were no face masks and face shields found floating in the lakes.

For the aquaculture lakes, according to the fisherfolks there was a reduction in stocking of tilapia fingerlings. A decrease in fish stocking would also decrease in feeds which is a contributing factor to decreasing water quality. This could reduce the biochemical oxygen demand level and increase dissolved oxygen level which is favorable to fish. It is known that fish management practices such as daily feed input can significantly impact and deteriorate water quality (Abdel-Wahed, 2018). But since they are not introducing a new fish stock, the feed inputs were reduced. However, the City Environment and Natural Resources Office of San Pablo City had indicated that there could be an increase in effluent discharge to the lake due to increase in demand for water for washing hands and frequent bathing to avoid getting infected with the virus. There could be an increase in the nutrients (phosphorus and nitrogen) on the lakes due to increased usage of soap and detergents for washing and cleaning. This should still be validated through conduct of water quality assessments.

23.4.3 Waste management

In terms of waste generation, the COVID-19 pandemic has both environmentally beneficial and hazardous effects on health and environment. One of its many adverse consequences is the sudden surge of plastic waste volume due to personal protection and medical purposes. Even before the outbreak, the plastic management was a main environmental problem in these localities. COVID-19 pandemic has caused overwhelming concern about plastic pollution both in terrestrial and aquatic ecosystems.

23.4.3.1 Negative impacts of COVID-19 pandemic to solid waste pollution

Authorities recommend the use of disposable face masks to prevent the person to person spread of COVID-19. Moreso, authorities have enforced the use of face masks and face shields by the public, patients, and healthcare workers. Wearing of face mask and face shield has also been effective in controlling the touching of one’s own face, mouth, or nose with unwashed hands.

This unprecedented pandemic emphasizes the important role of plastic in people’s daily life. It is because managing the virus requires single use of face masks and face shields that are made out of plastics. There has also been an increasing demand in the production of various plastic products such as gloves, face masks, and face shields which serve as personal protective equipment (PPE) for the general public and the health workers. Unfortunately, this increase in the plastic production and consumption creates massive waste disposal problems.

The improper disposal and management of waste have led to main challenges in handling municipal solid waste (MSW) and harmful medical waste. Microplastics (fragments of plastic particles under 5 mm in size) can emerge from disposable face masks. When microplastics get into food like fish for human consumption, it becomes a serious concern about food safety (Fadare et al., 2020).
The indiscriminate disposal of face masks can serve as a medium for disease outbreak. It is because the plastic particles propagate invasive pathogens (Reid et al., 2019). Furthermore, many kinds of medical and harmful waste are generated. So far, no evidence is found that COVID-19 is spread in any way through medical waste (WHO, 2020d).

In San Pablo City, the Local Government Unit (LGU) is continually implementing the regular collection of household waste amidst the COVID-19 pandemic. However, there are still areas that are not being accessed by the garbage trucks. Thus, some of the residences tend to burn their waste instead. Lockdown measures increased the amount of packaging used for food and grocery delivery to the residents living near the seven lakes. The LGU said that the delivery of food to houses exacerbates the waste pollution in the area. Since the clean-up drive by the Fisheries and Aquatic Resources Management Council (FARMC) of each lake has been hampered, wastes had accumulated in the lake during the pandemic.

23.4.3.2 Positive impacts of COVID-19 pandemic to solid waste pollution

The COVID-19 pandemic also has constructive environmental effects. Since many social activities were restricted due to the pandemic, studies revealed that individuals became conscious of food waste. People, especially the vulnerable ones, are trying to reduce their waste and prevent food waste. According to an analysis, this behavior is not because of environmental awareness but is due to the negative socio-economic effects that the people experience (Jribi et al., 2020). These socio-economic effects include food anxiety, limited movements, and lack of income. On the other hand, the demand for plastic from automotive and aviation applications is due to worldwide economic recession (Klemes et al., 2020).

As per the seven lakes in San Pablo City, the waste in the lake was found to be lesser than before the COVID-19 pandemic. Perhaps, it is because of the restricted movement of residents and tourists caused by the lockdown. There are no face masks found in the lake yet. But there are few face masks disposed improperly on the lake’s surroundings (personal communication). Generally, it’s a good thing that due to the restricted movement of people, domestic and commercial wastes are reduced. This led to the aesthetic and recreational restoration of the lakes.

The impending surge of waste volume, specifically plastic waste brought about by COVID-19 pandemic, impedes to overwhelm the current waste management and healthcare capacity. However, the focus should not just be on plastics but all the more on the inappropriate consumption of society and post-consumer plastic treatments. It should be noted that several environmental issues are consequences of behavioral patterns such as improper waste disposal of consumers.

Today, it seems that placing a ban on the use face masks is the last option because of its positive effects in the fight against the COVID-19 pandemic. To formulate sustainable solution addressing the plastic pollution, it is significant to reinforce critical thinking to offer eco-friendly substitutes and enhance effective waste management systems starting from the local level.

23.4.4 Biodiversity

People benefit from biodiversity in ways that are not always apparent or directly observed. For example, in human health that rely on ecosystem goods and services such as provision of food, fresh water, clean air, and fuel, which are necessary for productive livelihoods and good health. This means that loss of biodiversity can have a significant impact on human health because ecosystem services would become inadequate to provide for social needs. Moreover, it can also indirectly affect other aspects such as livelihood, and possibly cause a political conflict.

Fish biodiversity provides livelihood through capture fisheries, aquaculture, as well as tourism. In 1940–1960, fish diversity in the seven lakes of San Pablo City includes mudfish (Channa striata), catfish (Clarias sp.), silver barb (Barbomyxus gonionotus), anchovy (Engraulidae), snakehead gudgeon (Giuris margaritacea), lacustrine goby (Gobioperus lacustris), silver perch (Leiopotherapon plumbeus), tilapia (Oreochromis niloticus), and gourami (Osphronemidae). Anchovy, snakehead gudgeon, lacustrine goby, and silver perch are the only native species while the mudfish, catfish, silver barb, tilapia, and gourami are introduced species. From 2001 to present, snakehead gudgeon and the silver perch are the only native species that are still present but there are other native species such as milkfish (Chanos chanos) and golden tank goby (Glossogobius aureus) that were added in the list (Fig. 23.6). Lost native fish species might have been due to displacement caused by non-native species introduced in the lakes.

Biodiversity has an important role also in health research and traditional medicine. Medicinal plants are from the wild populations while health research strongly relies on the microbes, plants, and animals to know human physiology and treatment of diseases. Medicinal plants are used by approximately 60% of the world’s population (WHO, 2020a). In the Philippines, DOH has permitted 10 medicinal plants including garlic (Allium sativum), Ngai
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Camphor (Blumea balsamifera), ringworm bush (Cassia alata), mint (Clinopodium douglasii), scorpion bush (Ehretia microphylla), bitter melon (Momordica charantia), silver bush (Peperomia pellucida), guava (Psidium guajava), rangoon creeper (Quisqualis indica), and five-leaved chaste tree (Vitex negundo) for treating infections and some diseases (Boy et al., 2018). In the seven lakes of San Pablo City, people use malunggay (Moringa oleifera) for treating wounds and reducing high blood pressure, yerba buena (Clinopodium douglasii) for stomach ache and diarrhea, Ngai camphor (Blumea balsamifera) for common colds and urinary tract infections, turmeric (Curcuma longa) to lower body cholesterol level, and five-leaved chaste tree (Vitex negundo) for treating cough and fever.

23.4.4.1 Impacts of COVID-19 on fish biodiversity

According to FARMC in the seven lakes of San Pablo City, lockdown implementation due to COVID-19 pandemic resulted to increase in population size of non-native species such as red devil (Vieja sp.) and jaguar guapote (Parachromis managuensis) because fishing was limited only to residents near the lakes (personal communication). During normal times, people from other barangay and towns can do fishing in the Seven Lakes. Although these fish species are edible, only a few people consume them because they are not popular as food. Fish farmers are complaining about the increase in population of these species because they eat young individuals of tilapia, milkfish, and other species which are of higher market value.

23.4.5 Aquaculture

The Seven Lakes of San Pablo City are one of the major sources of agro-fisheries growth, contributing to overall socio-economic development of San Pablo City, Laguna (Paller et al., 2017). Aquaculture of tilapia using fish cages was first introduced in Sampaloc Lake in 1976. After its expansion and success in 1989, this practice was also introduced to other lakes of San Pablo City. In 2009, Laguna Lake Development Authority reported that Lake Calibato provides abundant fish to the city and nearby towns while Lake Mohicap Lake provides abundant supply of tilapia to Metro Manila and suburbs (Laguna Lake Development Authority 2009). In 2014, it was reported that Lake Sampaloc produces tilapia mainly for local market and not for national or international market (Global Nature Fund, 2014).

In 2014, the seven crater lakes in San Pablo City were proclaimed as “Threatened Lake of the Year” by the Global Nature Fund due to their advancing destruction (Global Nature Fund, 2014). Human activities that contributed to their destruction include illegal squatting along the shores, illegal fish pens, overcrowding of fish cages, overfeeding of cultured fishes, and commercial activities done in the infrastructures built near the lakes. With the emergence of Covid-19, these activities were stopped due to limited movement being implemented in the city. Aquaculture-related activities became limited to selling fish from grow-out culture and fingerlings to market and other nearby towns and provinces. Therefore, time of pandemic can be treated as a rejuvenation period for the lakes.

23.4.5.1 Impacts of COVID-19 on aquaculture

The lockdowns implemented in different towns in Laguna and other nearby provinces have resulted in difficulties in trades of aquaculture products in relation to transportation and border restrictions. Scarcities of feed, fingerlings,
and other aquaculture items were also reported because of restrictions on travel, transportation, with specific effects on the aquaculture industry. Closure of restaurants, hotels, resorts, work canteens, and schools resulted in a drop in demand and price of fresh fish. The unsold yields will then result to higher costs for feeding, higher fish mortalities, and increase of live fish stocks (Food and Agriculture Organization, 2020).

23.5 Effects of the pandemic on society and economy

23.5.1 Health and safety

23.5.1.1 Protocols for COVID response

In the province of Laguna, there are only two COVID-19 testing laboratories certified by DOH to perform real-time polymerase chain reaction (RT-PCR). One of which is the San Pablo City District Hospital - Laguna Molecular Laboratory. This was inaugurated on June 25, 2020, along with the Intensive Care Unit (ICU) of Laguna Provincial Hospital - San Pablo City District Hospital (LPH-SPCDH). This testing facility is set to operate until December 31, 2020.

23.5.1.2 IATF guidelines on lockdown implementations

During different types of community quarantine (Table 23.1), the public is strongly encouraged to follow quarantine and health regulations such as wearing face masks, frequent handwashing, physical distancing, and avoiding mass gatherings.

In the case of San Pablo City, its LGU launched the “Stay in the Circle for Physical Distancing”. White circles were drawn one meter apart on the streets around the public market to effectively implement the physical distancing. This is to serve as an easy guide for the shoppers on the practice of proper physical distancing to avoid the spread of COVID-19 through close contact. There are frontliners present around the area to ensure strict compliance to this project. According to the LGU, the low number of COVID-19 infection and mortality in San Pablo City can be greatly attributed in part to the implementation of this physical distancing project.

When the entire Luzon was placed on lockdown in mid-March 2020, non-essential travel including the movement of millions of Filipinos who have not returned to their provinces was banned. Those foreign nationals or Filipino citizens in a specific locality within the Philippines who have expressed intention to return to their home origin were classified as Locally Stranded Individuals (LSIs). In response to the influx of LSIs, the Local Government Unit (LGU) of San Pablo City, Laguna created a One-Stop Shop for them. This aims to establish a facility that will provide a more efficient, time-saving, and more seamless process of acquiring medical clearance certificates and travel passes.

| TABLE 23.1 Activities allowed in different quarantine classifications. |
|---------------------------------------------------------------|
| **Activities**               | **Enhanced community quarantine (ECQ)** | **Modified enhanced community quarantine (MECQ)** | **General community quarantine (GCQ)** | **Modified general community quarantine (MGCQ)** |
| Movement                     | No movement regardless of age and health status | Limited movement for essential services and work | Limited movement to services and work | Movement goes back to normal with minimum public health standards |
| Economic Activity             | Minimal economic activity except for utility services | Operation of government offices and selected industries up to 50% workforce | Operation of government offices and selected industries up to 75% workforce | Permits private and public sector at 100% capacity with minimum public health standards |
| Transportation                | No transportation activity | Limited transportation for essential work and services | Limited transportation for government and private operations | Public transportation resumes with health protocols observed |
| Classes                       | Suspension of physical classes | Suspension of physical classes | Flexible learning arrangements that include physical classes in a limited manner | Flexible learning arrangements; Normal physical classes may resume with health protocols enforced |

Source: Republic of the Philippines Inter-agency Task Force Resolution No.67 (2020).
Meanwhile, all repatriated OFWs and non-OFWs are required to undergo mandatory quarantine in any government quarantine facility or hotel accredited by the Bureau of Quarantine (BOQ) until they receive their RT-PCR test results proving them to be negative for COVID-19. This is in accordance with a memorandum released by the DILG of the Province of Laguna.

23.5.2 Economy

23.5.2.1 Transportation

The LGU of San Pablo City, in line with the protocols imposed by the National Government and the IATF for the management of the COVID-19, launched the San Pablo City Anti-COVID 19 Task Force that oversees the updates and status of the COVID-19 within the city. As announced by the SPC Anti-COVID-19 Task Force through social media platforms, the local chief imposed the total ban of all public utility vehicles within the city. In response to travel ban restrictions, two jeeps/vans were provided for each barangay that serves as service for individuals who need access to the public market and other essential goods and services. Strict implementation of one member for each family to have access for a specified market day was done by providing a quarantine pass per household issued by the barangay captain. The City Disaster Risk Reduction Management Council of San Pablo City established checkpoints in all entry and exit points of the city and barangays.

In response to deliveries of food supplies, essential and critical utilities and businesses under the threat of the pandemic, Food Lane Vehicle Pass Card was given to the vehicles that transport essential goods and services with the approved clearance issued under the supervision of the City Veterinarian Office of San Pablo City.

A public service advisory was released on May 18, 2020 that tricycles within the city may start to operate as long as drivers abide by the following guidelines: 1) drivers must bring their unified quarantine pass from the Barangay; 2) drivers must wear proper attire such as face mask and face shield; 3) franchise numbers must be written or posted on the top of the tricycle; 4) the plastic separator should be placed in between passenger’s seat and driver’s seat; 5) one passenger per tricycle is allowed per trip; 6) schedule of trips based on franchise number must be followed; and 7) tricycles must stay in their designated lanes.

Safety protocols have been the first priority for every commuter and drivers. Wearing a face mask and face shield has been implemented as initial practices when going out to the public. The LGU of San Pablo strictly adheres to the guidelines released by the Department of Transportation (DOTr) allowing the use of private vehicles for individuals buying basic necessities and medical supplies.

23.5.2.2 Tourism

In San Pablo City, tourism is one of the most significant sectors in their economy that provides revenue and employment. Due to the global pandemic, the tourism ecosystem collapsed. It brought major changes to how people live and view the perspectives of travelling. Due to the challenges brought by the outbreak of COVID-19, Small and Medium-sized Enterprises (SMEs) face a threat of business collapse. Numerous countries are now moving into a new phase in battling the global pandemic while taking into consideration how to find opportunities and recover the tourism economy. According to the impact assessment study conducted by DOT through a survey across the industry sector, 82.5% responded that their income or livelihood from the tourism industry was directly affected by COVID-19.

The seven lakes offer several opportunities for the residents such as catering tourism services, practicing aquaculture, and conducting other livelihood programs. In the current times of COVID-19 pandemic, tourism had been affected as total lockdown in the area was imposed. A total shutdown of small businesses and a drastic effect on the employment of the local residents that rely mainly on the tourism of the lakes brought major challenges on their daily lives.

Lakes Pandin, Yambo, Mohicap, and Sampaloc are the known tourist destinations in the city. Lakes Calibato, Palakpakin, and Bunot are utilized mainly for aquaculture. According to the City Tourism Office of San Pablo, COVID-19 pandemic has severe adverse effects on the locals living around Lakes Pandin, Yambo, and Mohicap whose main income is rafting for the tourists when they stopped operation due to the lockdown. The travel guidelines set forth by the San Pablo Anti-COVID Task Force restrict tourists and operators to resume any kind of tourism activities within the city. This resulted to loss of income and jobs for the locals.

Currently, tourism areas in Lakes Pandin, Yambo, and Mohicap are highly affected by the COVID-19 pandemic. According to the statistics from the City Tourism Office of San Pablo, it shows that from January to July 2019 tourists’ arrival of 977000 drastically decreased to 214051 tourists’ arrival in January to July 2020. The tourism in the city is still adapting the guidelines set by the Anti-COVID Task Force and by DOT in which tourism can survive...
through different platforms, providing a diverse approach under the new normal. Alternative ways of earning a living are encouraged by the City Tourism Office to the locals by way of selling handicrafts online, producing delicacies and other farm produce, Agri-Tourism, planting and selling of crops and handicrafts making. Through gradual transitions, tourism operators of Lakes Pandin, Yambo, and Mohicap are highly encouraged to have alternative means either by growing produce or concentrating on their fish pens.

For the seven lakes fisherfolks, the Bureau of Fish and Aquatic Resources and the Social Amelioration Program (SAP) of the Department of Social Welfare and Development (DSWD) gave them financial assistance to ease the crisis brought by COVID-19. The City Tourism Office in line with the conducted webinars of the DOT can only offer free trainings in preparation for the new normal for the tourism establishments and its tourism workers to continuously operate. Some of the mentioned practices to be included in the new normal are observing proper hygiene, diversified tourism approaches like alternative livelihood including crafting, gardening, online selling, cooking and baking, and creating Quick Release code for the services and products as one way of promoting one’s establishment online.

The tourism industry not only in San Pablo City but in the entire country through the Department of DOT is conducting a series of webinars since the start of the pandemic in preparation for the new normal for the continuous operation of all its tourism establishments in the country. The Tourism Response and Recovery Plan (TRRP) of the DOT in coordination with the Tourism Council of the Philippines, and through the consultation with the World Bank aims to address and mitigate the prolonged impact of the COVID-19 crisis. According to the Tourism Secretary of the Philippines, “the TRRP seeks to protect workers and businesses during and post-pandemic, enable the government and private sector to work cohesively towards a sustainable and resilient tourism industry.” This allows some of the LGUs to gradually reoperate some business with safe standard protocols in other areas with low risk or zero cases of COVID-19 promoting domestic tourism.

### 23.6 Resilience

#### 23.6.1 Governance

#### 23.6.2 Health and wellbeing

It is a challenge to maintain a healthy lifestyle in the middle of a pandemic. Amidst the COVID-19 pandemic, it is normal and understandable to experience fear, worry, and stress regarding finances, health, job, childcare, elderly parents, education, and daily lifestyle (World Health Organization 2020c). New realities of working from home, temporary unemployment, distance learning, and lack of physical contact with other relatives and colleagues should be accepted. Moreover, the uncertainties of the world’s future should be faced (Chan, 2020).

Regardless of all the stress caused by COVID-19 pandemic, it is still very important to maintain a healthy lifestyle and get back into a routine. There are ways to manage stress and promote mental, physical, and social wellbeing.

#### 23.6.2.1 Mental wellbeing

Evidence shows that practicing meditation and mindfulness in daily activities can increase the capacity to cope up with traumatic events, improve control over our emotions, and reduce anxieties. Since ceaseless news coverage and social media posts regarding the pandemic can increase the sense of anxiety, it is very important to limit news consumption to trusted sources only to avoid spreading of false and misleading information. Most importantly, empathy must be practiced. Stigma has negative effects on the mental health of an individual and it can be combated by showing kindness and putting oneself to others’ shoes.

#### 23.6.2.2 Physical wellbeing

During this pandemic, it is important to keep the immune system strong by setting and sticking to routines, eating healthy food, getting enough sleep, practicing sanitary behaviors, and exercising. It is necessary to stay active, maintain regular meal patterns, and maximize productivity while studying or working from home. Although working from home has been the new normal work environment, it is recommended to still set up a workstation at home to have a sense of “going to work” as well as to separate personal and work matters. When working, it is also important to move around, stretch, and take some screen breaks to help refocus on work. Learning and trying something new can take the mind off from immediate problems. Trying a new hobby has also proved to reduce stress, promote creativity, and promote relaxation.
23.6.2.3 Social wellbeing

Social distancing and restricted interactions between individuals have been implemented since the COVID-19 outbreak to prevent the spread of the virus. Fortunately, there are still ways on how to communicate with family and friends. Social Media, phone calls, text messages, and video chat have been used to reach out to other people. Many community drives and charity works are being done online. Since hospitals are currently in need of blood, donations are very important as it can save lives. Most especially, cooperation with the government is an important to prevent the spread of virus.

23.6.3 Risk communication

Risk communication is an interchange of information, opinions, dialogue, and advice among the experts, risk assessors, news media, general public, and other interested groups. In the case of COVID-19 pandemic, the messages involve are about the threats brought about by the current pandemic to the health, social well-being, and economy. These messages are disseminated to the general public through community engagement, mass communication, social media, and other media (World Health Organization no date).

In the Philippines, different communication strategies related to COVID-19 pandemic have been conducted. For instance, a message toolkit was developed by DOH together with the USAID, UNICEF, and WHO to assist the DOH staff, LGUs, NGOs, international organizations, and other private organizations to consistently and effectively communicate information about COVID-19 (DOH, 2020c). The country also uses another toolkit which was disseminated by WHO mainly for the healthcare facilities and workers. It contains simplified information and procedures required to safely and effectively work in their current environment (WHO, 2020e). These toolkits were disseminated up to the municipal level so all hospitals and different organizations can use and apply it.

For information dissemination to the general public, two websites entitled “COVID-19 Dashboard” (https://covid19.gov.ph/) and “Healthy Pilipinas” (https://covid19.healthypilipinas.ph/) were launched by the Philippine government. The COVID-19 Dashboard contains update about the current statistics related to COVID-19. News, video broadcasts, and basic information related to the pandemic are also posted in the website. On the other hand, the Healthy Pilipinas is specifically managed by DOH. It contains primary resource about COVID-19 health information. The website was created with the support of USAID. With an option to view the website in English or Filipino, the general public can understand well its contents; namely: basic information about COVID-19; prevention and protection; testing for COVID-19; about community quarantine; government strategies; public health standards for different places; other health concerns; basic guidelines for everyone, health workers, LGU and community leaders, parents, teens, young adults, people at risk, media, and businesses; fact check to help determine fake news; case tracker; and other Information, Education, and Communication (IEC) materials such as infographics, educational materials, and multimedia. Aside from the website, a Facebook page also entitled “Healthy Pilipinas” was also created by DOH to reach other people who cannot access their website. Same information and IEC materials are posted on their page. People can also easily connect to the DOH through Facebook Messenger to ask questions and give suggestions.

As of September 2020, there are 129 organizations which help in conducting more than 8,000 activities related to COVID-19. Around 65% of the activities are ongoing, 28% were already completed, and 7% are being planned. More than half of the activities are information sharing and awareness sharing. Next to it is gathering feedback from the community or rumor tracking. Only a few activities were conducted for calling donations. Moreover, the most used channels for information dissemination are IEC materials, Facebook, Twitter, and SMS. Only few use face to face communication since it is discouraged and social distancing is implemented. Most of the information being communicated is about general information about COVID-19, support provided by the government and other organizations, and quarantine/lockdown guidelines. Even with the need for mass testing, only few information about access to medical facilities for testing are being disseminated. With the status of the pandemic in the country, most of the activities are still ongoing (United Nations Office for the Coordination of Humanitarian Affairs, 2020).

In Laguna, the risk communication strategies implemented by the national government have been consistently implemented at the provincial level. Aside from the different IEC materials about COVID-19 that were produced by DOH, the Provincial Government of Laguna continues to create other IEC materials to educate more the public. Their presence in social media has been an important strategy since most of the people can access information from their social media platforms. Their Facebook page has been helpful in disseminating basic information about COVID-19, updated number of cases, prevention and protection, testing for COVID-19, community quarantine guidelines, government strategies, public health standards, and other health concerns. Everyday, they post the updated number of cases and reminders about prevention and protection. They can also be easily contacted through Facebook Messenger.
In the case of San Pablo City, the risk communication strategies implemented by the national and provincial government have been also consistently implemented at the city level. The LGU of San Pablo is strictly imposing the guidelines set by the Anti-covid Task Force of San Pablo City. Information dissemination through televisions and social media has been effective in communicating COVID-19 related news and topics. Specifically, the City Information Office has been actively using their Facebook page which was specifically created in March 2020 for sharing updates on COVID-19 situation in San Pablo City. Moreover, their Facebook page is used to show the city ordinances, market and tricycle schedules, updated number of cases, prevention and protection, community quarantine guidelines, LGU strategies, and public health standards. Aside from DOH’s campaigns that are being shared in their Facebook page, they also create original contents and materials. They have maximized the use of social media because they can be easily contacted through Facebook Messenger and gather information about the needs and issues in the community level.

Aside from these strategies, the chairman, counselors, and community officials have been actively communicating with the community members about the community quarantine guidelines and their needs. Even with the strict implementation of social distancing, they still conduct face to face communication with the community members to ensure that those who do not have access to their social media will be informed about COVID-19.

The information being disseminated to the community through personal communication and use of social media have been helpful in preventing the spread of COVID-19 and avoiding being penalized for not following the guidelines. With all these risk communication strategies implemented by the LGU of San Pablo, all members of the community with different ways of receiving information will be informed.

23.7 Summary and lessons learned

During the ECQ, the number of COVID-positive cases in the Philippines was kept at low levels. Strict implementation of restricting people movement and gatherings, wearing of facial masks and shield, and social distancing proved beneficial in preventing the spread of virus. However, with the easing of the quarantine and gradual opening up of the economy in June, there was a rapid increase in the number of COVID-19 cases towards the end of June until August, 2020.

The Philippine Government has taken up various measures including legal (Bayanihan Act 1), inter-agency task force, COVID-19 infrastructure including quarantine and swab-testing facilities and designated hospitals for the treatment of COVID-19, and economic recovery plan (Bayanihan Act 2). Local government units were in the forefront of protecting the local communities from the spread of COVID-19. The Bayanihan Act 1 provided cash and food support to low income families hardly hit by the pandemic; swift purchase of PPEs, equipment and protective gear for the health-care workers; and support to the heath-care system and insurance. Multiple stakeholders also volunteered in preventing the spread of the virus.

COVID-19 pandemic has both positive and negative impacts on the environment and livelihood of local communities in the seven lakes of San Pablo City. The lockdown has reduced the fishing, aquaculture and tourism activities in the lakes. This has provided respite for the lake environment to recover and biodiversity to flourish. The quality of the water improved and the fish population increased. Industries and transportation stopped their operations during the lockdown which greatly reduced the emissions of greenhouse gases and particulate matter into the atmosphere. A negative impact of the pandemic is the rise in plastic wastes as the disposable facial masks, face shields and other protective gears are all made in plastic. Tourism activities were greatly reduced thus it greatly affected the livelihood of those families relying solely on tourism activities. Thus, the San Pablo Tourism Office is providing training on alternative sources of livelihood for these communities under the new normal.

In terms of risk communication, various COVID-19 related communication strategies engaging the community have been conducted from the national up to the barangay level. These communication strategies include message tool kits for effective communications about COVID-19, Philippine government websites, IEC materials, Facebook, Twitter, and SMS.

Lessons learned from COVID-19 have shown that decisive and swift actions by the national and local governments, science-based policy making, close monitoring of COVID-19 cases, multistakeholder participation, public awareness, and knowledge on the nature and transmission of the COVID-19, protocols for protection and tracing, establishment of COVID-19 testing and treatment facilities, and social support are key to winning the war over COVID-19.
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References

Abdel-Wahed, R., Shaker, I., Elnady, M., Soliman, M., 2018. Impact of Fish-farming Management on Water Quality, Plankton Abundance and Growth Performance of Fish of Earthen Ponds. Egytpt. J. Aqua. Biol. Fish 22 (1), 49–63.

Bandibas, J.C., 2020. PHLCOVID19. (Mobile Application). Retrieved from https://gb-spatial.com/phlcovid19/.

Boy, H.I., Rutilla, A.J.H., Santos, K.A., Ty, A.M.T., Yu, A.I., Mahboob, T., Tangpoonng, J, Nissapattorn, V., 2018. Recommended medicinal plants as source of natural products: a review. Digit. Chin. Med. 1 (2), 131–142.

Chakraborty, I., Maity, P., 2020. COVID-19 outbreak: Migration, effects on society, global environment and prevention. Sci. Total Environ. 728, 138882.

Chan, K., 2020. Compromised wellbeing, British Dental Journal, 229 (11). https://doi.org/10.1038/s41415-020-2462-2.

Cinco, T.A., de Guzman, R.G., Hilario, F.D., Wilson, D.M., 2014. Long-term trends and extremes in observed daily precipitation and near surface air temperature in the Philippines for the period 1951–2010. Atmos. Res. 145–146, 12–26.

Department of Health, 2020c. Risk Communication for the COVID-19 Health Situation Message Toolkit: Philippines. Retrieved August 30, 2020 from https://www.thecompassforbcs.org/sbctools/message-toolkit-version-2-risk-communication-covid-19.

Dokulil, M., 2013. Environmental impacts of tourism. eutrophication: causes, consequences and control. DOI 10.1007/978-94-007-7814-6_7.

Fadare, O., Wan, B., Guo, L., Zhao, L., 2020. Microplastics from consumer plastic food containers: are we consuming it? Chemosphere.[PubMed] [Google Scholar].

Floyd, R., 2003. Dissolved oxygen for fish production. University of Florida: IFAS Extension, pp. 1–3.

Food and Agriculture Organization, 2020. Novel coronavirus (COVID-19). Retrieved August 17, 2020 from http://www.fao.org/2019-ncov/q-and-a/imp-act-on-fisheries-and-aquaculture/en/.

Global Nature Fund, 2014. Intensive fish farming threatens Philippine crater lake - Lake Sampaloc is “Threatened Lake of the Year 2014”. Press Release of GFN_Threatened Lake of the Year 2014_Sampaloc. Accessed August 20, 2020.

Hepburn, C., O’Callaghan, B., Stern, N., Stiglitz, J., Zenghelis, D, 2020. ‘Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?’ Smith School Working Paper 20-02.

IEA, 2020a. ‘Global Energy Review 2020.’ Flagship Report, International Energy Agency (IEA).

IEA, 2020b. ‘Oil Market Report - April 2020.’ Oil Market Report, International Energy Agency (IEA).

Jacobson, M.Z., 2010. ‘Short-term effects of controlling fossil-fuel soot, biofuel soot and gases, and methane on climate, Arctic ice, and air pollution health.’ Journal of Geophysical Research: Press, Cambridge, United Kingdom and New York, NY, USA.

Jribi, S., Ben, H., Doggui, D., Debbabi, H., 2020. COVID-19 virus outbreak lockdown: What impacts on household food wastage? Environ. Develop. Sustain. https://doi.org/10.1007/s10668-020-00740-y.

Kantis C., Kiernan S., Bardi J.S., 2020. UPDATED: Timeline of the Coronavirus. Think Global Health. Retrieved August 30, 2020 from www.thinkglobalhealth.org/article/updated-timeline-coronavirus.

Klemes, J.J., Fan, Y.V., Tan, R.R., Jiang, P., 2020. Minimising the present and future plastic waste, energy, and environmental footprints related to COVID-19. Renew. Sustain. Energy Rev. doi:10.1016/j.rser.2020.109883.

Laguna Lake Development Authority, 2019. Water quality reports of the seven crater lakes 2006–2008. Environmental Quality Management Division. Laguna Lake Development Authority, Taytay, Rizal, p. 25.

Le Quéré, C., Jackson, R.B., Jones, M.W., Smith, A.J.P., Abernethy, S., Andrew, R.M., Peters, G.P., 2020. Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement. Nat. Clim. Change. https://doi.org/10.1038/s41558-020-0797-x.

Lokhandwala, S., Gautam, P., 2020. Indirect impacts of COVID-19 on environment: A brief study in Indian context. Environ. Res. doi:10.1016/j.envres.2020.109807.

Myhre, G., Shindell, D., Bréon, D.-M., Collins, W., Fuglestvedt, J., Huang, J., Koch, D., Lamarque, J.-F., Lee, D., Mendoza, B., Nakajima, T., Robock, A., Stephens, G., Takemura, T., Zhang, H., 2013. ‘Anthropogenic and Natural Radiative Forcing’. In: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Eds.), Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth.

Paller, V.G., Corpuz, M.N.C., Bandal M.Z Jr, 2017. Freshwater fish assemblages and water quality parameters in Seven Lakes of San Pablo. Asian Journal of Biodiversity, Laguna, Philippines, pp. 1–22.

Phillips, C.A., Caldas, A., Cleetus, R., Dahl, K.A., Declet-Barreto, J., Licker, R., Merner, L.D., Ortiz-Partida, J.P., Phelan, A.L., Spanger-Siegfried, E., Talati, S., Trisos, C.H., Carlson, C.J., 2020. Compound climate risks in the COVID-19 Pandemic. Nat. Clim. Change 10, 586–598.

Pleto, J.V.R., Arboleda, M.D.M, Simbahan, J.F., Migo, V.P., 2018. Assessment of the Effect of Remediation Strategies on the Environmental Quality of Aquaculture Ponds in Marilao and Meycauayan, Bulacan, Philippines. J. Health Pollut. 8 (20). https://doi.org/10.5696/2156-9614-8.20181205.

Preet, L., Kumar, A., Kumar, S., Kumari, S., Saikia, P., Dayanandan, A., Adhikari, D., Khan, M.L., 2020. The dark cloud with a silver lining: Assessing the impact of the SARS COVID-19 pandemic on the global environment. Sci. Total Environ. 732, 139297.

Prideaux, B., Thompson, M., Pabel, A., 2020. Lessons from COVID-19 can prepare global tourism for the economic transformation needed to combat climate change. Tour. Geogr. 22 (3), 667–678.
Reid, A.J., Carlson, A.K., Creed, I.F., Eliason, E.J., Gell, P.A., Johnson, P.T.J., Kidd, K.A., MacCormack, T.J., Olden, J.D., Ormerod, S.J., Smol, J.P., Taylor, W.W., Tockner, K., Vermaire, J.C., Dudgeon, D., Cooke, S.J., 2019. Emerging threats and persistent conservation challenges for freshwater biodiversity. Biol. Rev. [PubMed] [Google Scholar].
Schulz, L., 1981. Quarry ponds and fishing. Hyg. Int. Abst. Orig. 173, 528–548.
United Nations Office for the Coordination of Humanitarian Affairs, 2020. Philippines: COVID-19 Operational Presence Risk Communication and Community Engagement (RCCE). OCHA website. Retrieved August 29, 2020 from https://data.humdata.org/dataset/philippines-covid-19-operational-presence-risk-communication-and-community-engagement-rcce.
World Health Organization, 2015. General Information on Risk Communication. Retrieved August 29, 2020 from https://www.who.int/risk-communication/background/en/
World Health Organization, 2020a. Climate change and human health. Retrieved August 20, 2020 from https://www.who.int/globalchange/ecosystems/biodiversity/en/.
World Health Organization, 2020c. Mental Health & COVID-19. Retrieved August 30, 2020 from https://www.who.int/teams/mental-health-and-substance-use/covid-19.
World Health Organization, 2020d. Shortage of personal protective equipment endangering health workers worldwide. Retrieved August 30, 2020 from https://www.who.int/news-room/detail/03-03-2020-shortage-of-personal-protective-equipment-endangering-health-workers-worldwide.
World Health Organization, 2020e. The COVID-19 risk communication package for healthcare facilities. Manila: WHO Regional Office for the Western Pacific. https://apps.who.int/iris/handle/10665/331140. License: CC BY-NC-SA 3.0 IGO.
Yunus, A., Masago, Y., Hijioka, Y., 2020. COVID-19 and surface water quality: Improved lake water quality during the lockdown. Sci. Total Environ. 731, 1–8.