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Positive and Negative Effects of COVID-19 Pandemic on Aquatic Environment: A Review

(Kesan Positif dan Negatif Pandemik COVID-19 ke atas Persekitaran Akuatik: Suatu Ulasan)

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ABSTRACT

In December 2019, a novel coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) outbreak was reported for the first time in Wuhan, Hubei province, China. This coronavirus has been referred as Coronavirus Disease 2019 or COVID-19 by World Health Organization (WHO). The spread of COVID-19 has become unstoppable, infecting around 93.5 million people worldwide, with the infections and deaths still increasing. Today, the entire planet has changed due to the greatest threat on the planet since the introduction of this lethal disease. This pandemic has left the world in turmoil and various measures have been taken by many countries including movement control order or lockdown, to slow down or mitigate the infection. Since the lockdown has been implemented almost in all affected countries, there has been a significant reduction in anthropogenic activity, including a reduction in industrial operations, vehicle numbers, and marine-related activities. All of these changes have also led to some unexpected environmental consequences. As a result of this lockdown, it had a positive and negative impact on the environment including the aquatic environment. Hence this review will therefore focus on the good and bad perspectives of the lockdown toward the aquatic environment.

Keywords: Anthropogenic; aquatic environment; COVID-19; lockdown; pollution

ABSTRAK

Pada Disember 2019, satu koronavirus baru yang dikenali sebagai SARS-CoV-2 telah merebak dan dilaporkan untuk pertama kalinya di Wuhan, Wilayah Hubei, China. Koronavirus ini telah dinamakan sebagai Coronavirus Disease *2019 atau pandemik COVID-19 oleh Pertubuhan Kesihatan Dunia (WHO). Penyebaran COVID-19 ini tidak dapat dikawal dan dihentikan dan telah menjangkiti hampir 94.5 juta manusia di seluruh dunia dengan kadar jangkitan dan kematian masih meningkat pada hari ini. Kini, persekitaran bumi telah berubah kerana ancaman terbesar sejak kemunculan wabak ini. Pandemik ini juga menjadikan seluruh dunia menjadi panik dan pelbagai langkah telah diambil oleh kebanyakan negara termasuk perintah kawalan pergerakan untuk memperlahankan dan mengawal jangkitan ini. Sejak perintah ini dilaksanakan di kesemua negara yang terjejas di seluruh dunia, aktiviti antropogen telah berkurangan secara signifikan, termasuk aktiviti perindustrian, jumlah kenderaan di jalan raya dan juga aktiviti berkaitan dengan laut. Semua perubahan ini turut membawa kepada perubahan persekitaran yang tidak dijangka oleh manusia. Hasil daripada kawalan ini, ia memberi kesan positif dan juga negatif terhadap alam sekitar termasuklah persekitaran akuatik. Oleh itu, ulasan ini akan menumpukan kepada perspektif baik dan buruk perintah kawalan pergerakan terhadap persekitaran akuatik.*

Kata kunci: Antropogen; COVID-19; kawalan pergerakan; pencemaran; persekitaran akuatik

Introduction

The coronavirus disease 2019 or well known as COVID-19 (Lai et al. 2020) is becoming a hot issue and a big world crisis. The first case of this virus was detected in Wuhan City, Hubei Province, Central China. It was reported to the WHO Country Office in China on 31st December

2019 before it spreads and shocks people worldwide (Lu et al. 2020). To date, more than 94.5 million cases with a total of 2.1 million deaths reported in 200 countries and territories around the world, with the United States, India, Brazil, and Russia currently experiencing the most widespread have been affected by this deadly virus. The COVID-19 can spread *via* airborne zoonotic droplets, in which the animals spread the virus to humans (Ahmad et al. 2020; Chakraborty et al. 2020). However, this virus has undergone some genetic mutations that enable it to afflict humans and can be transmitted among humans itself (Shereen et al. 2020). When this transmission occurred, the confirmed cases increased (Adhikari et al. 2020) and still growing today.

The outbreaks of COVID-19 are far more than a health emergency (Sohrabi et al. 2020; Wenham et al. 2020). This pandemic has affected every segment of the human population such as economic (Nicola et al. 2020) and social (Van Lancker & Parolin 2020) crisis and as well as environmental quality (Abdullah et al. 2020; Wang & Su 2020). The emergence of COVID-19 has become unstoppable since an outbreak in late December. It has been increasing day by day to date. Because of the global threat, on 30th January 2020, the World Health Organization (WHO) declared COVID-19 a Public Health Emergency of International Concern (PHEIC). WHO (2020) announced on 11th March 2020 that COVID-19 had been adjudicated as a pandemic that propagates across dozens of countries or continents. This pandemic declaration was due to the sudden increase in the number of positive cases reported with this virus outside the country of origin, China over the past two weeks worldwide.

Since the number of cases related to COVID-19 is expected to increase further, WHO Regional Director for Europe, Dr. Hans Henri P. Kluge advises countries worldwide to continue implementing a containment strategy while speeding up their efforts to control the disease (WHO 2020). Despite this, most country leaders have announced a national lockdown to fight the spread of COVID-19 (Hamzelou 2020). In Malaysia, the government has announced several levels of lockdown namely, Movement Control Order (MCO), Conditional Movement Control Order (CMCO), Recovery Movement Control Order (RMC) that started from 18th March 2020 to date. This order stops all non-essential businesses and activities or may operate at minimum conditions while implementing government rules and regulations. People are encouraged to limit their outdoor activities and work from home. After a few weeks of implementation, this approach showed positive feedback when the number of confirmed new cases of COVID-19 began to decline (Deshwal 2020; Lau et al. 2020).

Since the lockdown has taken place around the world, most of the positive impacts on the aquatic environment can be seen from the naked eye (Chen et al. 2020; Saadat et al. 2020). However, we are concerned about the negative impact or invisible pollutants such as chemical and biological pollutants that enter the aquatic. Most of these pollutants may build up in the environment through bioaccumulation, biomagnification and bioconcentration processes from unnoticed to toxic levels (Álvarez-Ruiz & Picó 2020; Loften et al. 2018; Ong & Gan 2017). In this review, we summarise the positive and negative impacts of COVID-19 pandemic lockdown on the environment, particularly in the aquatic environment.

LOOKING AT THE POSITIVE PERSPECTIVES

Reduced emission of carbon dioxide (CO_2) gas and ocean acidification

Since the lockdown enforcement implements worldwide, offices, businesses, and industrial activities have been shut down. Transport networks are also dwindling due to the shutdown of domestic and international routes. The running of trains, busses and vessels have also been ceased to operate. As quickly as all these activities stopped, the major problems we have been fighting for decades have happened in a few days and nature has become accustomed to it. All of these have significantly reduced fossil fuel consumption (Dutheil et al. 2020) and as a result, CO_2 emission has been touched the trough in the existing CO_2 profile of the region. It has led to a sudden drop (Figure 1) as much as 40% in CO_2 emission profile in the atmosphere of the major cities around the world (Fattorini & Regoli 2020; Zhu et al. 2020a) such as Kolkata, India (Mitra et al. 2020), Barcelona, Spain (Tobías et al. 2020), São Paulo, Brazil (Freitas et al. 2020) and Kuala Lumpur, Malaysia (Suhaimi et al. 2020).

Several scientists have proved that CO_2 is more than greenhouse gases that are the leading gases responsible for ocean acidification (Kitidis et al. 2017). Atmosphere exchanges with the sea and interactions with atmospheric CO_2 usually lead to this phenomenon (Williamson et al. 2017). The excess anthropogenic atmospheric CO_2 is absorbed by the ocean, becomes aqueous and reacts with H_2O to form carbonic acid (H_2CO_3) (Doney et al. 2009). This carbonic acid can dissociate itself by losing hydrogen ions to create carbonate CO_3^{2-} and bicarbonate HCO_3^- ions. Study by Raven (2005) shows that a 0.1 reduction in pH can increase 30% of hydrogen

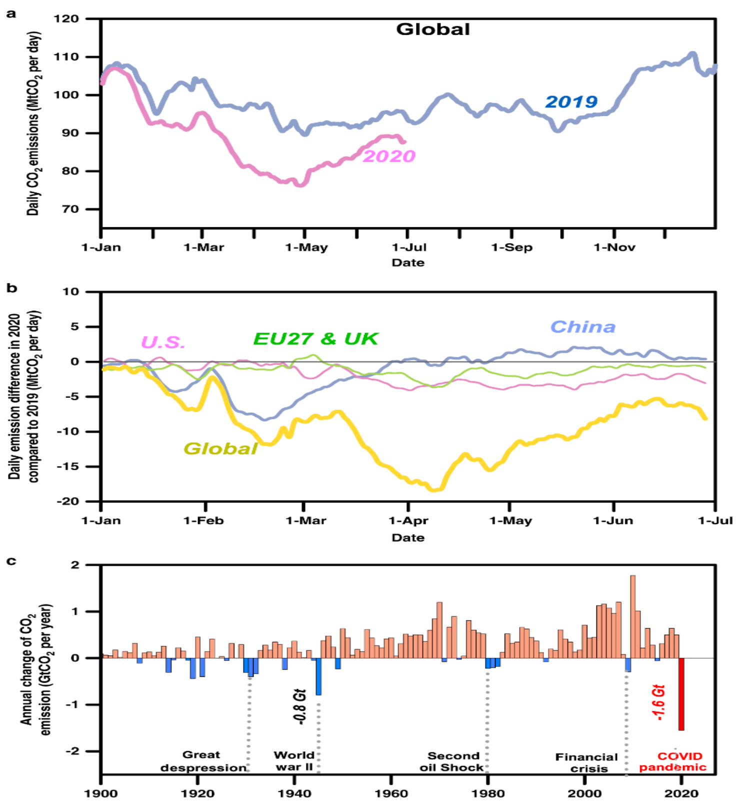

FIGURE 1. Effect of pandemic COVID-19 lockdown on global CO_2 emissions (Zhu et al. 2020b)

ion concentration in the ocean. The liberation of hydrogen ions in the seawater leads to decreased pH and can affected marine organisms (Doney et al. 2009).

The lower concentration of CO_2 in oceans for a few months during the lockdown is still beneficial for coral reefs and all calcifying organisms (Connel et al. 2017) such as oysters and clams. Gagliano et al. (2010) reported the mean pH for the world's open oceans ranges from 7.9 to 8.3, and this range is suitable for almost all marine organisms. If the sources of ocean acidification dropped drastically during the last months, we could expect to see changes in ocean pH worldwide. With no continuous input of CO_2 into the atmosphere, oceans could have absorbed enough carbon dioxide (DeVries et al. 2017) to return to the once usual equilibrium of CO_2 concentrations in the atmosphere. With normal interactions between air and water, we can expect to see an increase in pH, thus ocean basification can occur (Brodersen et al. 2020).

Improve the clarity and quality of water

Anthropogenic by human activities can mechanically disturb water chemistry (Batista et al. 2016; Fernandes et al. 2020). Plus, boat propellers mix the different layers and add oxygen in the first one, thus modifying the water chemistry (Sagerman et al. 2020). Indeed, maritime traffic, recreational, and fishing boats create waves when their propellers mix the water (Burgin & Hardiman 2011). This water turbulence can stir up sediment, resulting in shading of aquatic plants due to increased water turbidity and in smothering when sediment settles on the shoots (Sagerman et al. 2020). Since a single boat does not have a tremendous impact, the number used daily across the world is substantial. Most of the aquatic environments used to be brownish before the lockdown but are now blue and crystal clear (Lokhandwala & Gautam 2020).

For example, In Italy, with a nationwide lockdown established on the 9th March 2020 (Zanin et al. 2020), the canals of Venice have seen an improvement in water clarity due to the reduction of water traffic, not only from the tourist-famous gondolas but notably from motorised boats including Vaporetto water buses, main transportation for the Venetian and cruise ships (Braga et al. 2020). In effect, the greater water flow and visibility is not a result of lower pollution but rather a reduction of sediment stirring (Bilkovic et al. 2019). The improved water clarity has led to reports of previously obscured many aquatic species that were not present before the pandemic such as the reappearance of small fish, crabs, jellyfish and seaweeds within the canals (Brunton 2020).

Since the lockdown in Malaysia, reduced commercial activities have been reported to reduce waste produced and sullage water which ends up in rivers without wastewater treatment. As a result, many communities in the Klang Valley, particularly in Sungai Kemusing, Sungai Way and Sungai Gombak have reported improved water clarity in many rivers (Goi 2020). One significant example is Sungai Melaka, which before the MCO, the river water was murky and brown colour (The Star 2020). Most evidence of improved water quality remains anecdotal; a survey from the Department of Environment (DOE) of Malaysia, ammoniacal nitrogen, biochemical oxygen demand, dissolved oxygen, pH and total suspended solid data from 29 water monitoring stations in Malaysia indicated an improved river water quality index (Goi 2020).

Reduced acoustic pollution of the marine environment

The introduction of noise into the marine environment may significantly impact marine species and ecosystems (Peng et al. 2015). Many marine animals use sound and acoustics energy to adapt to their environment (Stocker 2002). The COVID-19 pandemic was also linked to a reduction in marine acoustic pollution (Thomson & Barclay 2020) as well as terrestrial pollution. For example, in British Columbia, Canada, there has been a significant decrease in cruise ships and freight shipping, with imports and exports falling by 16% in some ports compared to 2019, according to Statistic Canada (Bennett et al. 2020). Researchers analysing real-time sound signals from Ocean Networks Canada underwater observatories reported a significant drop in low-frequency sounds off Vancouver Island and the coast of British Columbia since the onset of the pandemic (Thomson & Barclay 2020). Several studies reported that the acoustic pollution can cause changes in individual and social behaviour, auditory masking, population distribution and abundance and other physiological impacts of the marine organisms (Peng et al. 2015; Rako-Gospić & Picculin 2019). Considering the detrimental effects of acoustic pollution on marine mammals, notably cetaceans such as baleen whales (Mysticeti) and toothed whales (Odontoceti), which rely on high to low frequency sounds for navigation, communication and/or hunting, the biological implications of quieter oceans could be substantial (Jiang et al. 2021).

The recovery of aquatic life and fishery resources

Due to the effects of the COVID-19 lockdown measures, notably with restaurants and hotels' closure, reduced demand for fish and seafood has affected many parts of the world (Korten 2020). Furthermore, as many fishing vessels around the world are unable to leave harbour due to movement control orders and an increased risk of transmission to crews, fish populations may see a respite from fishing to allow the recovery of populations (Korten 2020). Korten (2020) estimates that if fishing activities are limited for more than a year, long-enough to allow for a large number of species to complete their spawning cycles, these species could proliferate, allowing the fish recovery stocks above current levels. In Europe, after a year's fishing break, it has been suggested that stocks of herring, flatfish and whitefish could double in biomass.

Since this lockdown began mostly in March, it can help marine life to recover and conservation plans to achieve their goals more quickly, as many species breed between March and May in the Mediterranean (Aspillaga et al. 2016) and between April and June in the Atlantic (Mazzoni et al. 2018). For example, sea turtles have benefited from the reduction of tourism and their offspring could reach the sea without any disturbance because the beaches are cleaner and with less noise and people. In addition, the peak nesting season for sea turtles was estimated to occur between May and June (Salleh et al. 2018).

RECOVERY OF CORAL REEFS COMMUNITIES

Coral reefs are often pressured by natural disasters and anthropogenic influence. Over the years, the decline of coral reefs health is more often related to climate change, major coral bleaching events, and physical disturbances such as urbanization, trawling and fish bombing (Lough et al. 2018). The nature and usage of coral reefs provide food for the local people, a shelter for marine organisms, recreational and tourism activities, and coastal protection (Praveena et al. 2012). If the coral reefs are wisely managed over the years of human evolution, the coral reefs still can maintain the optimal function by providing essential services. But as human population increases and lack of awareness, the damage of coral reefs are now cannot be revert. The cause of coral reef degradation can be due to high sedimentation loads (Lee & Mohamed

2011), increases of human settlement which related to deforestation and agriculture, river runoff (Edinger et al. 1998) and fish bombing (Alcaca & Gomez 1979). Recovery of coral reefs can be short as in 10 years or more than 40 years (Steneck et al. 2019), according to the level of damage and recovery processes.

During the COVID-19 outbreak in Malaysia, the east coast of Peninsular Malaysia just ended the monsoonal cycle from mid-November to mid-February (3 months). Movement Control Order (MCO) was enforced in mid-March 2020 which require all business to stop operating except essential services. Stringent lockdowns with no traveling between countries or states certainly reduced the tourism impacts on coral reefs. This generally gives a positive input to the coral reefs within the area. Several studies also reported the enhancement of the marine ecosystem and improved the health of the environment (Edwards et al. 2021; Gordon 2020; King et al. 2021). Less anthropogenic impacts such as limited boating activities that cause water pollution; wave energy from boats and ferries services that cause coastal and beach erosion; snorkelling and diving activities that increase sedimentation, sunblock pollution, noise pollution; and light pollution at coastal resorts that hinder the landing of turtles nesting. Although it is not feasible to repair coral reefs to their past wellbeing (Hughes et al. 2017), active restoration and less anthropogenic influence can still provide better function and ecosystem services (Seraphim et al. 2020).

LOOKING AT THE NEGATIVE PERSPECTIVES

Trash in marine environment

Even though, reduction of anthropogenic activity due to the COVID-19 pandemic has positive impacts on the human health and marine environment, it also has created a new form of pollution to the environment. COVID-19 is caused by the coronavirus and can cause respiratory virus infection through contact (direct and indirect), droplet spray in short range transmission and aerosol in long-range transmission (airborne transmission). To control and avoid the spread of this contagious virus, WHO has advised the health workers, front liners and public to wear personal protective equipment such as wearing face mask and gloves particularly on the infected area (WHO 2020). This has caused the demand on the face mask and gloves increased rapidly worldwide and some places were in shortage.

Moreover, there are lack of information and guidance to the public on how to properly dispose the used face mask and gloves. This problem also worsen by inadequate disposal facilities to deal with the biohazard materials. Recently, in the mass media there are reports showing a glut of discarded single-use masks and gloves was washing up on shorelines and littering the seabed (The Guardian 2020 & World Economic Forum 2020). Adding to the problem, the report also estimated that if every person used a single-use face mask a day for a year, it would create an additional 66,000 tonnes of contaminated waste and 57, 000 tonnes of plastic packaging which greatly impacting the marine environment and human health as a new form of marine pollutant and source of water borne-diseases.

Pharmaceuticals waste in the aquatic environment

The use of pharmaceuticals and drugs to combat the COVID-19 pandemic is unavoidable. Pharmaceuticals compounds from different classes such as chloroquine, hydroxy chloroquine, azithromycin, remdesivir, lopinavir, ribavirin, and ritonavir have been widely used to treat the patient with coronavirus infection (Baron et al. 2020; Fanin et al. 2020). With the increasing number of positive cases reported worldwide, more pharmaceuticals will be introduced and tested in the future to treat this disease. Therefore, there is a concern about the elevated level of pharmaceutical residues that might infuse into the aquatic environment due to the increasing number of pharmaceuticals and drugs used in medical facilities. Previous studies have shown that pharmaceutical residues were reported in the surface water, as reported by Omar et al. (2019a) and Praveena et al. (2018). Several sources have been linked with the contamination of these residues in the aquatic environment and one of it is from hospital waste (Sim et al. 2013). The presence of pharmaceutical residues in the aquatic environment will also affect other aquatic compartments such as sediment and biota (Omar et al. 2019b, 2018). In example, Oestrogen is one of the main female sex hormones that have been found to cause hermaphroditism (Jobling et al. 2006). As we all know, the aquatic environment consisted of many organisms being used as a food source. Thus, the uptake and bioconcentration of pharmaceutical residues by aquatic organisms are of concern due to its effect on human health. Besides the aquatic environment, there is also a possibility of coronavirus transmitted through faecal sterols and subsequently contaminated the wastewater system. This has been summarized by Quilliam et al. (2020), discussing the environmental implication of shedding the SARS-CoV-2 in human faeces. The ability of coronavirus leached into wastewater might also be an important consideration because it could also occur to the pharmaceutical compounds. Although there has been report on the occurrences of pharmaceutical residues in the wastewater effluent, but with the increasing volume of drugs used to treat the disease will lead to the elevated level of pharmaceutical residues in this effluent. Therefore, the pharmaceutical residues should also be assessed in the wastewater treatment system especially from hospital or medical facilities that are being used for COVID-19 treatment.

During this pandemic, the world has been under lockdown for a certain period. People stay at home, which will eventually lead to high pollution load into the aquatic environment due to domestic discharge and sewage effluents. Domestic discharge and sewage effluents have been several pollution sources of pharmaceutical residues. Although various treatments methods are used to remove pharmaceutical residue from both sources, the elimination is still not satisfactory, leading to the leach of these compounds into the aquatic environment.

Plastic pollution in the aquatic environment

The increase of single-use plastics during the COVID-19 pandemic is inevitable. Frontliners use plastics as their protective gear and people have been taking takeaway food using plastic containers. Many grocery stores and restaurants have also prohibited their customers from bringing their containers or shopping bags to avoid cross-contamination. With the uncertainties in this pandemic's duration, we predict this plastic pollution will be a major issue and impact for a long-term in the future. This prediction also agreed by Praveena and Aris (2021) that a massive of plastic waste was generated in several capital city in South East Asia countries such as Kuala Lumpur, Bangkok and Singapore. Improper deposition of plastic will eventually affect the aquatic environment.

Plastics will break down into smaller pieces called microplastics and due to their tiny scale, microplastics may be eaten by several marine species who perceive them as a food supply and may thus have harmful effects (Courtene-Jones et al. 2017). There are different pathways in which plastics are released into the ecosystem and a large amount of plastic waste comprises the marine environment. Microplastics occur on the surface waters of seas, seabed sediments and in a broad range of aquatic species, such as sea birds, fish, bivalves, mammals, and crustaceans. Microplastics and their low density lead to the widespread transportation and dissemination by currents over greater distances.

These tiny marine plastics are widespread in all aquatic environments worldwide (Eerkes-Medrano et al. 2015). Although some plastics enter oceans through marine activities, 80% are believed to come from sources based on land. Discarded plastic products reach the aquatic system by freshwater waters, sewer outflows, and wind or tide transport as waste, factory runoff, or litter. Waste production and waste leakage are inextricably tied to economic growth, local infrastructure, and regulation. It has been reported that out of 269 million tons of 5.25 trillion pollutants globally, 92% are microplastics and a hundred times smaller than predicted on the surface of the water, supporting the understanding that most microplastics sink into aquatic sediments (Eriksen et al. 2014).

Microplastics often adversely affect the essential component of the aquatic ecosystem, planktons. The presence of microplastics into the phytoplankton cell wall results in decreased absorption of chlorophyll. The heterotrophic plankton often undergoes the phagocytosis process when exposed to microplastics and preserves some tiny plastic particles in its tissues (Akdogan & Guven 2019). Microplastics in the intestine of fish results in malnutrition and food starvation, which eventually contributes to death. Larger-microplastic beads (5 mm) have been reported to stay longer in the gut of the fish compared to smaller beads (2 mm). These findings contribute to larger microplastic particles becoming more toxic to the aquatic fish population as compared to tiny pieces because tiny microplastics may be excreted by human faeces. In addition to fish, ingestion of various forms of microplastics was observed in Norway lobster where 83% of lobsters were reported to be microfibre infected (Andrady 2017).

Greywater runoff into the aquatic environment

The amounts of greywater runoff from kitchen and laundry activities in residential buildings are expected to increase during the lockdown due to household activities. Nonetheless, decentralised treatment for greywater is needed to reduce the pollution load in the sewage treatment plant. The transport of greywater produced from the residential buildings to sewage treatment usually takes a certain distance. There is a possibility of greywater runoff due to sewerage network leakage or disruption because of poor maintenance. Greywater is an alternative source for water reuse mechanism; however, organic matter in the greywater may prevent phosphorous adsorption. Therefore, before discharging into the stream, greywater runoff should be treated because it will pollute fresh water and affect aquatic life in the stream. This scenario was resulting higher probability of decreases quantities of clean water. To mitigate water scarcity and accomplish water sustainability in urban areas, the greywater runoff must be treated by a decentralised treatment system such as filtration and on-site greywater reuse treatment system.

Greywater is the wastewater produced from houses such as bathtubs, shower, hand basins, kitchen sinks, dish washer, and laundry machines. Greywater is a fraction of household wastewater with lower pollutant concentration (Boano et al. 2020). Greywater from urban runoff consists of body care products, food residue, oil, body fat, hair, bleaches and develop pollutants distinguished from organic carbon, total solid, total suspended solid, and nutrients (Noutsopoulos et al. 2018). Oktor and Çelik (2019) reported the greywater contribute over 50% of residential wastewater.

The urban runoff from greywater is usually discharged into the stream network and carries amount of dissolved nutrients and leads to low dissolved oxygen. Greywater runoff contamination is one of the issues in growing cities in many urban areas with conventional sewage treatment systems (Liang et al. 2019). Lockdown due to the spread of COVID-19 takes place in every country where people stay at home. As a result, stay at home policy has made the amount of greywater produced increase.

Greywater has the potential to pose degradation to the environment. During the lockdown, the main concern of the increased contaminants is the urban runoff from laundry greywater. The presence of metals and micropollutants poses a possible threat to stream systems and also to public health (Boano et al. 2020). Turner et al. (2019) found that triclosan is an antimicrobial agent and it is commonly used in personal care items, this agent is extremely toxic to algae and the existence of this agent in untreated greywater runoff can impair the reproduction and growth of some aquatic species. Moreover, parabens are esters of the p-hydroxybenzoic acid that have been extensively used as preservatives and antimicrobial agents in cosmetics and personal care products. Therefore, it is frequently detected in air, soil, water resources and human serum (Dionisio et al. 2018).

Production and consumption of greywater toward greywater footprint (GWF) reached 2,630.9 km^3 recorded globally in 2019 by 40 countries within three categories which is Brazil, Russia, India and China (BRIC), Organization for Economic Cooperation and Development (OECD) and European Union (EU) countries. The amount of greywater footprint production by BRIC, OECD, and EU countries were produced by 807.5 km^3, 102.8 km^3 and 361.6 km^3, respectively. It is found that half of greywater footprint production mainly generated from domestic sources before COVID-19 and China has been identified in BRIC countries as the largest greywater footprint production by a total of 536.6 km^3 (Zhao et al. 2019). However, during the pandemic of COVID-19, the greywater footprint production in China has increased rapidly by 1,574 km^3 in the year 2020. The greywater footprint production can be classified into three categories including local consumption, other provinces consumption, and foreign consumption. Hereby, 58% of greywater footprint production was produced from local consumption (Li et al. 2021). It can be concluded, a total of 1,037.4 km^3 of greywater footprint production increased during the COVID-19 pandemic from 2019 to 2020 in China itself.

Zoonotic diseases in fish and marine mammals

World Health Organization define zoonoses as diseases or infections that naturally transmitted from animals to human. Zoonotic diseases could be transmitted in virus, bacteria, or parasite forms. A virus is the smallest infectious microorganism but bacteria usually larger than a virus. Parasite is considered an organism as it could be in a cell size or in multiple cells such as worms. Viruses acquire energy from host cells while parasite require complex diet which consist of sugars, proteins and fats. Parasites have many features that is similar to human cells and able to replicate inside or outside of host. Those three zoonotic agents caused infectious diseases transmitted from animals and are capable of infecting humans (Atawodi et al. 2013).

Coronaviruses such as COVID-19 are common pathogens of the respiratory system and gastrointestinal tract in domestic and wildlife. Concern has been raised either this virus will contaminate the fish as the main protein source of maritime countries. Hemida and Abduallah (2020) listed five genera of coronavirus that usually infect only birds and mammals. None of the listed genera belong to the family Coronaviridae. Coronaviruses are also targeting the respiratory tract with pathology of the lung, which is absent in fish, hence this virus are not susceptible to fish. This virus cannot host on living fish due to the difference between evolves of their innate defence in mammals and fish (Bondad-Reantaso et al. 2020).

However, the probability of coronavirus transmission from surface contamination due to handling by infected people should not be neglected. The potential of transmission might vary depending on the survival period of the virus, but no data available regarding the survival on the surface of seafood so far (van Doremalen et al. 2020). Infection of coronavirus to fish might seem impossible, but this virus has been detected in Pacific harbour seals, beluga whales, and Indo-Pacific bottlenose dolphins (Nollens et al. 2010; Woo et al. 2014). The virus was also detected in the seal that genetically close to feline, canine, and ferrets virus, suggesting the transfer of the virus from terrestrial animal to marine mammals. Differ from the influenza virus, investigations on the impact of coronavirus on marine life are yet to be published. The previous reports on this virus in marine mammals justify the potential transmission, transfer and transportation of this virus from terrestrial animal to marine mammals that require further investigation.

Conclusion

The coronavirus disease 2019 or COVID-19 pandemic has spread very rapidly throughout the world since end of December 2019 to the present day. Since the lockdown has been implemented in almost all countries, there has been a loss to the world's economy. Although this pandemic poses a serious threat to human health, environmental pollutions from sea to space is declining and nature is recovering to almost the ambient condition. The positive environmental impact we have seen today may be temporary before the nation begins its daily economic and social activities as usual. We should learn from this incident how to reduce the negative impact on our environment on a long-term basis for sustainability and future generation. Since this outbreak has disrupted lives and killed many people, we need to understand the importance of the link between human well-being and the environment, particularly in the aquatic environment.

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