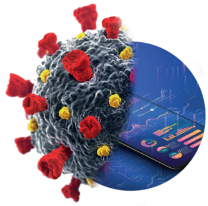

Environmental and Ecosystem Services in the Post-Pandemic Period

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Environmental and Ecosystem Services in the Post-Pandemic Period[1]

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Abstract
Recently, insufficient infrastructure, poor sanitation & hygiene conditions, air pollution, malnutrition, occupational & environmental infections have increased. The COVID-19 outbreak is the latest of the viral outbreaks that have occurred over the past 20 years. This pandemic is expected to have many effects on international relations, commercial activities, socio-cultural habits, individual behavior patterns and psychological conducts. Another expected effect is likely to be in the environment and ecosystem services implemented in this area. According to the available data and information regarding the corona virus, there is no definite information about COVID-19 being transmitted through domestic wastewater and/or wastewater-interfered waters. In addition, the COVID-19 outbreak does not require additional treatment in the existing municipal water treatment plants in which filtration and disinfection are applied. Final chlorination application is sufficient in terms of microbiological quality and safety of drinking water. After biological wastewater treatment in domestic wastewater, disinfection with UV or ozone is required in order to remove disease-causing microorganisms. It is important for the employees of water, wastewater and solid waste collection, distribution, and treatment facilities to apply appropriate hygiene rules through the use of personal protection equipment preferred by healthcare workers. Measures should be taken against the risk of pathogenic microorganism spreading via microdroplets released from the central wastewater treatment plants located within urban settlements. Joint action plans should be encouraged with the support of voluntary organizations in order to ensure sustainability through protecting worldwide wildlife and ecologically critical reserve areas.

Keywords
COVID-19 pandemic, environment, ecosystem, waste management

[1] This study is a translation and updated version of the paper previously published in the book titled "Küresel Salgının Anatomisi: İnsan ve Toplumun Geleceği" by TÜBA in June 2020.

Introduction

Mankind is the most advanced of all living things on Earth, and the only living creature to dominate his/her environment and other livings. While establishing this domination, continuous interaction with the environment and other living things takes place. Although this interaction often works in favor of mankind, it certainly has various consequences in the medium and long term. Infectious diseases are amongst the most important negative consequences of this interaction, and pandemics related to various human infections have been observed throughout history. The causes of new pandemics can be climate changes and irregularities, demographic and human behavior changes, socio-economic factors, ecological changes, lack of hygiene and sanitation, hospital treatments and resistance problems, alterations in global trade, and travel, wars and microbial adaptation and change. In recent years, especially inadequate infrastructure, poor sanitation and hygiene conditions, air pollution, malnutrition, occupational and environmental infections have increased. Severe Acute Respiratory Syndrome (SARS) followed by the Middle East Respiratory Syndrome (MERS), and finally the 2019 Coronavirus Disease (COVID-19) are among the most important of virus-borne pandemics in the past 20 years. The COVID-19 pandemic has spread to many countries, especially in the Asian region, and reached an international dimension affecting the whole world (Şeker, et al., 2020).

The corona virus pandemic is expected to have many effects, from international relations to the commercial sphere, from socio-cultural habits of societies to individual behavior patterns and psychological conducts. Another expected impact is likely to be in the environment and ecosystem services implemented in this area. The contagiousness of the disease is directly related to indoor air quality and hygiene. Many reports have been published on this subject stating that if SARS-CoV-2 enters the digestive system via mouth, it is expected to be inactivated in the stomach (pH: 1.5-3.5), however, after abdominal pain and diarrhea symptoms in many patients, virus were detected in tissue samples taken from the digestive system (stomach, small & large intestine). This revealed that the virus can pass from the respiratory system to the digestive system, multiply in the stomach and intestinal tissue to be excreted by feces (Uno, 2020). In many studies, the RNA of the virus has been detected in feces (Gao et al., 2020; Holshue et al., 2020; Jiehao et al., 2020; Tang et al., 2020; Wu et al., 2020; Wölfel et al., 2020; Zhang et al., 2020a), and at least three studies found that the virus in feces is viable (Wang et al., 2020; Xiao et al., 2020; Zhang et al., 2020b). However, fecal-oral transmission has not been proven yet (WHO, 2020).

The genome of the virus was determined in wastewaters taken from the sewage system of many countries, such as Netherlands, Australia, USA, France, Spain, and Turkey. In North America and Europe, the virus genome has been measured as 0.15-141.5 million copies per liter (Hart and Halden, 2020). In a recent study from Turkey, SARS-CoV-2 concentration of 2.89 to 93.3 thousand copies/L were measured at the influents of large wastewater treatment plants in Istanbul (Kocamemi et al., 2020). The q-PCR method used in the measurement of the virus in wastewater studies can detect the virus, but it does not show whether the virus is alive/active. Therefore, the virus should be isolated from the wastewater to be reproduced by the culturing method, although such a study has not yet been reported (Dereli, 2020).

In this study, the current situation of the environment and the ecosystem, projections for the future, the possible negative and positive effects of the pandemic on the services in these fields have been discussed in detail. Finally, findings, suggestions and prospects were also presented.

Environmental and Ecosystem Services

193 member countries of the United Nations (UN) agreed at the General Assembly in September 2015 to transform the world with the "Sustainable Development 2030 agenda (Agenda 2030)". Agenda 2030 is an action plan for humanity, our planet, and prosperity. The member states of the UN have demonstrated their desire and determination to transform the world in a sustainable and robust direction in order to eliminate all kinds of poverty "without leaving anybody behind".

Agenda 2030 includes 17 Sustainable Development Goals, and 169 global indicators related to expected outputs and practices for the period of 2015-2030. The implementation goals and indicators are designed to enable sustainable development to be achieved through social, economic, and environmental aspects.

According to the United Nations General Assembly Decision (64/292) dated June 20, 2010, access of all people to water and wastewater services is one of the basic human rights. Clean, safe, affordable, accessible drinking water should be provided to everyone (UN, 2014). According to the "Right to Water" report published by the World Health Organization in 2003, the amount required for a person to access water at a basic (minimum) level is 20 L/capita.day; the amount of water required to provide moderate access is 50 L/capita.day and the amount required for optimum access is 100-200 L/capita.day (WHO, 2003).

Sustainable Development Goal 6 (SKA-6) is about ensuring that everyone has full access to clean water and adequate sewerage services and aims to keep the place of interest and sensitivity in these issues alive in the global political agenda. SKA-6 envisages achieving 6 global sub-targets (SKA 6.1-6.6) that are universally accepted and supported (WHO, 2017; Öztürk, 2019).

World Overview

The United Nations (UN) Water Unit has published an assessment (synthesis) report on the current status of SKA-6 indicators in the early 2015-2030 period (UN Water, 2018). The world view that emerged in this report is summarized below:

SDG 6.1 Goal

The ratio of population provided with water supply services managed at basic and safe levels, increased from 81% to 89% in the period of 2000-2015. However, 844 million people worldwide still does not have access to basic water supply services, and 2.1 billion people lack access to safe (clean) water supply services, when needed.

SDG 6.2 Goal

The ratio of population benefiting from basic sewage and hygiene services increased from 59% to 68% in the period of 2000-2015. However, 2.1 billion people worldwide (70% in rural areas) still use shared toilets with other households. 4.5 billion people worldwide still lack clean / hygienic and independent toilet facilities. 892 million people living in the rural areas of Central and South Asia and Sub-Saharan Africa meet their toilet needs in open land. 27% of those living in under-developed countries lack the basic opportunity to wash hands with soap.

SDG 6.3 Goal

59% of domestic wastewater is treated well in high and medium-high income countries. 76% of wastewater flows of the population connected to the sewerage network, and 18% of wastewaters from independent households are subjected to adequate treatment in these countries. The fact that wastewater treatment is still not sufficient even in medium-high income countries affects worldwide water quality negatively.

SDG 6.4 Goal

The added value of water varies in a wide range (2~1,000 \$ / m^3) on a global scale, and is estimated to be ~15 $/m^3 on average. Although the added value is low, the water use of the agricultural sector is approximately 70% (average) of the total usable water potential worldwide, while the rate in countries with arid climates can reach up to 90%.

SDG 6.5 Goal

Although the rate of implementation regarding integrated river basin management (IWRM) in OECD countries is approximately ~48% as of 2015, major differences are observed among countries. In the previous century, 70% of all natural wetlands were lost along with the freshwater creatures within. 2016/17 Assessment Report of UN Global Drinking Water and Sewerage Service state that 80% of member countries participating have agreed to increase financial resources in order to accomplish the SDG-6 related goals. Although official development expenditures of the water sector increased from $ 7.4 billion to $ 9.0 billion from 2011 to 2016, the 2030 targets related to SDG 6 are still not achieved. According to the World Bank (WB), the annual investment requirement for reaching the SDG targets by 2030 is approximately ~114 billion $.

Climate change has important impacts on freshwater systems, thus on freshwater management. 1.6 million people died, while 5.5 million people were affected by natural disasters during 1990-2005. Water-related disasters account for for 62% of all natural disaster deaths. Additionally, 96% of population were affected by water-related disasters which also account for 75% of financial losses (~2.5 trillion USD) (UN, 2018).

Turkey Overview

According to Turkey's Eleventh Development Plan (2019-2023) the targets envisaged for Urban Infrastructure are as follows;

- The ratio of municipal population served with drinking water is 100%,

- The ratio of municipal population served by wastewater sewer network is 95%,

- The ratio of municipal population served by wastewater treatment plants is 100%.

According to Turkish Statistical Institute's (TSI) 2018 Environmental Statistics in Turkey as of 2016;

- The ratio of municipal population served with clean & safe drinking water via drinking water network is 98%

(National Environmental Integrated Compliance Strategy target is 100% in 2023),

- The ratio of municipal population served with sewerage network is 90% (National Environmental Integrated Compliance Strategy target is 100% in 2023),

- The ratio of municipal population served with wastewater treatment is 75% (National Environmental Integrated Compliance Strategy target is 100% in 2023).

Access to safe drinking water, and the utilization of sewerage & septic systems in rural areas outside of the municipal boundaries (under the responsibility of Special Provincial Administrations) are estimated to be ~90% and ~65%, respectively (UN, 2018).

The existing statistical data reveal that Turkey can achieve the UN SGD 6 goals for 2030 to a great extent with respect to the OECD countries average. In order for Turkey to meet the SDG 6.4 and 6.5 targets, Turkey is approaching the average of OECD countries through reduction of the agricultural water usage below 65%, and implementation of Integrated River Basin Management (IWRM) (Currently, Watershed Protection Action Plans in all of 25 Basins of Turkey were completed and put into practice, while River Basin Management Plans have been prepared in ~35% of them). Turkey allocates approximately 1.2-1.5% of each year's national income for the Environmental Protection Sector with respect to the SDG targets (Çiçekalan et al., 2019).

Ecosystem Services

United Nations (UN) and World Bank (WB) studies show that the low-income segment is more dependent on food from the ecosystem with its immediate surroundings and likewise provides economic benefits from a wide range of marine and coastal ecosystem services. There are four basic components within the scope of ecosystem services defined by the Millennium (Millennium) Ecosystem Assessment Report (UNEP, 2006); namely supportive, supplier, regulatory and cultural ecosystems are summarized in Table 1.

Fisheries are a critical component of economic wealth or natural capital and, when managed well, can play an important role in reducing economic growth and poverty. Small-scale fishing activities provide valuable protein and livelihoods for the low-income population living on the shore.

Table 1. Ecosystem Services Provided by Coastal and Marine Ecosystems Contributing to the Welfare of Coastal Residents

Ecosystem Service Type	*Ecosystem Service*	*Key Ecosystems Providing Service*
Supportive	*Habitat*	*Coral reefs, mangrove*, sea grass*
	For aquatic life	*Open ocean currents*
	Hydrological cycle	*Coastal forests, wetlands, mangroves*
	Food cycle	*Various coastal ecosystems*
Supplier	*Construction materials*	*Mangrove, coral reefs*
	Fuel (wood and wood coal)	*Mangrove, coastal forests*
	Fishery	*All marine habitats*
	Seafood	*Coastal areas, mangroves*
	Agricultural products	*Coastal areas*
	Other natural products (eg. honey)	*Mangrove, coastal forests*
	Employment and income	*Systems that provide basic preparation*
	Freshwater	*Shallow lagoon*
	Seaweed production	*Coral reefs, beaches*
	Tourism income	
Regulatory	*Erosion protection*	*Muddy coastal benches*
	Storm and flood protection	*Mangroves, coastal vegetation*
	Protection of air and water quality	*Mangrove, coastal forests, coral reefs*
	Waste disposal	*Offshore and tidal currents*
	Climate regulation	*Various coastal ecosystems*
	Pest and disease control	
Cultural	*Cultural identity related to coastal livelihoods*	*Various coastal ecosystems*
	Education and research	
	Heritage value	
	Recreation	

Source: *(Braga et al., 2014)*

** Mangrove is the name given to some types of trees and shrubs that form dense forests in the estuaries, salty marshes and muddy coasts and the forests they form.*

Natural resources (natural stock of assets) are an essential pillar of economic activity and human well-being. Natural resources differ according to their physical characteristics, abundance, countries or regions. Effective management and sustainable use of these resources are crucial for economic growth and environmental quality (OECD, 2014). The main issues in the approach put forward by OECD regarding natural resources are listed below (OECD, 2014);

- ***Availability and quality of renewable natural resource stocks;*** *fresh water sources and forests,*
- ***Availability of non-renewable natural resource stocks;*** *mineral resources, especially metals, industrial minerals and fossil energy carriers,*

- ***Biodiversity and ecosystems;*** *species and habitat diversity and the efficiency of land and soil resources*.

Natural assets stock and economic activities (production, consumption and investment) are directly related. Country policies and opportunities affect both natural resource stock and economic activities.

Many of the natural capital and ecosystem assets are not comfortably measurable values (returns) in economic markets. However, the ecosystem service does not have to be built by nature. Therefore, it is very difficult to clearly observe the values produced by ecosystem services. A study in 1997 developed a system in which current global land uses were divided into 17 categories in order to estimate the total value of ecosystem services. The primary distinction in this system is on marine and terrestrial systems. value has been calculated as as $ 33 trillion in the study carried out by Costanza et al. (1997). This value has been updated to $ 125 trillion considering the biome field and unit price changes over the years and through completing the biome field data obtained in the first study.

In the updated study, the extent to which biome area changes during 1997-2011 affected the economic value of the ecosystem has also been presented. The loss of ecosystem services resulting from the changes in land use is estimated to be $ 4.3-20.2 trillion (Costanza et al., 2014). Ecosystem services are one of the most important factors contributing to public welfare worldwide. Today's level of welfare increases in direct proportion with the necessary weight given to natural capital. The value of global ecosystem services is estimated to be approximately 4.5 times the GNP worldwide as of 2000 (Costanza et al., 2014). In the future, as the services to be provided by natural capital and ecosystem will be more limited, their value will inevitably increase. If unforeseen natural disasters happen, these values will become invaluable.

Damage of ecosystem due to human activities such as deforestation, urbanization, industrial activities, intensive agriculture, aquaculture, and intervention in river systems causes habitat loss. There exist buffer zones that serve as boundary between human activities and areas where biodiversity needs to be protected. As these buffer zones disappear or change over time, a dangerous rapprochement can occur with species that should not be intertwined with humans. All regions where human elements and wildlife begin to unite become a potential center for pandemic. A report prepared by the Wildlife Conservation Foundation (WWF) stated that since 1970, the loss in mammals, birds, fish and reptiles has reached a very high level of 60% (WWF, 2018). Interference with wildlife habits can lead to an exchange of microorganisms between humans and other species. These microorganisms, which are not harmful to wild species, may become deadly pathogens for humans (Carrington, 2020). The destruction caused by Ebola, which is linked to bat species and has reached a deadly level in humans and primates, is associated with deforestation in the Sub-Saharan African region.

It is known that climate change is the driving force of migration for many species. Living things migrate latitudinal to north and to higher altitudes in the mountainous areas due to rising temperatures. As a result, pathogens can spread to larger areas through such migrations. Since every living creature cannot migrate at the same speed, the risk of pathogens infecting new hosts also increases, as the vectors and hosts of pathogens are spreading. The fact that certain diseases transmitted via mosquitoes, such as Zika or West Nile Virus, have started to occur in geographies where they have not been observed before is proof of this situation. It is almost impossible for species that migrate due to climate change not to cross paths with humans, thus more pathogens are expected to reach mankind in the future. In this context, an increase is expected not only in pathogens that cause human diseases, but also in diseases and pests transmitted to plants and animals. This also leads to a reduction in food production, triggers the food crisis and in addition, affects soil and water pollution as more chemicals will be used to combat pests.

Many ecosystem services today are associated with engineering infrastructure. Considering solely the water system, engineering infrastructure is utilized in services such as clean water supply, wastewater collection, treatment & disposal, flood control, and recreational facilities. The most economical alternative among the options planned for creating a more effective living and working environment, especially in urban areas, is to combine established (built / artificial) and natural infrastructures. One of the main reasons for developing infrastructure is to design, operate and ensure the sustainability of the system that is compatible with nature, which minimizes negative externalities at a lower cost than traditional foreign investments.

Municipal Solid Waste Management

Municipal Solid Wastes (MSW) generally consist of two main components: recyclable/recoverable wastes (packaging wastes, newspaper/magazine papers), and other wastes (kitchen and garden wastes etc.). Packaging waste can be easily recycled through a well-established dual collection system. Kitchen, garden and marketplace wastes can simply be recycled via composting. The most important factors affecting waste generation and its components are the geographical location of the settlement, its socio-economic structure, available energy resources, and seasonal changes. These factors are also related to the level of unit national income (per capita) of countries (Twardowska et al., 2004).

Nowadays, legal legislation has been developed for recyclable components within the MSW, which envisages the achievement of certain targets. For example, the US National Environmental Protection Agency's (EPA) total packaging waste recycling rate target in 2000s was 35% as some states had already reached 50% (Vesilind et al., 2002). The packaging waste recycling rate target for EU countries in 2013 was 60%. The recycling/recovery target foreseen for 2020 in the Packaging Waste Regulation of the TR Ministry of Environment and Urbanization is 60% in line with EU.

According to the report prepared by Hoornweg and Bhada-Tata (2012) for the World Bank, solid waste generation is highest in OECD countries. The average waste generation rate in OECD countries, including many developed countries, is around 2.2 kg/capita-day. As of 2012, OECD countries constituted 44% of the total waste generation in the world with 572 million tons. Solid waste treatment technologies applied across the EU reveal that 33% of MSW is disposed of via incineration, composting, recycling and landfilling. Only in the case of Romania, almost all of MSW is disposed of in landfills. As of 2012, the amount of MSW diverted to landfills has been set to zero in Germany and Switzerland through the use of waste management technologies. The amount of MSW directed to landfill is <5% in Belgium, Sweden, the Netherlands, Austria, Denmark, and Norway. On the road map of the EU Commission's 7th Environmental Action Plan, it is foreseen that the amount of MSW directed to landfilling in EU states will completely be reset as of 2030 (Kozmiensky, 2014; Öztürk, 2015).

The EU Circular Economy changes were published in June , 2018, to come into effect in the preceding month Accordingly, by 2035;

- *Recycling 65% of MSW (Interim Goals: 55% in 2025, 60% in 2030)*
- *Storage of maximum 10% of urban solid wastes,*
- *Recycling 75% of packaging waste,*
- *Recycling 55% of plastic packaging waste (2025),*
- *Recycling 75% of wood packaging waste,*
- *Recycling 85% of iron-based metal packaging wastes,*
- *Recycling 85% of aluminum packaging waste,*
- *Recycling 85% of glass packaging waste,*
- *Recycling 85% of paper / cardboard packaging wastes has been targeted (Sayman, 2019).*

TR Ministry of Environment and Urbanization published the Zero Waste Regulation in July 2019 (MEU, 2019). The purpose of the regulation is to cover the general principles regarding the establishment, dissemination, development, monitoring, financing, recording, and certification of the zero-waste management system that aims to protect the environment, human health, and all resources in waste management processes in line with the principles of efficient management of raw materials, natural resources, and sustainable development. According to the regulation, local administrations are divided into 3 groups and local administrations are foreseen to switch to Zero Waste Management System starting from 2021 until the end of 2022. Buildings and campuses are divided into 4 groups, and it has become compulsory to establish a zero-waste management system for public institutions and organizations starting from mid-2020 till the end of 2022.

Effects of Virus Pandemic on Environment and Ecosystem Services

Wastewater Collection Systems and Treatment Plants

Wastewater has been the source of many diseases and pandemics throughout history due to containing many pathogenic microorganisms (bacteria and viruses) (Waller, 2013). According to WHO estimates, today, ~120,000 people die from cholera every year due to untreated or poorly treated wastewater mixed with drinking water sources. The concentration of SARS-CoV-2 virus in domestic wastewater can be measured in many countries, including our country, by q-PCR method. Although this method does not show whether the virus can cause active / live disease, it is thought that this method can be used to determine in which parts of the city is concentrated with COVID-19. For example, the trace of SARS-CoV-2 could be measured in wastewater three weeks prior to the clinical detection of the first case in the Netherlands (Medema et al., 2020). This indicates that wastewater monitoring systems can be used as an early warning system. In this method known as wastewater-based epidemiology, wastewater of a society, is considered as a collective example not a person-based (Eraydın, 2018). Wastewater carries traces of the lifestyle of a society. Therefore, it is possible to reach a lot of information about the society (eg nutritional habits, addictions, drug use) by following only some parameters in wastewater. In many countries, including Turkey, wastewater-based epidemiology, is used to monitor the illegal drugs and drug addiction in sewers. In the future, techniques and analysis methods used in wastewater epidemiology are expected to be among the standard monitoring components of wastewater collection and treatment systems.

According to the available information, the risk of SARS-CoV-2 contamination from wastewater appears to be quite low (WHO, 2020). An indicator of this is that the staff working in wastewater sewage and treatment plants, which can be described as high-risk groups, did not have a statistically significant level of disease. Transmission routes of COVID-19 are water droplets, aerosols and contact. In this regard, the units where the aerosols are spread (screens, pumping stations, inlet structures, grid chambers) in wastewater treatment plants are places where the risk of contamination can be high, and the personnel working in these units must take precautions and use personal protective equipment. In addition, aerosols and water droplets that may occur during aeration in activated sludge systems pose a risk for the transmission of viruses and other pathogenic microorganisms. If ventilation is done mechanically, the risk increases even more. In this regard, especially covering the grid chambers and aeration tanks and collecting and treating the scented gases in a central deodorization unit will reduce the mentioned risk (Dereli, 2020).

It is very important for the environmental staff who perform routine analysis in wastewater treatment plant laboratories, and for academicians and students who conduct experimental work with raw and / or treated wastewater in university laboratories should take care of hygiene not to be affected by infectious diseases caused by wastewater. In the COVID-19 pandemic, personnel performing maintenance and repair of sewer lines are at risk as well. Sewage connections of hospitals, especially where COVID-19 patients are treated, are at risk. Unless necessary in this process, it is recommended that maintenance should not be performed in wastewater lines, pumping stations and personnel should not be placed in sewage manhole. The consumption of wet wipes and gloves used for personal cleaning (hygiene) and precaution in COVID-19 pandemic has increased considerably. Disposal of these materials to the toilet can cause clogging of sewer lines, wastewater treatment plant pumps and screens. This situation has been observed especially in the USA and has caused important operational problems in wastewater treatment plants.

Viruses encountered in wastewater are mostly intestinal based (enteric) envelope-free viruses. Such viruses are more resistant to environmental factors than corona viruses. Viruses are eliminated to a certain extent in many levels of conventional wastewater treatment plants. The removal efficiency of viruses at treatment plants may vary depending on the type of virus, the design parameters of the facility and the operating conditions (eg. sludge age, hydraulic retention time). In the literature, scientific studies related to virus removal efficiency of different processes of treatment plants are very limited. In a study conducted in the Netherlands, removal of f-bacteriophage virus was measured as 1,3- and 2,1-log removal efficiency in two treatment plants using conventional activated sludge process (Barrios-Hernández et al., 2020). In the activated sludge process, bacteria secrete a high amount of RNA degrading (Ribonuclease) enzyme, and an RNA virus such as SARS-CoV-2 is highly likely to be biodegradable in secondary treatment. Studies carried out in the Netherlands, SARS-CoV-2 could not be detected at the exit of the wastewater treatment plants (Dereli, 2020).

Due to their enveloped structure, coronaviruses are highly susceptible to environmental / external influences compared to intestinal-borne viruses (adenovirus, norovirus, rotavirus and hepatitis A) in wastewater. High temperature, low or high pH, sunlight and disinfectants cause rapid death of the virus. The most important process that provides virus removal in wastewater treatment plants is disinfection. Disinfection in wastewater is preferably done by UV-rays or ozone (Tchobanoglous et al., 2013). A total of 4-log removal should be provided throughout the facility for an effective bacteria and virus removal. Even though there is no study in the literature about disinfection of SARS-CoV-2 yet. However, there are some studies on SARS-CoV-1, a similar virus. Wang et al. (2005) reported that the SARS-CoV-1 virus was completely inactivated at a concentration of 10 and 20 mg/L chlorine within 10 minutes and 1 minute, respectively.

In order to obtain an effective disinfection, the suspended solids concentration should be low at the exit of the treatment plant. The suspended solid contains virus and other pathogenic microorganisms and provides protection against the effects of disinfectants. Therefore, the final settling tanks of the treatment plant should be well operated and the amount of flock escaping from the sluices should be low (AKM <10-20 (max 30) mg / L). The most common disinfection method used in wastewater treatment plants is UV. When this process is designed and operated correctly, it can inactivate bacteria and viruses with high efficiency. When the UV dose is 44 mJ / cm^2, 3-log (99.9%) inactivation can be achieved for poliovirus-1 and rotaviruses (Health Canada, 2019). In UV systems, adenoviruses at a dose of 40-199 mJ / cm^2 can be removed up to 3-log (99.9%) (USEPA, 2006). In only 53 of the 603 wastewater treatment plants in Turkey have a disinfection unit. Only 42 of the 221 plants used for irrigation are disinfected (TR Ministry of Agriculture and Forestry, 2020). According to the researches of the Ministry of Agriculture and Forestry, only 13 of these 42 units are operated. In addition, it was found that irrigation water criteria could not be met microbiologically in 4 plants that operate disinfection units (Ministry of Agriculture and Forestry, 2019). In our country, there is a big deficiency in the disinfection of wastewater. This situation poses a great risk for public health.

Another risky process in wastewater treatment plants is the processing of excess sludge. Although the activated sludge process can remove many viruses up to 2.5-log, the sludge generated can still contain high amounts of bacteria and viruses. Biological, chemical and thermal processes are used to stabilize the sludge. High temperatures applied in thermophilic anaerobic digestion and composting from biological processes inactivate many pathogenic microorganisms, including viruses. For example, the SARS-CoV-1 virus is completely inactivated above 56 ^{o}C. The high pH (> 10) formed during the lime stabilization method also inactivates other pathogens such as coronaviruses. Sludge drying and burning processes thermally kill all pathogens. In this regard, the agricultural use of properly stabilized sludge does not pose a high risk for COVID-19 and other diseases. The riskiest processes in terms of COVID-19 contamination are the thickening and dewatering of the raw sludge. In this context, environmental personnel responsible for maintenance, repair and operation of equipment such as sludge pumps, centrifuge, press filter and belt filter should use personal protective equipment, pay attention to hand hygiene and do not put their hands on their faces.

Water Intake Structures, Treatment Plants and Distribution Networks

Coronaviruses are very sensitive to disinfection due to their envelope structure. For example, SARS-CoV-1 is completely inactivated at 10 mg / L chlorine dose and 10 minutes contact time (Wang et al., 2005). To remain on the safe side, it is recommended to reach 30 minutes contact time and 0.5 mg/L free residual chlorine concentration (WHO, 2020). Disinfectants (chlorine, chlorine dioxide and ozone) and doses used in drinking water treatment plants are quite sufficient to remove SARS-CoV-2 and other viruses. In this regard, the risk of COVID-19 contamination from drinking water treated in conventional surface and water treatment processes (filtration + disinfection) is very low. In this context, disinfection process is indispensable for the microbiological safety of water in drinking water treatment plants and emergency response is required for the problems that may occur in this process. Therefore, the units and equipment required for disinfection must be redundant. In addition, there should be temporary storage units in the facility for disinfection chemicals against possible problems and delays in the supply chain.

In order to maintain the microbiological safety of the water supplied to the City/Drinking Water Network for a long time, it is recommended by WHO to have at least 0.5 mg/L free residual chlorine at each point of the network (WHO, 2020). For microbial safety of drinking water, it should be checked regularly that there is enough free chlorine at every point in the network. Shock chlorination should be applied for a certain period of time to the water supplied to the network after failure / maintenance.

Receiving Water Bodies / Resources

Coronaviruses can survive for more than 10 days in lake waters at 25^{o}C. It is considered that SARS-CoV-2 will be similar to other coronaviruses, although there is no scientific study regarding the survival time in surface waters. According to the guidance document published by WHO, SARS-CoV-2 and other coronaviruses have not been detected in groundwater and surface water sources used for drinking water until now (WHO, 2020). In this regard, the risk is very low. However, there are three important issues that may affect the chemical and microbiological quality of our surface waters in terms of public health.

The first of these important issues is the untreated domestic wastewater discharges to surface water resources. The ratio of the municipal population connected to treatment plants to the total municipal population of Turkey is 79% according to data for 2018 (TUIK, 2020). The Ministry of Environment and Urbanization plans to fill the gap in this area by 2023. Another issue is the treated wastewater discharges to surface waters (river, lake, dam). For example, 50 of 603 WWTPs in Turkey (flow> 2000 m3 / day) is discharged to the receiving water bodies used as irrigation reservoir. The total flowrate of these facilities is around 1.4 million m3/day which correspond to 8% of the daily amount of wastewater discharged in Turkey. In addition, only 8.8% of the existing wastewater treatment plants have a disinfection unit (TR Ministry of Agriculture and Forestry, 2020). Finally, it should be mentioned that the wastewater channel networks, which are operated as a combined system, is very important. The capacity of existing sewage systems, and central wastewater treatment plants may be insufficient for certain periods of time, especially ddue to high precipitation regimes changing with the effect of climate change. In this case, some of the rainwater contaminated with domestic wastewater is discharged into surface waters without treatment from combined sewer system. These discharges that may occur in extremely rainy weather conditions, contaminate surface waters microbiologically and pose a risk to public health (Samsunlu, 2020).

Water and Sewerage Administrations

In pandemics similar to COVID-19, risk analysis and emergency action plans should be made considering that a significant portion of the personnel of the water and sewage administrations can get sick. In Italy (Rome) and England (South West Water), where the COVID-19 pandemic was very effective, there was a 1-9% loss of workforce in the water and sewage administrations. Only 2 people from 1200 staff of the Washington (USA) Water and Sewerage Administration got sick. There has been no sick from the staff of the Water and Sewerage administrations in Shanghai and Hong-Kong cities of China. This situation may vary depending on the measures taken and working conditions. It should be considered that not only the sick personnel but also the personnel who come into contact with a person who has a positive COVID-19 test should isolate him for 14 days and cannot come to work within this period.

Water and wastewater treatment plants are systems operating 24 hours a day, seven days a week. In the future, the level of automation in the facilities should be increased to better combat such pandemics. In this case, staff will be less at risk. One of the biggest effects of the COVID-19 pandemic is that distance work becomes very important as a requirement of physical isolation. Considering that the 21st century is the age of information and communication; it is a fact that the opportunities for remote and flexible work have increased considerably. Like many private companies, water and sewage administrations need to establish infrastructures that will enable them to provide these services remotely for non-critical and remote works (invoice collection, customer service and call centers, etc.). In this way, the number of personnel that should be physically present in the offices can be reduced and thus, possible contamination will be prevented

Under pandemic conditions, equipment and chemical supply chains of water and sewerage administrations may experience disruptions and delays. Especially in order to carry out disinfection processes, tanks that will allow the necessary chemicals (chlorine, chlorine dioxide, parasitic acid, etc.) to be stored in the facilities for at least two weeks must be available. In addition, support should be given to the production and supply of critical chemicals and equipment by domestic manufacturers. In this way, both domestic production is supported and risks and delays that may arise in supply from abroad can be reduced. In addition, considering the problems that may be experienced in the supply of personal protective equipment (mask, gloves, glasses, face shield, apron, boots, etc.) that the personnel will need, these equipments should be stocked in sufficient number. It is important to inform the public about the cleanliness and safety of drinking water correctly and transparently in cases of pandemics and emergencies, especially in order to prevent misinformation that can be spread from social media. Therefore, water and sewerage administrations should keep their communication channels open and build trust by providing necessary information to the public on time.

Many infectious diseases (typhoid, cholera, giardiasis, dysentery, hepatitis A) are caused by wastewater and are transmitted through wastewater mixed with drinking water sources when there is not enough treatment. Wastewater treatment plants protect public health along with environmental and clean water resources. Although we are not aware of these facilities, it is necessary to be aware that they have a very important role in our lives and to increase the awareness of the public on the subject. Therefore, water and sewage administrations should enlighten their subscribers through training programs, technical trips, written and visual media organs and social media campaigns.

The revenue of subscribers and service providers is expected to be evident in the COVID-19 pandemic process. For example, the collection/accrual rate of water and sewage administrations in Brazil decreased from 95% to 70%. In India, the collection has stopped completely. In Italy, it is expected that water consumption will decrease by 5-15% and revenue of water and sewage administrations will decrease by 10-30% in 2020. Due to the pandemic in water administrations, an income loss of 201.6 billion (5-6 $/capita.year) is expected in 2020 (AWWA, 2020). It is also expected that the revenue of water and sewage administrations in Turkey will also reduce by 20-30%.

Ecosystem Services

In the corona virus pandemic period, the pollution emission pressure on the ecosystem has decreased greatly in all continents and countries due to the huge slowdown and capacity decrease experienced in global industrial, tourism and transportation activities since February 2020. The reduction in pollutant emissions released into the nature has also been reflected in the quality of air and aquatic environment, with significant improvements in environmental quality, especially in most cities and rivers known for intense air and water pollution. This is evidenced by satellite images (Wuhan), local observations (Ergene) and quality measurements (Istanbul). In this period, especially the aquatic ecosystem feasted with its dolphins and birds. If the disruptive effects and activities created by human beings can be controlled effectively, it is in the eyes of the human world that the ecosystem can restore itself in a very short period of time.

As mentioned earlier, ecosystem assets in the world grant humanity every year 4-5 times the economic value of the total national income of the world countries (Constanza et al., 2014). In order for such a large and important natural wealth to be preserved and transferred to the next generations in a sustainable manner by considering the balance of protection and use, the waste habits at every level of life should be minimized with the concept of circular economy. Preservation of ecosystem assets and services, considering the needs of the next generations, necessitates cooperation with a much more effective and sincere international cooperation on a global scale than today. The sincere expectation of all intelligent owners is the normalization of the introverted and non-cooperative attitude exhibited by the rich and industrialized countries around the world due to the corona virus pandemic.

Urban Solid Waste Management

In the corona virus epidemic process, there was a significant increase in the production of packaging (food and clothing) and disposable medical equipment (mask, gloves, injector, overalls, face shield, etc.), despite the huge decrease in domestic commercial and industrial waste production. Such wastes (other than health facilities), which must be managed as infected medical wastes, are collected, and disposed with significant domestic wastes. Additional infected wastes related to the pandemic in health facilities have reached the levels that will force the Municipalities Medical Waste Disposal (Sterilization / Incineration) capacity. Outbreak period virus-contaminated wastes collected and removed together with urban wastes also led to an increase in the pathogenic microorganism burden of such wastes. Considering the fact that municipal solid waste disposal via landfill waste collection and disposal is very high (75%) in Turkey, taking the protective/personal health (mask, goggles, visor, gloves, etc.) measures with the highest sensitivity in the waste collection and disposal process has become even more important for this section at risk before the pandemic. In this context, accelerating the process of rehabilitating and shutting down the Irregular Landfill Facilities and switching them to Regional Landfill facilities has become critical in the operation of landfill facilities.

In the post-pandemic period, in line with the Circular Economy strategy, which has become widespread around the world, packaging and biodegradable waste recovery is expected to be accelerated in the waste management sector and the amount of waste going to Landfill for final disposal is minimized. In this context, Turkey's waste recycling and processing (mechanical, biological treatment, composting and thermal treatment) is needed to increase the capacity starting from the Metropolitans. 'Zero Waste' and paid plastic bag applications carried out by the Ministry of Environment and Urbanization are expected to provide a 35% reduction in the amount of waste going to the Landfill Until 2023 (MEU, 2017).

The New Normal in Environment and Ecosystem Services: Findings, Suggestions and Prospects

The findings, suggestions and prospects related to the New Normal Period following the corona virus (COVID-19) pandemic within the framework of the issues mentioned in the previous sections can be summarized as follows:

- *Current data and information related to corona virus enable the detection of the virus RNA by q-PCR method, yet it does not show the presence of live/ active COVID-19 in domestic wastewaters. Therefore, there is no definitive information about COVID-19 being transmitted through domestic wastewater and / or wastewater-induced waters (WHO, 2020).*
- *In the existing central water treatment plants where filtration and disinfection processes are applied, there is no need for additional treatment due to the COVID-19 outbreak. In water treatment plants (WTPs), the final chlorination application with a total residual chlorine level of ≥ 0.5 mg/l maintained at every point of the water distribution network is sufficient in terms of microbial quality, and safe potable drinking water.*

- *After biological wastewater treatment, it is necessary to apply disinfection with UV or ozone in order to remove pathogenic microorganisms in discharges to water bodies used or intended for human consumption, irrigation, swimming and recreational sports. Starting from the municipal WWTPs with a large capacity (> 10000 m^3/day), it is important to eliminate deficiencies in this area. However, problems in rural settlements with insufficient and/or non-existent wastewater infrastructure need to be eliminated in terms of controlling water-borne diseases.*
- *corona-virus epidemic has made the application of "mask, social distance, hygiene" principles a mandatory arragement currently in order to control the transmission of the disease around the world. It is expected that the habit washing hands at WC, which has decreased to 50% even in some industrialized countries before the pandemic, will reach the required level (> 95%) with the public awareness gained during COVID-19 measures. In this context, it is important that the employees of water, wastewater and solid waste collection, distribution and treatment facilities should use personal protective equipment apply the same set of hygiene rules as of healthcare workers.*
- *The entrance structures of the central wastewater treatment facilities located within cities -especially in the ones located in the near proximity of residences and workplaces- the grid chambers and the aeration units should be covered, and necessary odor treatment systems should be installed. Accordingly, the risk of pathogenic microorganism spreading by micro-droplets (aerosols) released from wastewater to the environment will be minimized.*
- *Digital technologies based on big data analysis and artificial intelligence applications in the water, wastewater and solid waste sectors, especially in the process control of water treatment facilities, pressure and residual chlorine control in the water distribution networks, and flood alarm and waste collection vehicles fleet management are expected to become widespread following the COVID-19 outbreak.*
- *As in the health sector, importance should be given to developing domestic and national opportunities regarding the provision of critical equipment, hardware and software in Environment and Ecosystem services, and current resistance and bureaucratic obstacles in practice should be removed immediately.*
- *Significant improvements were observed in water, air and ecosystem quality indicators due to reduced transportation, tourism, and industrial activities during the corona virus epidemic period. This situation clearly shows that if the pollutant emissions in these areas can be effectively controlled, the pessimistic overview observed in many parts of the world during the pre-pandemic period can be restored in a short time. This situation is expected to preserve keeping the need for effective global cooperation, especially in the reduction of greenhouse gas emissions & utilization of plastics, and the elimination of global deficiencies in the UN SDG 6 field.*
- *Unfortunately, global solidarity and cooperation required during COVID-19 pandemic period were not provided excluding exceptional behavior by very few countries along with Turkey. It is hoped that the extraordinary protective and*

decomposing air observed in the pandemic period will be rapidly dispersed and the global cooperation ground for the solution of common problems of humanity and the planet are established.

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