The impact of the Covid-19 pandemic on the economy, water resources and sustainable development

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FOREWORD

March 2020, when the COVID-19 pandemic was officially declared, will be remembered as a turning point in the history of modern humanity. While the world was facing this health crisis, with far-reaching consequences to our lives and work, global uncertainty and challenges unprecedented in any of the crises before emerged.

History teaches us that the crisis brings the possibility of change for the better. It is an opportunity, not only for recovery but also for further progress. In this situation, while the whole country is working to strengthen its health system and health capacities, it is necessary to progress towards economic and sustainable development. In addition to the numerous misfortunes in various areas, brought to us by the pandemic, there are some fine examples from a socio-economic point of view. Solutions of social distance and lockdown have led to an enormous increase in the use of all e-commerce services and new digital products and services (e.g. in finance and banking). Work from home and the organization of telework have contributed to introducing new standards in the organization of work in all sectors, with the assistance of the latest Internet technologies and software applications. These solutions existed even before the outbreak of the COVID-19 crisis but were moderately used. Today, they are the standard, and some new ones appear every day. Thus, the pandemic has contributed to unmatched growth and acceptance of digital innovations.

To provide the correct answer and identify the need for new solutions, we need to understand the impact of this pandemic on people's lives, the work of institutions, businesses, and the environment. Of course, the effect of the pandemic on the economy and resources is immense. An analysis is needed on all new ones - globally, regionally, and locally. In addition to the macroeconomic point of view, it is necessary to analyze the effects of the crisis on the microeconomic level, i.e., at the company level. Also, reconciling the impact of the pandemic on some sectors and industries that have been most affected (for example, tourism, auto-industry) is indispensable.

In front of you is a thematic proceeding of scientific papers entitled "The Impact of the COVID-19 Pandemic on Economy, Resources and Sustainable Development". Some works published in this collection were presented at the 11th International Symposium on Natural Resources Management, held on October 23, 2021, at the Faculty of Management in Zaječar. This content represents our attempt to partially present the impact of COVID-19 on global, regional, and local economic and sustainable development. The authors of papers, each in their own domain and field, analyzed various problems in a comprehensive and scientifically-based manner and presented the results of their research along with short-term and long-term solutions for recovery. The authors emphasize the need to accelerate the achievements of sustainable development goals, which are now relevant more than ever: health security, equality and prosperity for all, green recovery, and strengthening the resilience of society and economy to potential risks and shocks.

In this way, the authors have provided valuable information that we all have to fully comprehend and act accordingly. Perhaps the decisions that will be made and the steps that will be taken will determine the course of this pandemic that is still ongoing without losing its intensity.

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THE IMPACT OF THE COVID-19 PANDEMIC ON THE ECONOMY, WATER RESOURCES AND SUSTAINABLE DEVELOPMENT

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ABSTRACT

The entire world is struggling with the COVID-19 pandemic. It is a major challenge because the SARS-CoV-2 virus spreads quickly. The pandemic has led to lockdowns and human activity has been reduced in an attempt to minimize transmission. Compared to other pandemics, COVID-19 is probably the worst in modern history because of the number of deaths, hindrance of human activity and adverse effect on the global economy. The paper discusses the impact of the COVID-19 pandemic on water resources. It presents possible scenarios of groundwater contamination with wastewater that carries the SARS-CoV-2 virus and addresses the effect of lockdowns on the water sector.

KEYWORDS

Lockdown, groundwater contamination, water sector

1. INTRODUCTION

Water plays a major role in human health. However, water often contains pollutants of natural (geologic) or anthropogenic origin. Most countries are experiencing an increasing number of illnesses and fatalities caused by drinking water of inadequate quality. The water demand is increasing due to population growth and intensifying activities in various sectors, such as industry, agriculture and households.

Pollution is a serious challenge facing the entire world and particularly developing countries. Increasing human activity is having several adverse effects on the environment, including aquatic ecosystems. Heavy metals are highly persistent in nature because of their low biodegradability; they can be extremely toxic in high concentrations (Verma, 2020). The presence of organic pollutants and pathogens also creates major issues. When found in aquatic environments, these pollutants can have a negative effect on plants, domestic animals, people and the food chain (Yan et al. 2019).

Efficient water resources management is one of the most important aspects of sustainable development. Groundwater management is an integral part of efficient water resources

management. It is highly complex because groundwater is not a "visible" resource and detailed investigations are required to determine available quantities. Numerical models are often used to quantify groundwater. The hydrodynamic model applied to determine the infiltration parameters, water budget and groundwater reserves of the Vić Bare alluvial aquifer is an example (Polomčić et. al 2013). Hydrodynamic models are also used to design drainage systems that dewater mines (Polomčić et al. 2015) and assess the impact of floods on the groundwater regime (Polomčić et al. 2018). One of the comprehensive and state-of-the-art approaches to groundwater management is multicriteria analysis based on fuzzy logic (Bajić et al. 2017, Polomčić et al. 2017, Bajić et al. 2020, Polomčić et al. 2019).

Adding to pre-existing challenges, the COVID-19 pandemic has become a significant water quality issue. More than 200 countries worldwide have been combatting COVID-19 since January 2020. It has top priority in most countries. As a result, the scientific community has published more than four million articles on COVID-19 (according to a Google Scholar search of COVID-19 on 30 June 2021). They address a broad range of topics related to COVID-19, focusing on the perspectives of various scientific disciplines such as medicine, biology, tourism, socioeconomics, and environmental studies (Casado-Aranda et al., 2020). An important question that has arisen from the COVID-19 pandemic is whether aquatic ecosystems play a direct or indirect role in the spread of this disease and, if so, under what conditions?

The objective of the paper is to discuss the impact of the COVID-19 pandemic on water resources and the water sector. Since no detailed investigations of the impact of the pandemic on water resources have been undertaken in Serbia, the paper refers to the results reported by El-Ramady et al. (2020), who studied possible interactions between the SARS-CoV-2 virus and water, as well as those of Butler et al. (2020), who studied the effect of the COVID-19 pandemic on the water sector under the auspices of the International Finance Corporation, a member of the World Bank Group.

2. GROUNDWATER AND COVID-19

Water scarcity is a global problem, especially in arid and semi-arid regions. Conserving sources of clean and safe drinking water is of critical importance worldwide. Groundwater is the primary drinking and irrigation water source in many countries, with a major role in the preservation of natural terrestrial ecosystems (Huang et al. 2019). As a result of global climate change, involving temperature increase and redistribution of precipitation, groundwater recharge has decreased in many countries and water salinity has increased. Groundwater pollution has attracted global attention over the past decade due to the frequency and potentially adverse effects on aquatic ecosystems and human health (Kuroda & Kobayashi, 2021). Numerous studies focus on groundwater pollution and remediation.

By contrast, only a few studies dealing with COVID-19 and groundwater have been published in the previous period. Patni and Jindal (2020), Núñez-Delgado (2020) and Steffan et al. (2020) discuss a potential indirect impact of COVID-19 on groundwater. Patni and Jindal (2020) speak of certain positive effects. More specifically, they conclude that groundwater volume and quality have improved during the pandemic due to the decline in human activity. Research that focused on the impact of lockdowns on groundwater has been conducted in India. In one example (Punjab, India), Krishan et al. (2921) examine the effect of lockdown on the salinity of shallow and deep groundwater. In another, Aravinthasamy et al. (2021) assess the impact of lockdown on heavy metal concentrations and microbiological parameters of shallow groundwater in Coimbatore, southern India. Both studies conclude that

lockdowns have had a positive impact on groundwater quality. Núñez-Delgado (2020) and Steffan et al. (2020) discuss adverse effects of COVID-19 on the groundwater system, primarily the occurrence of waterborne SARS-CoV-2 in groundwater due to contact with contaminated wastewater. There are a few open questions relating to the connection between groundwater and COVID-19, such as those about its direct and indirect effects on global groundwater resources. Does groundwater play a role in the spread of COVID-19? What are the positive and negative effects of COVID-a-19 on global groundwater resources? And how much protection do geologic strata that overlie aquifers provide against contamination with SARS-CoV-2?

2.1 COVID-19 and contaminated wastewater

Wastewater has been defined as water originating from households, public institutions, and industries that do not require specific wastewater treatment (Lahrich et al. 2021). Wastewater can be a source of pathogens, such as that discharged by hospitals and households. According to WHO (World Health Organization), roughly 80% of global human diseases are waterborne. Every year, 1.5-12 million fatalities are attributed to waterborne diseases, including cholera, diarrhea, typhoid and viral hepatitis (Bhatt et al. 2020). Lethal viral illnesses include gastroenteritis and respiratory diseases like COVID-19 caused by the SARS-CoV-2 virus (Cao, 2020). Recent studies have demonstrated the presence of SARS-CoV-2 in wastewater (Mallapaty, 2020; Lodder and Husman, 2020; Ahmed et al., 2020; Wu et al. 2020; Bhatt et al. 2020). It has been suggested that surface water and groundwater bodies should be checkpoints for SARS-CoV-2 due to wastewater discharges and contamination coming from health facilities, sewage and drained water (Kumar et al. 2020a). As such, the transmission pathways of SARS-CoV-2 associated with water need to be identified in order to prevent a further rapid spread of the disease (Bhatt et al., 2020). According to WHO, SARS-CoV-2 can reach an aquifer by different routes, such as feces, evacuated wastewater and infiltration from the land surface. Because it is known that SARS-CoV-2 is airborne and has also been registered in water sources, the possibility of transmission through aquatic and non-aquatic environments needs to be examined closely.

Multiple studies have addressed the transmission and fate of SARS-CoV-2 in wastewater. Some of the important topics include:

- Detection and distribution of the SARS-CoV-2 virus in wastewater (Lahrich et al. 2021).
- The roles of water, salinity and hygiene in the spread of COVID -19 via the fecal-oral route, particularly in low-income countries. It is currently assumed that COVID-19 spreads through respiratory and contact transmission; however, the fecal-oral route has also been suggested as a transmission pathway of SARS-CoV-2, from the human stomach to feces and wastewater (Bhatt et al. 2020).
- The occurrence and persistence of SARS-CoV-2 in various environment and the conditions that favor the survival of the virus in water/wastewater/sewage have not yet been determined, because of evidence of transmission of the contagious virus in communities (Ihsanullah et al. 2020; Mohan et al. 2021),
- Potential secondary transmission of SARS-CoV-2 through wastewater and reducing the risk of transmission by limiting COVID-19 resurgence. Future research should focus on the virus in different aquatic environments (Liu et al. 2020).
- The consequences of SARS-CoV-2 in river water and groundwater that are hydraulically connected to surface waters, in countries with poor sanitary conditions, including major

SARS-CoV-2 loading from urban environments, and how the level of wastewater treatment can affect the risk of COVID-19 (Guerrero-Latorre et al. 2020).

- Epidemiological monitoring of wastewater for the SARS-CoV-2 virus might be an efficient detection technique, but it requires an effective method for SARS-CoV-2 RNA recovery from wastewater (Al Huramiel et al. 2020; Bhatt et al. 2020; Kitajima 2020).
- The seasonality of SARS-CoV-2 and its fate in the environment, transport, inactivation and resistance to antiviral drugs; SARS-CoV-2 is transmissible as a fecal virus through wastewater, surface water and groundwater, leading to human potential exposure (Kumar et al 2020b).
- Environmental conditions conducive to SARS-CoV-2 transmission, such as air temperature and humidity, might control the ability of SARS-CoV-2 to survive in droplets; the fecal-oral route might be a pathway for COVID-19 transmission from contaminated water bodies; and chlorination will not remove/inactivate SARS-CoV-2 fully or effectively (Mohapatra et al. 2020).

Based on research undertaken to date, the main two aspects that likely control the fate of SARS-CoV-2 in aquatic environments are its survival and migration. Enveloped viruses, such as SARS-CoV-2, can be quite mobile in subsurface environments (e.g., groundwater). Transport mechanisms and pathways that affect a water source and its interaction with soil properties (e.g., infiltration rate, soil pH, ionic strength and viral adsorption), as well as the characteristics of overlying sediments, protect groundwater systems from contamination (Kumar et al. 2020a).

In addition to the above, two studies focused on the effect of the COVID-19 pandemic on groundwater quality in India.

- For a study conducted in Punjab, 48 groundwater samples were collected in three major industrial districts (Ludhiana, Jalandhar and Moga). Thirteen samples were from shallow aquifers (<50 m) and 35 from deep aquifers (50–200 m). Sampling was undertaken after lockdown, in the pre-monsoon season (June 2020). The total dissolved solids (TDS) of these samples were compared to those recorded during the monsoon season (August 2020) and post-monsoon season (November and December 2019), to assess the effect of lockdown on groundwater salinity.
- The second study found a positive effect of COVID-19 lockdown on heavy metal concentrations and biological parameters of samples of shallow groundwater in the city of Coimbatore, southern India. The samples (n=15) were collected from shallow wells before and after lockdown (24/25 February and 2/3 June 2020). The samples were analyzed for heavy metals (Fe, Mn, Ni, Cr, Pb) and microbiological parameters (E. coli, fecal coliforms, fecal streptococci and total coliform bacteria) (Aravinthasamy et al. 2021) (Krishan et al. 2021).

Some diseases are caused by waterborne viruses. SARS-CoV-2 has already been detected in wastewater, but further investigations are needed to determine the fate and transmission in water systems. Some of the important questions are whether transmission of COVID-19 through water is possible, how to decrease the occurrence of SARS-CoV-2 in wastewater, what are the risks of COVID-19 transmission through drinking water and water supply/distribution systems, and how much groundwater protection is provided by overlying strata? There are several challenges facing the world with regard to aquatic environments and their connection with COVID-19. Will lockdowns implemented due to the COVID-19 pandemic have a positive effect on addressing environmental problems such as air and water pollution? Or will they aggravate these issues in the future? Such questions constitute serious challenges for all countries, but they concern developing countries in particular.

3. IMPACT OF THE COVID-19 PANDEMIC ON THE WATER SECTOR

Butler et al. (2020) discuss several exceptions and how COVID-19 is reflected in reduced water sector investments across the world. The pandemic has also elevated the importance of operational reliability due to the cost of disruption. Operational requirements originate from work shifts, water demand patterns, supply disruptions and various extraordinary measures implemented by governments to combat the pandemic.

The poorest countries in the world are experiencing a COVID-19 shock in addition to pre-existing issues with urban water supply and sanitation, leading to a potentially overwhelming burden. Low levels of access, reliability and quality of water supply, as well as sanitation and hygiene, constitute risks in developing countries. Large cities are also faced with risks associated with population density and illegal development. A recent World Bank facility that identifies pandemic hotspots has pointed out that crowded living conditions and inadequate public services, especially inefficient waste management and sanitation, are major sources of contagion risk in large and growing cities such as Cairo and Mumbai.

Big water consumers have decreased their activity, which has resulted in a reduced industrial water demand. The reduced water demand of large industrial and commercial users due to lockdown and travel restrictions will decrease water utility revenues. According to Global Water Leaders Group's research, industrial water demand will decrease by 27%, on average, due to the COVID-19 pandemic.

A number of countries have instituted crisis management measures that will affect revenues. Globally, partial suspension of collection from low-income users and moratorium on water service cut-offs are the most common crisis responses. Specific measures include (a) delay or exemption from payment of utility bills for vulnerable groups, (b) suspension of water service cut-offs substantiated by the need for hygiene in order to curtail the spread of the virus, and (c) deferral of meter reading and billing.

For example, the Chilean water supply utilities have reached an agreement with the government to postpone water and wastewater billing for nearly half of its lowest income clients, who consume up to 10 cubic meters of water per month, for the duration of the "state of catastrophe". The amounts accrued during this period will be paid in equal interest free-installments over the next 12 months. In Brazil, water supply utilities have instituted three months of exemption/no charge for low-income households, a three-month tariff adjustment delay, and drinking water donations.

These measures have shrunk water utility revenues. The Global Water Leaders Group (https://www.watermeetsmoney.com/global-water-leaders-group/) believes that water suppliers and water treatment plants can expect a decline in revenues of 15%, on average, due to the COVID-19 crisis. In the mid-term, well-managed markets will likely compensate their losses through monthly installments, government transfers or tariff adjustments. These measures might have an effect on utility management and users' payment culture, especially if they are in place for a long time.

Capital expenditures (CapEx) will decrease in both short and mid term. New capital projects will probably be deferred because municipalities will prioritize operating expenses (OpEx) and emergency response. Global Water Intelligence (GWI) estimated that water sector CapEx will decrease in 2020 and 2021, and thereafter possibly revert to pre-crisis forecasts. CapEx projections for 2020 expected a 7% decrease. It is currently unclear to what extent water supply and sanitation CapEx will shrink and how much time will be needed to revert to pre-crisis levels.

Operations could be affected by a higher risk of infection among utility personnel, including both routine and construction work. The continuity and flexibility of operations are of key importance for ongoing water supply and sanitation services, while simultaneously moving forward any construction that had already begun. Many governments have designated people working in the water and sanitation industry as essential workers, thus ensuring continuity of service. However, social distancing protocols necessitate that only critical personnel be kept on site. Logistics and supply chain disruptions have been reported.

Evidence from markets in which IFC operates indicates that financially strong utilities are coping. Most of them are experiencing a short-term revenue shortage and unfavorable borrowing conditions. However, these companies are generally able to bridge cash flow gaps and at the same time continue implementing pre-crisis CapEx plans, albeit with some delay or modifications to financial plans.

3.1 Crisis response

According to Butler et al. (2020), countries coping with historic drinking water supply gaps and lack of access to water are resorting to emergency measures, such as water trucks. For example, South Africa has set up water supply points for hand washing across the country. Ghana and Peru have implemented similar measures. In the mid and long term, the clear lesson learned from the crisis is that water supply and sanitation in insufficiently covered areas need to be expanded and improved. COVID-19 has accelerated project approval in several markets because the pandemic is stressing the importance of water supply and sanitation. Such projects are also part of economic incentives for the public, given the planned level of spending in countries like South Africa.

In response to COVID-19, IFC has been proactive in three water sector areas:

- Crisis response for existing clients. IFC is providing liquidity financing for rapid response facilities to assist long-term clients who have demonstrated strong operational and financial performance and are now facing a decrease in revenues and more stringent liquidity criteria of commercial banks.
- Long-term CapEx support to water supply companies, to build resilience. IFC is providing long-term financing to support water companies that are undertaking critical capital projects which ensure continuity of service in the short and mid term.
- Exchange of knowledge and capacity building. IFC hosts webinars for water companies on crisis recovery, along with World Bank's Water Global Practice.

3.2 Prospects

According to Butler et al. (2020), COVID-19 has highlighted the importance of access to safe and reliable water supply. Capital projects can be deferred, but economic incentives might mitigate decreasing revenues for CapEx financing. Stakeholders should attempt to re-assess water sector priorities after decades of inadequate investment and lack of political prioritizing of water.

The permanent lessons learned about crisis preparedness and resilience of personnel, systems and equipment might lead to increased spending on digital solutions. The pandemic might also help boost the implementation of automation and remote control, which are becoming increasingly important at times such as these. Given the effect of COVID-19, GWI estimates that global spending on digital solutions will grow by 8% per annum on average, from 32 billion in 2019 to 47 billion US dollars by the year 2024.

Today's automated user interfaces might change the future culture. Social distancing due to COVID-19 will prompt suppliers and customers to avoid contact with service centers and give priority to other channels of engagement. More user and useful interactions will take place via telephone, web applications or the internet, which is often the case.

IFC intends to implement initiatives to provide water sector support in the following areas: (a) continuity of investment in essential CapEx and progress toward SDG 6, (b) digitizing and energy efficiency improvement in water utilities, to build future resilience, (c) more water recycling as a viable solution for water scarcity and strengthening of upstream activities to create markets, and (d) systematic development of investment in infrastructure by structuring private-investment risk mitigation mechanisms such as hybrid annuity models, World Bank Group guarantees or mixed finance.

With regard to groundwater, efficient use, detailed investigations, resource quantification, feasibility of regulation and, of course, conservation and reduction of pollution of this valuable resource should be the future focus. In addition, awareness needs to be raised about the importance of groundwater, given that an increasing number of countries are facing water scarcity.

4. CONCLUSION

The COVID-19 pandemic has emphasized the importance of sanitary conditions and adequate drinking water. Given that the SARS-CoV-2 virus reaches wastewater through human excretions and that such wastewater might come in contact with surface water and groundwater, there is a high risk of waterborne transmission. This aspect has not been examined in detail, but in view of the high risk comprehensive investigations should begin as soon as possible.

The water sector, like other sectors, has been affected by the COVID-19 pandemic. The paper presented several responses of this sector (under the auspices of the IFC/World Bank Group) to the current emergency situation, from both technical and customer relations perspectives. Adverse effects of the pandemic on the water sector include shrinkage of water utility revenues, hindrance of ongoing investigations and infrastructure expansion, and the like. On the other hand, there have been some positive effects, such as a decrease in water demand, particularly of the industrial sector, which has in turn reduced industrial wastewater discharges. The pandemic has shown that the water sector must operate efficiently in emergencies. It has also highlighted potential shortfalls and possible aspects of more efficient use of water, as well as innovation in the water sector.

It has become clear that the COVID-19 pandemic is the longest and possibly worst pandemic that has befallen humankind. In addition to its impact on human health, the pandemic has virtually halted human day-to-day activities. Temporary suspension of industrial, agricultural and other essential activities has had a major impact on the economy. However, there are also some positive effects of the COVID-19 pandemic. For example, there has been a substantial decrease in harmful gas emissions and quantities of solid waste and wastewater, resulting in improved environmental conditions. There are reports of groundwater quality improvement in some parts of India. Given that the situation is now beginning to stabilize and as the world slowly returns to normal, strategies need to be developed to avoid similar scenarios in the future or at least minimize their impact.

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