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Review

Water Quality and Water Pollution in Time of COVID-19: Positive and Negative Repercussions

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Abstract: On 11 March 2020, the World Health Organization declared the new COVID-19 disease a pandemic. Most countries responded with a lockdown to reduce its effects, which brought beneficial consequences to the environment in many regions, but the pandemic also raised a series of challenges. This review proposes an assessment of the COVID-19 pandemic positive and negative impacts on water bodies on different continents. By applying a search protocol on the Web of Science platform, a scientific bank of 35 compatible studies was obtained out of the 62 open-access articles that were initially accessible. Regarding the positive impacts, the SARS-CoV-2 monitoring in sewage waters is a useful mechanism in the promptly exposure of community infections and, during the pandemic, many water bodies all over the world had lower pollution levels. The negative impacts are as follows: SARS-CoV-2 presence in untreated sewage water amplifies the risk to human health; there is a lack of adequate elimination processes of plastics, drugs, and biological pollution in wastewater treatment plants; the amount of municipal and medical waste that pollutes water bodies increased; and waste recycling decreased. Urgent preventive measures need to be taken to implement effective solutions for water protection.

Keywords: water quality; water pollution; COVID-19; pandemic; lockdown; positive and negative impacts

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1. Introduction

Since January 2020, the fight against COVID-19 has become the planet's main priority. On 11 March 2020, the World Health Organization (WHO) declared the new COVID-19 disease a pandemic [1] as its fast outbreak, geographical expansion and intricate repercussions match the attributes of a global disaster [2–9]. Most states reacted by physical distancing rules and sharply reduced economic and non-economic activities.

During this period, in their attempt to annihilate this worldwide pandemic, scientists have produced thousands of studies in a broad range of knowledge fields such as medicine, biology, environment, socioeconomics, and tourism [2,10–35].

The new coronavirus pandemic changed the way the world was functioning for several months. The restriction of movement, the slowdown of industrial activity and the decline in consumption had consequences on the natural milieu.

It is known that environmental elements shape the onset and dissemination of epidemics or pandemics that, in turn, can cause environmental reactions. The COVID-19 pandemic has induced plentiful environment impacts, both positive and negative, that are visible within the lithosphere, atmosphere and hydrosphere, and in their responses to each other. Water is one of the most essential components of the environment and is a source of life. Anthropogenic pressure on water resources have been contributing to their degradation for many years.

The availability of global water capital is diminishing. The cause of this phenomenon is the ever-higher freshwater pollution generated by the high-volume discharges of partly treated, or untreated, wastewater into rivers, lakes, aquifers and coastal waters [36]. Water quality is evaluated by analysing its physicochemical and biological elements comparing to a set of standards, and it is used to determine the water suitability for consumption or its safety for the environment [37]. Water quality is deteriorating in developed and developing countries as well. Hence, a particularly important task is to constantly monitor the water pollutants and their impact in various world regions, taking into account the number of people and the degree of socio-economic development. Water quality and pollution problems are ubiquitous on a global scale, and they are aggravated by the unavailability of credible water quality information in most countries worldwide [38].

This paper's aim is to estimate the positive and negative COVID-19 pandemic time impacts of water bodies and types on different continents by comprehensively reviewing relevant open-access studies sourced from the Web of Science (WoS) database, which is the top source of peer-reviewed scientific information for the academic and research milieu.

We start by stating that our paper does not review articles that present the connection between wastewaters and the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) contamination, considering that this topic requires a separate and detailed study, but also that, if the analyzed articles also touched on issues regarding wastewater and COVID-19, they were mentioned in our work.

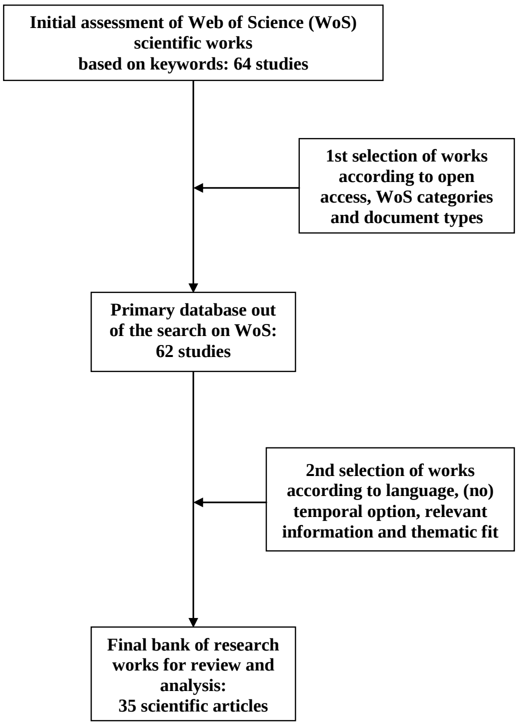
Our main objective is to concisely analyse the bulk of scientific papers published on the topic. A secondary objective is to investigate two specific issues: space-related SARS-CoV-2 impacts on water body quality and time-related COVID-19 impacts on water quality, by comparing pre-lockdown and lockdown trends (when data was available). It must also be noted that the open-access scientific articles that feature data on the COVID-19 impact on water quality sum up to a limited database, which should be further developed.

2. Materials and Methods

A WoS platform-sourced bank of COVID-19 and water quality/pollution studies was built using a set of relevant keywords. The final search is dated 4 January 2022.

Said keywords, e.g., "COVID-19", "SARS-CoV-2", "water", "quality", and "pollution", were used in different combinations. Initial results (64 studies) were subsequently narrowed through several filters (open-access, WoS categories, and document types) and by applying a specific search protocol (works written in English, no temporal option, relevance for our review, and thematic fit). This resulted in a second bank consisting of 35 relevant studies (Scheme 1).

Fifteen articles are reviews focusing on COVID-19 effects on all environmental factors (including water), all over the world (Figure 1), 2 of which note the importance of SARS-CoV-2 monitoring in wastewater; 11 papers go into more detail regarding said effects in India (8 tackle water quality, while 3 present all environmental factors) (Figure 1), 2 articles look into the effects the pandemic time had on water quality in South Africa, 1 is on the same effects in the water bodies of Lombardy (Italy), 1 is on Meriç–Ergene River Basin in Turkey, 1 is on South America waters, 1 is on water quality in Bangladesh, 1 is on waters in China, 1 is on the COVID-19 environment effects (including water) in Southeast Asia, and 1 analyzes COVID-19 effects on air and water in South Asia (Figure 1; please also see Section 3).



Scheme 1. The systematic review process scheme.

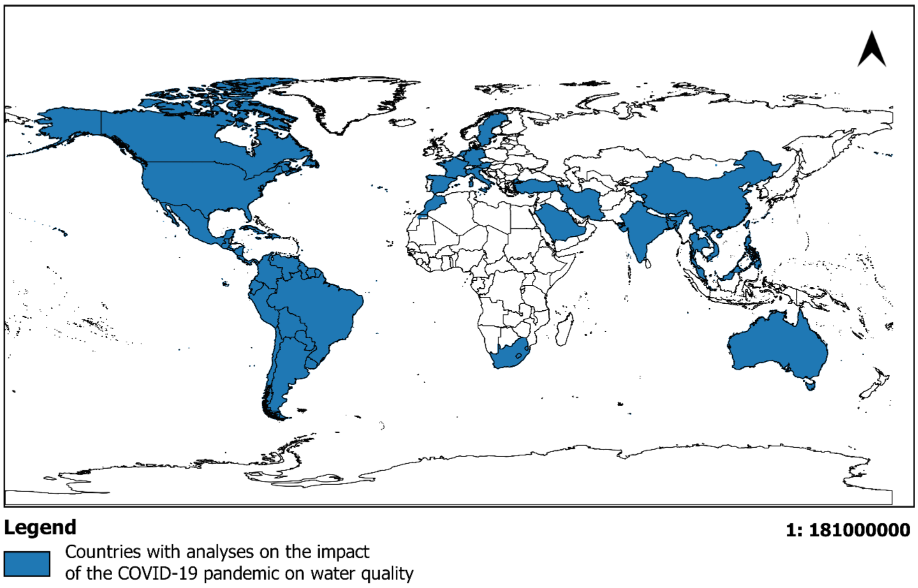


Figure 1. Countries with analyses on the COVID-19 impact on water quality.

Fifteen articles present the positive pandemic time effects on the environment (including water), 8 papers look at the negative COVID-19 effects on the environment (including water), and 12 others analyse both the positive and negative impacts on environmental factors, including water (please see Section 3). Twenty papers were published in 2021, and the remaining 15 in 2020. The full-text versions of the 35 papers were retrieved and reviewed thoroughly.

3. Results and Discussions

We will first present (Table 1) and then discuss (the present section) the results of this review considering scientific contributions on the pandemic time's impact on various water bodies worldwide.

Table 1 emphasizes our review landmarks:

Table 1. The WoS platform review process results on COVID-19 impact on water quality.

Type of Article	Location of Water Quality COVID-19 Impact Analysis	Investigated Hydrosphere Component/ Water Type	Evaluated Parameters/ Pollutants of the Hydrosphere Component/ Water Type	Positive Effects	Negative Effects	Sources of Water Quality COVID-19 Impact Information
Review on COVID-19 environmental effects	Spain, Netherlands, Australia, USA, France, Italy, Turkey, Ecuador, and China	Wastewater	SARS-CoV-2 virus and its RNA	✓+ SARS-CoV-2 exposure in wastewater	✓	Al Huraimel et al. 2020 [39]
	India, China	Wastewater	SARS-CoV-2 virus		✓	Bhowmick et al. 2020 [40]
	India	Surface water (river, lake); groundwater	Suspended particulate matter (SPM); heavy metals	✓		Casado-Aranda et al.2021 [25]
	Italy, Hong Kong, Canada, Germany, and Austria	Surface water; wastewater	SARS-CoV-2 virus; medical and hygienic waste	✓+ SARS-CoV-2 exposure in wastewater	✓	Cheval et al. 2020 [4]
	Asian countries, Italy	Surface water; wastewater	Chemical pollutants; plastic waste; and suspended solids	✓	✓	Espejo et al. 2020 [41]
	India, Italy, and Saudi Arabia	Surface water (rivers); sea/ocean water	Dissolved oxygen (DO); biochemical oxygen demand (BOD); total coliforms (TC); pH; and aquatic life	✓		Khan et al. 2021 [30]
	China, India, and Spain	Surface water; sea/ocean water	Medical and plastic waste; dioxin		✓	Patricio Silva et al. 2021 [42]
	China, Iran	Surface water; wastewater	Chlorine (Cl); infectious and plastic waste; and chemical and biological pollution		✓	Poursadeqiyan et al. 2020 [43]
	China, India, Iran, USA	Wastewater	SARS-CoV-2 virus	✓	✓	Rahimi et al. 2021 [9]
	India, Bangladesh, Italy, Malaysia, Thailand, Maldives, Indonesia, Australia, Sweden, Netherlands, USA, China	Surface water (rivers); sea/ocean water	Medical and plastic waste; chemical pollution; DO; and BOD	✓	✓	Rume and Islam 2020 [44]
	India, France, Italy, USA, Spain, China	Surface water (rivers); sea/ocean water	Chemical pollution	✓		Rupani et al. 2020 [45]
	China, India, Iran, and USA	Sea/ocean water	Chemical pollution; plastic waste	✓		Sivaranjanee and Kumar 2021 [46]
	Italy, India	Surface water; sea/ocean water; wastewater; recreational activity and physical therapy pools	Chemical pollution; plastic waste; and SARS-CoV-2 virus	✓	✓	Usman and Ho 2021 [47]
	India, China, Malaysia, and Morocco	Surface water (rivers and lakes); sea/ocean water; wastewater	Biodiversity; macroplastic and microplastic pollution; chlorophyll a (Chl-a); phyto-plankton; nitrogen; turbidity; pharmaceuticals and disinfectants; and SARS-CoV-2 virus	✓	✓	Yusoff et al. 2021 [48]
	China, USA, Italy, Spain, Mexico, Ecuador, Australia, Bangladesh, India, Netherlands, and Sweden	Surface water; sea/ocean water; wastewater	Chemical pollution; plastic waste; and SARS-CoV-2 RNA	✓	✓	Zambrano-Monserrate et al. 2020 [49]

Table 1. *Cont.*

Type of Article	Location of Water Quality COVID-19 Impact Analysis	Investigated Hydrosphere Component/ Water Type	Evaluated Parameters/ Pollutants of the Hydrosphere Component/ Water Type	Positive Effects	Negative Effects	Sources of Water Quality COVID-19 Impact Information
Specific area article	India	Surface water (rivers)	Physical, chemical (e.g., DO) and heavy elements; and TC	✓		Chakraborty et al. 2021 [26]
		Surface water (rivers)	Chemical pollution; wildlife; bio-medical, hazardous and plastic waste	✓	✓	Debata et al. 2020 [50]
		Groundwater	Fluoride (F); nitrate (NO_3); ionic loads; and bicarbonate	✓		Karunanidhi et al. 2021 [51]
		Surface water (lake)	Chemical parameters	✓		Kulk et al. 2021 [52]
		Surface water (rivers)	Chemical parameters (e.g., DO, BOD)	✓		Lokhandwala and Gautam 2020 [53]
		Surface water (lake); groundwater	Chemical parameters	✓	✓	Mukherjee et al. 2020 [54]
		Surface water (rivers and lakes)	Hardness; alkalinity; total dissolved solids (TDS); TC; and pH	✓		Nandan et al. 2021 [55]
		Surface water (river)	BOD; chemical oxygen demand (COD); SPM; turbidity; algal signatures; and fecal coliforms	✓	✓	Patel et al. 2020 [56]
		Groundwater	Physico-chemical parameters (pH; TDS; electrical conductivity (EC); NO_3; F; heavy metals; As; Se); bacterial parameters (TC; fecal coliforms; and *E. coli*; fecal streptococci)	✓		Selvam et al. 2020 [57]
		Surface water (lake)	Chl-a; colored dissolved organic matter (CDOM); total suspended solids (TSS)	✓		Wagh et al. 2021 [58]
		Surface water (lake)	SPM	✓		Yunus et al. 2020 [24]
	South Africa	Surface water, ocean water	Antiretro-virals (ARVs); plastic and hygienic waste; and sanitizer chemicals		✓	Horn et al. 2020 [59]
		Surface water	Physico-chemical parameters	✓		Molekoa et al. 2021 [60]
	Italy	Surface water; sea water	Plastic and hygienic waste; microplastics		✓	Binda et al. 2021 [61]
	Turkey	Surface water (river)	Physico-chemical parameters; metal(loid)s	✓		Tocatlı and Varol 2021 [62]
	South America	Surface water; ocean water	Plastic, textile and hygienic waste; microplastics		✓	Ardusso et al. 2021 [63]
	Bangladesh	Surface water; ocean water	Plastic, textile and hygienic waste		✓	Islam et al. 2021 [64]
	China	Wastewater (pit latrines)	SARS-CoV-2		✓	Liu et al. 2021 [65]
	Southeast Asia (Indonesia, Malaysia, Thailand, the Philippines, and Vietnam)	Surface water (rivers); sea/ocean water	TSS; DO; and plastic and medical waste	✓	✓	Praveena and Aris 2021 [66]
	South Asia (Pakistan, India, and Bangladesh)	Sea/ocean water	Chl-a; turbidity; and nitrogen load	✓		Shafeeque et al. 2021 [67]

3.1. Virus COVID-19 in Water—General Information

WHO reported [68] that there is presently no confirmation of COVID-19 survival in potable water or wastewater. The COVID-19 virus is similar to other human coronaviruses for which there are already scientific databases on their survival in the environment, as well as the efficient suppression measures [9].

Commonly used methods of treating tap water—filtration and disinfection—should eliminate or suppress the SARS-CoV-2, as per the instructions supplied by the American Centers for Disease Control and Prevention (CDC) [69]. Coronaviruses are distinguished by low resistance to UV radiation and disinfectants generally used in technological water treatment processes, such as Cl (chlorine), sodium hypochlorite or chlorine dioxide. Furthermore, viruses of this type, such as other similarly-sized suspended particles, are removed from the water by coagulation combined with flocculation assisted by polyelectrolytes and filtration through sand, sand-anthracite and/or carbon filters. These types of processes are most often used in water treatment plants. Water intended for human consumption provided by the collective water supply system is safe both for consumption and economic purposes.

COVID-19, like many other viruses, can be found in wastewater. Here, too, standard methods of disinfection of waste are sufficient to eliminate the virus [9]. It is necessary to emphasize that municipal wastewater, due to the fact that it is generated in households, public facilities, hospitals, schools, shops, service facilities, etc., carries millions of viruses, bacteria, parasites, and toxic and poisonous substances. It is worth noting that any virus present in wastewater is largely removed by wastewater treatment. Ensuring adequate water and wastewater quality requires systematic control and compliance with water and wastewater quality procedures.

In 2020, Al Huraimel and his colleagues [39] analyzed the SARS-CoV-2 presence in wastewater and concluded that the coronavirus is unlikely to be transmitted via wastewater. Coronaviruses are sensitive to disinfectants and organic solvents; therefore, they die rapidly in sewage (2–3 days). Studies in hospital wastewater showed that the virus was detectable in sewage water before and occasionally after Cl disinfection, but there was no living SARS-CoV [39]. Accidental contact with treated wastewater has a negligible potential risk of infection, while contact with untreated wastewater, especially in poorly sanitary areas, can be a potential route of infection. Temperature is the most important factor in coronavirus persistence: higher water temperatures reduce virus survival. The primary wastewater treatment and coronavirus adsorption may provide protection against the virus, but more research is needed to assess the viability of SARS-CoV-2 in wastewater.

3.2. Reviews and Analyses of the COVID-19 Effects on Different Water Bodies All over the World

The monitoring of SARS-CoV-2 in the wastewaters is a useful mechanism in the promptly exposure of collective infections at the pandemic debut. This powerful instrument can help policy makers to prepare adequate COVID-19 mitigation policies.

Real-Time Reverse Transcriptase–Polymerase-Chain-Reaction Testing (RT-qPCR) is the technology used for SARS-CoV-2 RNA detection in the sewage water. It must be stressed that RNA exposure in sewage water does not imply a viral viability and a transmission risk [41]. SARS-CoV-2 RNA was identified at the pandemic onset in wastewater samples from Valencia Region (Spain), Schiphol Amsterdam Airport and Tilburg (Netherlands—only a few days after the confirmed COVID-19 cases in the country), Australia, Massachusetts (USA), France, Milan (Italy), Istanbul (Turkey), Quito (Ecuador) and China. All these are confirmations of RT-qPCR method sensitivity as an early monitoring instrument, but no official conduct code for the primal SARS-CoV-2 detection and quantification in wastewaters has been drawn up yet [39].

Bhowmick et al. [40] stated that conventional methods of disinfecting wastewater can remove SARS-CoV-2 from sewage systems. In largely populated states with undeveloped wastewater treatment plants, such as India, the risk of SARS-CoV-2 infection is very high as the new coronavirus can persist for a few days in raw wastewater and for a longer time in areas with low temperatures. In order to control the possible spread of COVID-19 through water in India, water sources' pollution should be prevented; water should be treated before supplying to population; and then water should be stored in clean, airtight tanks. A free residual Cl concentration of $\geq$0.5 mg/L in the distribution pipes [40] proves the efficiency of water disinfection. In China, SARS-CoV-2 has been completely eliminated from wastewater generated by Zhejiang University's affiliated hospital by using sodium hypochlorite solution. Other effective methods of disinfecting domestic water are heating to 92 °C for 15 min, boiling, nanofiltration, solar/UV irradiation or free Cl addition in adequate concentration [40].

In India, during the COVID-19 confinement, most Ganga basin districts encountered a 60% excessive rainfall, which induced an escalation of the river flow and a pollutant dilution, as Casado-Aranda et al. [25] have attested. The lockdown had a positive impact on the water quality of Vembanad Lake, the longest in India, with a 15.9% reduction of suspended particulate matter (SPM) concentration, and the groundwater quality in Tuticorin, an industrial city in southern India, improved regarding the heavy metal concentrations (arsenic (As), selenium (Se), lead (Pb) and iron (Fe)) as a result of significantly lower wastewater flows from the metallurgical industry [25].

According to Cheval et al. [4], as a consequence of limited water transport and traveller activities, Venice cleaned its waters amid the citywide COVID-19 confinement, in the spring of 2020. Additionally, in Germany and Austria, a restraining effect of water consumption was noticed. Cheval and his colleagues [4] reiterated the idea that SARS-CoV-2 RNA monitoring of the sewage waters proved to be an efficient instrument for coronavirus dissemination surveillance. They also presented the pandemic time's negative effects on water bodies and stressed that many reports had asserted the significant harm caused by medical and individual hygienic consumables that were found on the shores in Hong Kong, Canada and many other regions.

In 2020, Espejo et al. [41] reported positive and negative, and direct and indirect COVID-19 impacts, on water quality. The medications used to cure COVID-19 consist of persistent, bioaccumulative and dangerous substances to aquatic organisms, and they are considered emerging pollutants. The sewage water treatment technology cannot eliminate these remedies, and they will be discharged into inland bodies of water. At the same time, COVID-19 diagnostic laboratories pollute all environmental elements with different plastic materials and chemicals substances. In addition, it is important to mention the methacrylate from plastic screens and other physical spacing equipment, which can pollute waters and land, and the masks and gloves noted on many beaches and the sea floor, in the Asian states [41]. The different water animals can swallow the masks or become trapped in their elastic cords. On the other hand, Espejo and his colleagues, like other researchers, revealed a better water quality in Venice (Italy), where suspended solids decreased as a result of lesser use of motorboats. Unfortunately, it is expected that, when humanity comes back to the pre-pandemic conditions and reality, the plastic and chemical water pollution caused by the fight against the new coronavirus disease COVID-19 will prevail for long periods of time and will need to be removed using adequate technologies [9,41].

Khan et al. [30] indicated that, during the COVID-19 confinement, water quality improved following the interruption of industrial wastewater discharge. The Central Pollution Control Board of India and the Indian Institute of Technology Roorkee [70] reported a 40–50% substantial upgrade of the Ganga River water quality based on the measured values of dissolved oxygen (DO), biochemical oxygen demand (BOD), total coliforms (TC) and pH. The Yamuna River improved as well; DO analysis indicated values of 2.3–4.8 mg/L, compared to zero in 2019. The BOD of the Ganga's and Yamuna's most degraded sectors diminished substantially [70,71]. Khan and his colleagues, like many other scientists, underlined the fact that in Venice, the water cleared after the COVID-19 confinement and the aquatic species could be observed after many years of absence. With the suspension of numerous cruises and of other marine activities, tourism scaled down and, consequently, aquatic organisms regained their environment, as happened in the Saudi Arabian Red Sea waters [30].

Since the beginning of pandemic, the growing volume of medical waste has become a critical risk to population health and to the environment at the planetary scale. In countries such as China, India, Spain, and Bangladesh, the medical waste quantity doubled or even tripled, as happened in Catalonia region, in 2020 [42,44]. As a result of the lack of education regarding infectious waste handling, many people dispose of these wastes either in open spaces or together with domestic waste. Such disorganized dumping of this kind of trash blocks the water ways and aggravates water pollution [42,44], including with microplastic fibers, dioxin and other elements that are toxic to aquatic life. Once present in water bodies, both personal protective equipment (PPE) and plastic trash will obstruct the sewage system (especially in developing countries) and will also negatively alter the water drainage. Furthermore, plastic pollutants in the aquatic environment will deteriorate and fragment, which results in the formation of micro- and nano- size plastic particles [46] that affect the aquatic life by their ingestion.

Poursadeqiyan et al. [43] showed that the pandemic will have a delayed negative impact on the environment. The asepsis of the roads led to the presence of residual Cl in treatment plant effluents, which contaminates water and jeopardises water organisms. The COVID-19 outbreak increased the municipal and infectious waste quantities and, consequently, the environmental pollution, including water deterioration, in countries such as China and Iran. The new coronavirus increased the biological pollution, especially in hospitals and SARS-CoV-2 mortuary wastewaters, and this demands distinctive biological wastewater treatment methods [43]. Another pandemic time consequence is the more frequent washing of hands and higher consumption of soap and detergents, which results in an emergent focus on eliminating chemical compounds from wastewaters. In China and Iran, the disposal of contaminated wipes, masks, and gloves can pollute the surface water bodies and groundwater [43].

Rume and Islam [44] also indicated in their study that the pandemic lessened the water contamination in different countries and reduced the pressure on tourist destinations but increased the quantities of medical waste, disinfectants and the untreated PPE, which all finally affected the quality of water bodies.

During the lockdown, in India and Bangladesh, water pollution decreased because the most important industrial polluters reduced or halted their activity, visitor numbers dropped and volumes of sewage and industrial wastewaters diminished considerably [44]. As a result, the rivers Ganga and Yamuna, analyzed by numerous scientists, attained an unprecedented water quality proven by monitoring data, especially DO and BOD values [44]. As Rume and Islam mentioned, water contamination decreased on the shores of Bangladesh, Malaysia, Thailand, Maldives, and Indonesia. Moreover, due to the lower commercial activity, the traffic of merchant ships and other vessels decreased globally, which also reduced marine pollution.

At the same time, the absence of sightseers because of the social isolation imposed by the COVID-19 pandemic induced a remarkable positive impact on many seashores across the world [46].

Rupani et al. [45] reiterated the valuable effect of the new coronavirus pandemic on Ganga River water quality, which improved significantly. Water pollution decreases were apparent in Wuhan (China), Italy, France, Spain and Los Angeles (USA) [45].

Usman and Ho [47] asserted once more that in Italy and India, the quality of surface waters ameliorated. At the same time, according to these scientists, there is a SARS-CoV-2 contamination risk and health danger when the virus is detected in wastewaters, waters destined for recreational activities, and in physical therapy pools [47].

Yusoff et al. [48] evaluated the positive and negative impacts of pandemic on aquatic bodies. The COVID-19 lockdown resulted in an improvement of the water bodies' quality, wild angling capital and biodiversity; in the reduction of macroplastic concentration, chlorophyll a (Chl-a), phytoplankton and nitrogen in the Indian coastal area [48]; and in a turbidity decline in Wuhan lakes (China) and Malaysian waters. Water quality improvement has been seen in the Chinese rivers, estuaries and seas, and in the Morocco's estuarine and coastal waters.

The negative repercussions consisted of the escalating water contamination with microplastics, pharmaceuticals and disinfectants, and with the new coronavirus from the sewage treatment plants, mainly from hospitals, which may have important effects on the environment and human health. Hospital wastewaters should be treated efficiently to avoid the virus dissemination [48].

COVID-19 beneficial and adverse impacts on the environment, including water bodies, were also analyzed by Zambrano-Monserrate et al. [49] in countries such as China, USA, Italy, Spain, Mexico and Ecuador. In their study, Zambrano-Monserrate and his colleagues mentioned the favourable connection between contingency measures; the lack of tourists; and the cleaner beaches with pure waters, e.g., those of Acapulco (Mexico), Barcelona (Spain) or Salinas (Ecuador). At the same time, unfavourable effects such as less recycling, more waste and the SARS-CoV-2 RNA presence in municipal wastewaters, which may endanger and contaminate water bodies, were investigated by the same scientists in countries such as Australia, Bangladesh, India, Netherlands, Sweden and USA [49]. New wastewater treatment methods should be developed, as China did by using a higher concentration of Cl to hinder the novel coronavirus transmission, but the surplus of Cl in water bodies may lead to dangerous by-products.

3.3. Analyses of the COVID-19 Effects on Different Water Bodies in India

The scientific study elaborated by Chakraborty et al. [26] examined the Damodar River water quality during the COVID-19 confinement and pre-lockdown periods. In recent years, Damodar water quality had deteriorated as a result of untreated industrial effluent discharge and urban sewage. For this study, 11 effluent discharge sites were selected and investigated pre-confinement and during confinement. The conclusions were that "the physical, chemical and heavy elements" did not respect permissible limits in the pre-lockdown period, when 100% of water samples were highly polluted. During the lockdown, 90.90% of water specimens upgraded to "good quality" and 9.10% of specimens were "moderately polluted" [26], as a consequence of the heavy metal-industries' halt over the course of three months.

At the same time, Chakraborty and his colleagues specified that Ganga River water quality neighbouring Kolkata city showed a high DO concentration in the confinement time compared to preceding years. The investigation on Ganga River's lower course TC revealed a significant bacterial community drop because of the industrial, touristic and traffic activity interruption during the lockdown.

According to Debata and his colleagues [50], the COVID-19 lockdown brought about an environmental revival in India, due to less pollution and reduced industrial wastewater discharges in water bodies. As many other scientists stated, Debata et al. highlighted that Yamuna and Ganga Rivers showed a significant water quality improvement after the lockdown enforcement because Ganga waters became suitable for bathing, wildlife and fisheries. Conversely, the pandemic time resulted in an increase in bio-medical and hazardous waste amounts, as well as an increase in plastic usage and a decline in waste recycling [50].

Karunanidhi et al. [51] inspected groundwater quality in 30 locations in the Coimbatore region (Southern India), before and during the COVID-19 lockdown. The researchers evaluated the impact of diminished human activity on aquifer quality. The results showed that the fluoride (F) pollution decreased during the confinement and the water of the wells became proper for drinking during the lockdown period. At the same time, groundwater nitrate (NO_3) pollution declined by 33.4% during lockdown time relative to the pre-lockdown months [51]. The COVID-19 lockdown considerably reduced the high ionic loads as a consequence of the industry shutdown and the decline of agricultural activities. The lockdown increased the groundwater bicarbonate concentrations, which represented a considerable quality improvement. One of the study's conclusions was that controlling anthropogenic pollutant inputs may result in positive benefits to groundwater quality [51].

Kulk et al. [52], using in situ observations and the remote sensing imagery, analysed different water quality parameters of the Vembanad Lake water during the 2020 confinement, proving that Vembanad water quality ameliorated due to the halt of the main anthropic activities, such as industry, transport and tourism, and that the rainfall specific to the months of April and May (parts of the lockdown time) played a minimal role in this improvement.

Lokhandwala and Gautam [53] underlined, in their scientific paper, as other scientists did as well, that during the COVID-19 confinement, the water quality of Indian rivers started to improve, e.g., Ganga, Cauvery, Sutlej and Yamuna Rivers. The main reason for this was the halt of industrial effluents and domestic wastewater discharge in natural water bodies during the lockdown. Bathing and dumping flowers or other waste in Ganga waters stopped throughout the pandemic time. DO and BOD levels upgraded at Kanpur and Varanasi. During the COVID-19 lockdown, the Ganga River's self-purification increased and its water quality increased by 40–50% compared to the pre-confinement time [53].

Mukherjee et al. [54] built on other scientists' results on water quality improvement for both surface and groundwater, as was the case of Vembanad Lake and the Tuticorin city's groundwater, due to cutback of industrial activities and wastewater discharge reduction. Unfortunately, during the COVID-19 lockdown, many Indian urban areas experienced a severe water shortage because the travel restrictions caused a drop of the water trucking supplies and water storages [54].

Yunus et al. [24], using remote sensing imagery, also proved the improvement of the Indian Vembanad Lake water quality with regard to SPM concentration that decreased during the confinement period (when industries and tourism were suspended).

Nandan et al. determined the water quality for eight Indian water bodies: the rivers Ganga, Yamuna, Mandakini, Alaknanda, Bhagirathi and Gaula, and the Naini and Bhimtal lakes [55]. During the COVID-19 lockdown, the hardness levels, alkalinity, total dissolved solids (TDS), total TC index and pH increased and water quality went up for all the above-mentioned waters across the state, as the result of the diminished human activity (tourism, religious practices, rafting and other sports) and a lower discharge of industrial effluents [55].

The Yamuna's sector in Delhi has been considered for many years as the dirtiest river stretch in India [56]. The enforcement of the COVID-19 nationwide lockdown brought a ray of hope for its water quality. The nine water quality monitoring stations indicated a 37% improvement during the confinement time, in comparison with the pre-confinement period, after analysing different water parameters such as BOD, Chemical Oxygen Demand (COD), SPM, turbidity, algal signatures, and fecal coliforms [56].

Selvam et al. [57] presented, in their scientific work, the imprints of the COVID-19 confinement on groundwater quality in Tuticorin city, India. Twenty-two groundwater specimens were analysed biologically and chemically, before and during the lockdown. The physico-chemical parameters investigated were pH, TDS, electrical conductivity (EC), NO_3, F, chromium (Cr), copper (Cu), zinc (Zn), cadmium (Cd), Fe, Pb, As and Se, and the bacterial parameters were TC, fecal coliforms, *E. coli* and fecal streptococci. The Tuticorin groundwater quality improved as a result of the lower wastewater discharge from metallurgical industries, thermal power plants, and seafood and fishing industries during the COVID-19 confinement [57].

Wagh et al. [58] investigated the changes in Hussain Sagar Lake water quality parameters during the COVID-19 confinement, applying remote sensing techniques. It was evident from the results that the lockdown had a significant effect on lake pollution, when compared to previous years (2015–2019). A considerable reduction in the concentrations of Chl-a, colored dissolved organic matter (CDOM), and total suspended solids (TSS) was found. The decline of pollution levels was the consequence of the confining measures meant to restrict human activities and the halt of diverse industrial units in the city of Hyderabad [58].

3.4. Analyses of COVID-19 Effects on Different Water Bodies in South Africa

In South Africa, 7.9 million people (13.5% of the population) have HIV and the acquired immune deficiency syndrome, and half of them are being treated with antiretrovirals (ARVs) that pollute waters because ARVs cannot be effectively removed from the sewage system [59]. If this treatment is also used against SARS-CoV-2, South Africa will face a severe ARV water pollution escalation. During the COVID-19 pandemic, this country experienced water quality problems posed by the higher use of PPE and of chemicals such as triclosan, triclocarbon, and acrylate copolymers in sanitizers. Triclosan is one of the precursors of dioxins, which are very harmful and persistent compounds in the environment, including water. Future studies and thorough monitoring are necessary regarding the presence and effects of ARVs in South Africa's water bodies [59].

After one year, in 2021, Molekoa et al. [60] directed a spatiotemporal surface water quality analysis in Mokopane, Limpopo province of South Africa, and investigated different physico-chemical parameters in water samples collected from five water monitoring locations. The year 2020 showed a water quality improvement as the result of the lockdown period.

3.5. Analyses of COVID-19 Effects on the Water Bodies of Lombardy (Northern Italy) and on Meriç—Ergene River Basin (Turkey)

Binda et al. [61] evaluated the adverse effects of the abundant PPE use on the Lombardian environment, including the water bodies, which were extremely altered by the pandemic.

The high consumption of PPE can become a concerning plastic pollution issue. The 2020 impact assessment and the 2021 forecasts evidenced a considerable growth of PPE plastic waste in rivers, lakes and the sea [61].

PPEs negatively affect aquatic life because they suffer leaching processes in the water environment, and they are also disintegrated by UV radiations and abrasion, which generate microplastics that absorb pollutants and can be ingested by organisms.

The Lombardian population should avoid the improper dispersion of PPEs in order to limit their environmental impact.

Ergene River and Çorlu Stream, from the Meriç—Ergene River Basin in Turkey, are heavily polluted. The nationwide lockdown caused by COVID-19 led to a surface water quality upgrade. Tokatlı and Varol [62] evaluated the lockdown impact on water quality in the above-mentioned river basin by analyzing the physico-chemical parameters and metal(loid)s in water specimens of 25 monitoring stations. The results showed an important recovery of water quality for metal(loid)s as a consequence of industrial effluent cutback [62].

3.6. Analyses of COVID-19 Effects on Different Water Bodies in South America, Bangladesh and China

Ardusso et al. [63] stressed, in their scientific paper, the fact that this pandemic led to a greater usage and manufacturing of face masks, gloves and other PPE elements fabricated with polymers and antiviral textiles that end as microplastics and emerging contaminants, drawing attention to South America. The authors tried to sound the alarm about the use and mismanagement of this PPE, which represents an environmental issue, particularly for water bodies. Ardusso et al. pointed out that the pandemic escalated plastic usage and reduced plastic recycling, worsening the pollution of the South American shores [63].

The scientific work performed by Islam et al. [64] in Bangladesh found that more than 50% of online survey respondents declared dumping their used tissues, masks, gloves and household waste, which is dangerous for public health and the environment, including the state of water bodies. This study [64] revealed the necessity of an accurate infectious-waste management policy in Bangladesh.

In a 2021 scientific work, Liu and his colleagues [65] surveyed 27 villages in Chinese provinces Jiangxi and Hubei and discovered that pit latrines could cause SARS-CoV-2 water pollution. Putting an end to the pit latrines and fertilizers of untreated excreta could ameliorate the state of living environment and water body quality. This study results could be implemented in low-income countries, notably in Africa [65].

3.7. Analyses of COVID-19 Effects on Different Water Bodies in Southeast and South Asia

The environmental impacts of COVID-19 in Southeast Asia, including on water bodies, were examined by Praveena and Aris in 2021 [66].

One positive outcome of the COVID-19 lockdown and movement restrictions the scientists identified was, as in many other regions and countries, the improvement of water quality. For example, there were ameliorations in the Malaysian rivers' water quality, i.e., a decrease in the TSS and an increase in DO, which were explicable by the decline in the total amount of waste and the reduction in domestic and industrial pollution loads during the lockdown. The negative effects comprised a rise in the use of plastics and the generation of medical waste, which may finally have a high potential pollution impact on water bodies in Indonesia, Malaysia, Thailand, the Philippines and Vietnam [66].

In 2021, Shafeeque and his colleagues [67] investigated the COVID-19 lockdown benefits on South Asian aquatic ecosystems, linked to less intense anthropogenic activities. The results revealed an important drop of Chl-a concentration and turbidity, on the coastlines of Karachi, Mumbai, Calcutta, and Dhaka, respectively, but also lower nitrogen emissions in the air, which contributed to water quality improvement.

According to Shafeeque et al. [67], the application of the territorial constraints regarding fossil fuel use and population transport for certain periods (two weeks—one month) will help with "healing the planet's environment".

4. Conclusions

The present article analysed the positive and negative SARS-CoV-2 impacts on the status and quality of water resources of rivers, lakes, seas and oceans, identified over the course of the COVID-19 pandemic. No scientific divergence has been detected on beneficial impacts nor on adverse effects on water bodies and types.

The study managed to highlight the fact that water quality problems were diagnosed in densely populated territories where, even before the pandemic, the communities had issues with supplying water of adequate quality and treating wastewater using advanced and effective technologies. In heavily inhabited countries with inadequate wastewater treatment plants, the risk of contamination is particularly high as the new coronavirus can persist for a few days in raw sewage water and for a longer time in areas with low temperatures. We highly recommend that in these countries, urgent preventive measures be taken to implement effective solutions for water protection and wastewater treatment. This is only possible by improving existing water policies.

To summarize, the positive impacts are as follows:

- The SARS-CoV-2 monitoring in the wastewaters is a useful mechanism for the prompt exposure of collective infections at the pandemic debut. This valuable tool can help authorities implement the most adequate COVID-19 mitigation policies, and, in this respect, no discrepancy between scientists has been found. While SARS-CoV-2 RNA can be identified in the sewage water using RT-qPCR testing, no official conduct code for primal SARS-CoV-2 identification and quantification in wastewaters has been drawn up yet, which we acknowledge to be a priority.
- During the COVID-19 lockdown, many surface and ground-/subsurface water bodies all over the world saw lower pollution levels as a result of a significant decrease in domestic and industrial wastewater discharge and agricultural activities, boat/vessel traffic and tourist activities. This positive impact has been emphasized by all researchers who analysed the environmental benefits linked to the COVID-19 lockdown.

Succinctly, the negative impacts are along these lines:

- Following the COVID-19 pandemic outbreak, the SARS-CoV-2 virus could be detected in wastewater, but it is unlikely to be transmitted through contact with this type of water, due to its sensitivity to disinfectants, solvents, detergents and treatment methods and, in general, due to its poor stability when exposed to the environmental conditions of wastewater. Even if genetic fragments (RNA) can be detected in wastewater, the virus is not viable once its envelope is damaged. On the other hand, untreated wastewaters could be the agent for a high contamination risk. Due to the fact that a scientific uncertainty has been identified, we strongly recommend further analyses of SARS-CoV-2 viability in sewage waters.
- Many reports asserted the significant harm along the shorelines caused by the disposal of sanitary consumables (masks, gloves, contaminated wipes, protective suits, safety shoes, etc.) arising from the medical activities or personal protection. The different water animals can swallow the masks or get tangled in their elastic cords.
- COVID-19 diagnostic laboratories pollute all environmental elements, including water, with different plastic materials and chemicals substances. In addition, it is important to mention the methacrylate from plastic screens and other physical spacing equipment, which finally may also reach water bodies.
- The medications used to cure COVID-19 consist of persistent, bioaccumulative and dangerous substances to aquatic organisms, and they are considered emerging pollutants. Sewage water treatment technology cannot eliminate these remedies, and they will be discharged into inland water bodies. In this sense, new water treatment technologies should be developed by medical and technical scientists.
- Chemical compounds such as triclosan, triclocarbon and acrylate copolymers in sanitizers already posed environmental issues.
- Plastics and drugs in wastewaters, especially non-biodegradables, produced during the COVID-19 pandemic will persist for longer periods of time after pandemic end.
- The asepsis of the roads led to the presence of residual Cl in treatment plant effluents, which contaminates water and jeopardises water organisms.
- The new coronavirus increased biological pollution, especially in hospitals and SARS-CoV-2 mortuary wastewaters, and we consider this demands distinctive biological wastewater treatment methods.
- Since the COVID-19 outbreak, municipal and medical waste production has increased globally and represents a considerable danger for population health and the environment, including water bodies; this co-occurred unfortunately with a decrease in waste recycling.

These positive and negative impacts are briefly presented in Table 2:

Table 2. Positive and negative COVID-19 impacts on water bodies/systems/types.

Positive COVID-19 Impacts on Water Bodies/Systems/Types	Negative COVID-19 Impacts on Water Bodies/Systems/Types
SARS-CoV-2 monitoring in wastewaters—a useful mechanism in the promptly exposure of community infections Many surface and ground-/subsurface water bodies all over the world saw lower pollution levels caused by domestic and industrial wastewater discharge	SARS-CoV-2 presence in wastewaters > high risk of untreated wastewaters Plastic, drugs/chemicals and biological pollution in wastewaters > lack of adequate elimination processes at wastewater treatment plants Greater amounts of municipal and medical waste (sanitary consumables, disposable supplies, etc.) that may pollute surface water bodies, shorelines and beaches, and lower waste recycling rates.

As humans and the environment interact constantly, any environmental damage directly or indirectly affects human health, and any pandemic has inevitable consequences on the environment.

We highlight that this pandemic provides an unprecedented opportunity to the worldwide scientists: to re-estimate the impact of the development of human society and, implicitly, of the constant feedback of nature, in pre- and post-COVID scenarios.

Environmental deterioration is accompanied in many situations by pandemic risks. Human wellbeing and environmental health are deeply connected in a holistic circle. It seems that we have forgotten this. Nothing of this holistic form should be disturbed, destroyed or fragmented. We, as humanity, a society, the government or simple human beings, should reflect on what forced us to slow down during the pandemic lockdown, which had beneficial influences on the environment. We should enact this "slow and careful behaviour" in our daily life without any health emergency or threat.

Biologists (geneticists, virologists, etc.) should continue their sustained and hard work on SARS-CoV viruses and their possible recombination effects. At the same time, maybe this is the right moment for a new legitimate scientific field: food education. Our society should decrease animal protein consumption, should reduce wildlife exploitation and should improve husbandry practices. It is impossible to turn the entire world population vegetarian and/or vegan suddenly, but food education in order to diminish meat consumption is compulsory.

Additionally, certain social and economic practices and behaviors should be installed in the lives of communities after the COVID-19 pandemic ends: traffic reduction during the weekends or in city centres or on certain highways/avenues; temporary close of some polluting entities, without jeopardising local economies or jobs; increased hygiene awareness; access to safe drinking water and bathwater; investing in wastewater treatment plants in territories where they do not exist; and public education (using all mass media outlets) about the all-type-waste management: education in schools, high-schools, universities, education for youth and seniors, education for merchants and consumers, education for medical staff and patients, etc.

Let us hope that we have learned and are still learning valuable lessons from this pandemic crisis, which will be the basis for the proper, ethical and correct definition of society's priorities for the imminent future.

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