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CHAPTER NINE

PROVIDING CLEAN AND SAFE WATER TO ALL: A GLOBAL PERSPECTIVE

ASIT K. BISWAS AND CECILIA TORTAJADA

Introduction

Neither human beings nor ecosystems can survive without water. Not surprisingly, the British-American poet, W. H. Auden, wrote: "Thousands have lived without love, but none without water."

While the importance of water for human and ecosystem survival has been known for thousands of years, water has not been on the international political agenda until around the mid-1970s. In 1977, during the United Nations Water Conference, held at a very high decision-making level, it firmly entered the global political agenda for the first time. This Conference declared the decade of 1981–1990 to be the International Water Supply and Sanitation Decade (IWSSD). This was approved by the United Nations General Assembly. The objective was that by the end of this Decade, every person in the world would have access to clean water and adequate sanitation (Biswas, 1978). The target was very ambitious, and, not surprisingly, it could not be met. However, by any definition, the Decade was remarkably successful since it ensured that hundreds of millions of people in the developing world had access to water which would not have happened without the forces that were unleashed by this Decade (Biswas and Tortajada, 2009).

Nearly three decades later, in July 2010, the United Nations General Assembly declared water to be a human right (UN, 2010). This gave another impetus towards reaching universal access to clean and safe water.

At present, a decade after the United Nations Generally Assembly declared water to be a human right, the global situation with respect to the availability of clean water has become even more complex and

somewhat more convoluted than ever before. During the 1980-2017 period, an objective analysis will indicate that the focus of the world was primarily on providing water to the people, and make access to it easier. As long as the people had access to water, it was assumed that this was all that was needed. During this period, led by two major UN agencies, WHO and UNICEF, and followed by all international and national organisations, a meaningless term "improved sources of water" was devised. Unfortunately, it has absolutely no relation, or linkage, to water quality. By comprehensively fudging the water quality issue for over nearly four decades, the entire United Nations System was able to claim, erroneously, in 2012, that the Millennium Development Goal (MDG) target on water was achieved three years ahead of the deadline of 2015 (WHO/UNICEF, 2012). In reality, this was incorrect. There is no question that more people had better access to water than ever before in history. However, overall, the quality of water they received was dubious. In the entire developing world, very few people believed that the water supplied was either clean or safe to drink.

Water Quality and Health

Irrespective of the claims of the various United Nations agencies and international organisations, the fact still remains that the clean water and the sanitation targets of the Millennium Development Goals in the areas of water supply and sanitation were not met by 2015. In fact, in nearly all urban areas of developing countries, the quality of water in rivers, lakes and aquifers has steadily deteriorated over time. This is because of ineffective and inadequate management of wastewater from domestic and industrial sources. Since the varied qualities of the water sources deteriorated steadily and utilities did not treat, or were incapable of treating water adequately, households in developing countries did not perceive that the piped water they received in their houses was safe to drink without any health concerns.

In developing countries, even in 2020, significant percentages of domestic wastewater are still not being collected and then taken to wastewater treatment plants for any proper treatment. Industrial wastewater faces very similar problems. Domestic wastewaters at least are

biodegradable over time. In contrast, industrial wastewaters may contain hundreds of conservative contaminants, like chemicals, heavy metals and other hazardous materials, that do not break down over time. In addition, agricultural run-off containing chemicals like pesticides and fertilisers, further contaminate both surface and groundwaters by leaching. At present, only about 10-12% of the people in the developing world have access to proper wastewater collection, treatment and disposal. In the absence of proper domestic and industrial wastewater collection and adequate treatments, water quality all over the developing world has undergone continuous deterioration over the past five decades. This trend, most regrettably, is still continuing in much of the developed world.

Decades of neglect of proper domestic, industrial and agricultural wastewater management have ensured that all water bodies around and within population centres of the developing world are now seriously contaminated with numerous known and unknown pollutants. Equally, most urban water utilities in developing countries currently do not have adequate capacities, technological, management and administrative expertise, nor the funds to treat bulk raw water properly before supplying to households. Thus, the trust and the confidence of the people in the quality of water they receive from their utilities have progressively deteriorated, and currently, for all practical purposes, are almost non-existent.

In addition, as the levels of income and literacy have progressively increased in all developing countries, people have become increasingly aware of the potential adverse health implications of using not properly treated piped water.

The public awareness of the interlinkages between the quality of water and human health has been further heightened by the communication and information revolution that has been witnessed in all developing countries over the past 30 years. Wide availability of mobile phones, 24-hours news channels, and a wide range of television channels, including independent ones, in nearly all developing countries have contributed to the growing awareness of the potential adverse health impacts of using not properly treated water. In fact, in nearly all South Asian countries, significantly more people currently have mobile phones than toilets! Mobile phones have become a source of information even for illiterate or semi-literate people. Thus, the knowledge base of nearly all the people,

rich or poor, literate or illiterate, has increased dramatically in recent decades. Currently, nearly every person is aware of the interlinkages between unclean water and health in some fashion. They have also become aware that the quality of water that is being supplied by their utilities leaves much to be desired, and thus is somewhat dangerous to drink, in terms of health, without additional treatments in their individual homes.

Water Quality in Developing Countries

Over the past several decades, most households in the cities of developing countries have progressively transformed themselves into mini-utilities to cope adequately with both intermittent piped water supply and poor water quality.

Water supply in the majority of the urban centres is now intermittent. Often, households receive two hours of water in the mornings, one hour around noon, and another one to two hours during the evenings. Actual number of hours when they receive water is around three to five hours each day. This intermittent pattern of water supply is the norm rather than exception in most cities of developing countries of Africa, Asia or Latin America. During drought years, even this intermittent water supply is further reduced.

Most households, from India to Egypt, and Jordan to Mexico, have transformed this intermittent water supply to a continuous 24x7 flow by constructing their own mini-utility which has been, for the most part, quite effective. Households have constructed underground tanks where water is stored whenever there is supply. This is complemented by the construction of smaller overhead tanks. The two tanks are then connected by a pipe and a pumping system which pumps water from the underground tank to the overhead tank as and when needed. From the overhead tank water flows to individual houses or apartments by gravity, whenever needed, during day or night.

Each household thereafter purifies their own water for drinking and cooking, or they buy 20L jugs sold commercially. Some two to three decades ago, households used carbon filters to treat their own water supply. As technology has developed, economic conditions have improved, and

the economy of scale has reduced prices of treatment processes significantly, the preferred mode of cleaning has increasingly become reverse osmosis (RO). However, the RO system used in households is not efficient: about 60-70% of total water processed currently ends up as wastewater, and then mostly is thrown away.

In terms of continuous water availability, the coping strategy currently used has been generally quite effective. However, in terms of improving water quality by installing in-house water treatment processes, the results have been varied, depending upon the operation and maintenance practices of individual households.

This is because to maintain reasonably good water quality, membranes for reverse osmosis, or filters for the filtration systems, have to be changed as and when necessary. The timing of this change will depend primarily upon the quantities and qualities of water treated. Unfortunately, most households do not change membranes or filters as frequently warranted, often because of lack of knowledge, or to save money, or pure lethargy. An overwhelming number of households change the filters or membranes at regular intervals, say between every three to six months. Thus, the systems do not operate efficiently when membranes or filters are not fully functional. This means that the quality of water each household drinks could still be dubious after treatments.

Another major problem stems from the fact that all households must clean their underground and overhead tanks regularly, say every two to three months which is not always the case. These two tanks are major sources of contamination, unless they are cleaned properly and regularly. Accordingly, the bacteriological qualities of water in these tanks deteriorate over time. If membranes or filters are not efficient in removing pollutants, then the quality of water people drink is not safe, and thus could pose serious health hazards.

Regrettably, most households are not aware of the importance of these issues in terms of health implications. Water utilities do not consider it their task to make households aware of these requirements since the equipment belongs to individual households and not to the utilities. Thus, households often are not getting clean and safe water all the time, even after spending significant personal funds to improve the quality of piped water.

Water Quality in Developed Countries

A myth has developed over several decades that proper domestic water supply is an issue only for developing countries, and that the developed countries mostly solved their water problems over half-century ago. Very few academics have seriously and objectively analysed the overall status of water quality in developed countries. In this chapter, we cover the serious problems that some developed countries have been facing on the quality of water they receive from their utilities.

Loss of confidence and trust in the quality of piped water in developing countries should not come as a surprise to most people. It has been there for decades. What is most surprising is that the people in developed countries have started to lose trust and confidence in the quality of water they are receiving from their utilities for a variety of reasons. This loss of trust and confidence has increased steadily during the past two decades.

Water quality in urban centres of developed countries is presenting different types of problems compared to those experienced in developing countries. During the 1960s, 1970s and 1980s, and even in 1990s, an overwhelming majority of households in these countries used to drink water straight from the tap, without any health concerns. During these decades, very few households had in-house water treatment systems. Further, the use of bottled water was very limited, mostly under certain very special conditions.

During the 1990s, this situation started to change for at least two reasons. Starting from the early 1990s, several water utilities of important Western cities had poor management practices which resulted in serious and well-publicised health crises, including deaths of consumers. These incidents forced people to ponder on how good is the overall quality of water that they were receiving from the utilities. Also, if this water was safe enough for them and their family members to drink straight from the tap without any potential adverse health implications.

Consider the United States, the world's only superpower. Economically and technologically, it is the most important country of the globe. Yet, between 1982 to 2015, in any specific year, between 9 to 45 million Americans received drinking water from their utilities that violated the country's Safe Drinking Water Act. These violations have generally continued to increase during this period. However, except for some major

well-known failures in important urban centres, most of the people at risk live in rural and low-income areas (Allaire, Wu and Lall, 2018).

Many widely publicised failures of water utilities in the United States and Canada have steadily eroded confidence and trust in the quality of water from the utilities. These failures have contributed to serious unease of the population in other developed countries with regard to the quality of water they are receiving. An implicit assumption has been that if such catastrophic failures can occur in the most economically advanced country of the world, like the United States, can the water supply in their countries, which is less advanced than the US, be safe?

Among these serious failures have been the following. In 1993, in the city of Milwaukee, US, 403,000 persons, that is, one quarter of its population, became sick when the filtration system of one of the two water treatment plants failed to remove *Cryptosporidium oocysts* effectively. This resulted in substantial medical costs and productivity losses of the affected households, estimated at $96.3 million (Corso *et al*., 2003).

In May 2000, the worst Canadian public health disaster involving a water utility occurred in Walkerton, Ontario. The water supply system was contaminated by deadly strains of *Escherichia coli* and *Campylobacter jejuni* bacteria. At least seven people died and more than 2,300 people became seriously ill. This tragedy occurred due to improper operation and maintenance of the municipal water supply system and the decisions of the Ontario Government to cut staff and budgets in order to transfer the infrastructure responsibilities from the province to the municipality (Hipel, Zhao and Kilgour, 2003).

Probably the event that greatly shook the confidence of people in the Western world took place in Flint, Michigan, US. The city's source of water used to be from Lake Huron. However, to ensure sufficient amount of water is available for a growing population, the city decided to change its source of bulk water from the Lake Huron to the Flint River, in April 2014. This changeover was very poorly planned and carried out without serious considerations of the quality of source water and what impacts this could have on the network and the health of its inhabitants. The impacts of the change were soon noticed by the residents. Within a few weeks of the switch, residents started to complain about colour, taste and odour of the piped water. During the summer of 2014, E. Coli and total coliform violations meant three boil-water alerts had to be issued within

a 22-day period. This should not have come as a surprise since at the time of the switch, water quality of the Flint River was very poor due to decades of poor water quality management, including regular discharges of unregulated wastewater from domestic and industrial sources.

The problem was further compounded because the city officials failed to ensure that proper corrosion control measures were added to the new sources of water which was significantly more acidic, and thus more corrosive, than the earlier source from the Lake Huron. This corrosion contributed to intensified lead leaching from old lead pipes to the drinking water supply that was being received by the Flint residents.

During the summers of 2014 and 2015, 91 cases of legionellosis were also observed in Flint, with nine deaths. These levels were much higher than what was witnessed earlier.

The Flint public officials claimed for years that no link could be proven between the health hazards suffered by the Flint residents and the switch in water supply. Accordingly, they erroneously argued that the new water source was not to be blamed. However, several independent studies as well as one by the US Environmental Protection Agency (EPA) confirmed dangerous levels of lead in water in the city, and also high levels of lead in the blood of children.

Eventually, President Barack Obama declared a federal emergency in Flint on 16 January 2016 (Obama White House, 2016). This released up to $5 million of Federal aid to immediately assist with the public health crisis. It authorised Federal Emergency Management Agency (FEMA) to cover 75% of the costs of providing bottled water, filters, filter cartridges, etc., to the Flint residents. The balance of 25% was covered by the Michigan State.

Flint has now become a global cause célèbre for gross mismanagement of a water utility. It resulted in extensive coverage in the world media, in both developed and developing countries, as well as in a popular film and well over 15 books. Former Republican Governor of Michigan, Rick Snyder, admitted at a Congressional hearing, in 2016, that the Flint water crisis "was a failure of government at all levels. Local, state and federal officials-we all failed the families of Flint" (Committee on Oversight and Reform, 2016). The general assumption of most people in the developed world has often been if such mismanagement of water

utility can happen in the world's richest and technologically most advanced country, this could happen anywhere, including in their hometown.

The global publicity on Flint was not limited merely to two to four years. It has become an ongoing saga that is likely to contribute to further the reduction of public trust and confidence in the quality of water the people receive from their water utilities, irrespective of whether they live in developed or developing countries.

This adverse publicity will continue for several more years to come. In August 2020, the State of Michigan reached a settlement to pay $600 million to the victims of the Flint debacle. This generated further publicity and brought further public attention to the Flint fiasco.

Flint will continue to remain in the public eye for many more years to come. The State has now settled with the people of Flint. Felony charges that were initially filed against more than half a dozen state officials were dismissed in 2019. However, criminal investigations by the Attorney General's Department of Michigan are now ongoing for possible legal actions. Legal fallouts from the Flint crisis will thus continue for several years to come. This will result in further adverse publicity for water utilities all around the world.

Unfortunately, Flint's water crisis was not an isolated incident. Soon its echoes were felt in other parts of the United States. A somewhat similar event occurred in 2016, in Newark and northern New Jersey. Elevated levels of lead in water were observed in many public schools throughout the city. In 2017, more than 22% of drinking water samples tested had higher lead levels than stipulated by the federal standards. The reason for high lead content in piped water was very similar to that of Flint: failure of proper corrosion control treatment programme for an acidic water source. An estimated 18,000 homes in Newark had lead pipes which connected the households to the water mains. Lead leached from these pipes and reached the domestic consumers.

It should be noted that lead pipes were quite popular in the United States up to around the 1980s. Compared to iron pipes, they were more flexible and durable, and thus were preferred. The US Environmental Protection Agency started regulating lead from June 1991 when it published a regulation known as the *Lead and Copper Rule* (USEPA, 1991).

This Rule established an action level for lead at 15 parts per billion (0.015mg/L) and for copper at 1.3 parts per million (1.3 mg/L). There is considerable medical consensus at present that no level of lead is safe. All the European Union countries and Canada are now limiting lead levels to 5 ppb, that is 1/3rd of the permissible levels in the US. Permissible copper levels in European Union countries, at 1.00 ppm, are also less than the US, but not as much as for lead.

A major problem in the United States is its community water utilities are highly fragmented. There are over 50,000 water utilities. Many of them are small and thus do not have the resources or capacity to monitor water quality to determine if they comply with the EPA regulations not only for lead but also for all other contaminants, let alone to take proper and timely corrective measures when warranted. Not surprisingly, more than 20% of the water utilities do not know if they have lead service lines to households within the area they serve (Cornwell, Brown and Via, 2016). Nearly 30% of the water utilities have reported the presence of lead service lines.

A survey has estimated that the country has at least 6.1 million lead service lines which serve around 15-20 million people by community water systems (AWWA Engineering Modeling Applications Committee, 2020). They have either full or partial lead service lines serving households. This represents nearly 7% of the people served by such water systems. The number of lead service lines is estimated at between 6.1 to 11 million, which would represent around 50,000 miles of lead service lines. These means that, between 1 January 2015 and 31 March 2018, nearly 5.5 million Americans received water that exceeded EPA's lead action level. There were 13,991 violations of the EPA's *Lead and Copper Rule* by 8,339 community water systems during this period.

Replacing all the lead pipelines is likely to cost over $30 billion. Unfortunately, not only in the United States but also in nearly all developed countries, with very few exceptions like Singapore, there have been gross under-investments in the domestic water supply sector for generations. Singapore is probably the only developed country which uses the concept of preventive maintenance. For example, for several decades, it has been replacing about 2% of its total water networks. This means the whole network is renewed every 50 years. In recent years, Singapore has

been using sensors to determine the weakest links in their network and then replacing them.

In much of the Western world, water pipes were laid more than 50 to 100 years ago. In some parts of the US, some pipelines even date back to the time of the Civil War of the 1860s. Many of these are lead pipes. Equally, there are several water supply treatment plants in the US which are using pre-World War I treatment technologies. In contrast, Singapore uses the latest technologies and management practices to treat its bulk raw water and wastewater (Tortajada, Joshi and Biswas, 2013).

The American Society of Civil Engineers (ASCE) has been producing an Infrastructure Report Card every four years, for various sectors, since 2001. The grade A is considered to be exceptional, fit for the future; B is good, adequate for now; C is for mediocre, requires attention; and the lowest is D for poor, at risk. Between 2001 and 2017, drinking water infrastructure had consistently received either the grade of D or D$^-$ from ASCE. In 2017, this sector received a grade D. The 2017 report noted that there were an estimated 240,000 water main breaks each year, resulting in loss of over two trillion gallons of treated water (ASCE, 2017). Overall, some six billion gallons of treated water is lost annually due to leaks. An estimated $1 trillion is needed to maintain and expand service to meet the demands properly and efficiently for the next 25 years.

The neglect of America's drinking water infrastructure, like all other types of infrastructure, ranging from airports to highways, has been well documented for several years. However, the political system has never seen the urgency and importance of providing adequate financing to improve them.

The validity of the grade D, given by ASCE to the American drinking water infrastructure is confirmed by the American Water Works Association (AWWA). Each year AWWA publishes a report on the state of the water industry. This report is an industry-wide self-assessment of the latest status of the sector. In its latest report (AWWA, 2019), it noted that the biggest and most critical challenge being faced by this sector was renewal and replacement of water and wastewater infrastructure. This can only be accomplished by combined and determined efforts of all three levels of the government — Federal, State and Municipal — to have adequate financing in place over the long term. This, regrettably, has not

happened over generations, and thus the cumulative costs of fixing them have increased steadily over the decades. The total costs of updating and fixing America's poor infrastructure have now become astronomical.

With the current budget deficit running at about 20% of GDP in the United States, the chances of American Congress and all individual States earmarking substantial sums, on a long-term basis, for updating and improving drinking water infrastructure systematically and continuously are very slim.

Thus, the most likely scenario is likely to be there will be actions and funding availability, on an ad hoc basis, only when major crises occur, such as at Flint or Newark, and when there is considerable public and media scrutiny as well as serious and sustained pressures on all the three levels of the government to act quickly.

America is not only facing serious water quality problems of serious contaminations due to hazardous contaminants but also from non-point sources of pollution due to its large scale agricultural and animal husbandry farms. Proper water quality management due to large scale disposal of animal waste has been a serious problem not only in the United States but also in the rest of the world.

Large industrial scale cattle and hog farming produces enormous amount of animal waste. Agricultural farms use fertilisers extensively, including spreading manure, much of which leaches into groundwater and rivers. They contaminate all water sources. In rural America, numerous households depend on private wells for domestic water supply. It is estimated that 43 million people depend on them as their primary water source. A sample survey by the United States Geological Survey indicated that around 20% of these wells are contaminated (USGS, 2009).

A state report on water quality of private wells for Wisconsin noted that nearly 6% of its nearly 676,000 private wells exceeded the federal health standards for nitrates. In 2018, 40% of surface water samples tested in Nebraska had nitrate levels above EPA's safe limit of 10 ppm for drinking water. This limit was set in 1962 because of infant methemoglobinemia where babies skin turns blue because of decreased amount of haemoglobin in the blood. This could result in fatalities.

In 2020, at least four billion people in both developed and developing countries do not trust the quality of water they receive from the tap.

In the US, at least two million people do not have access to piped water and basic sanitary facilities. The indigenous people of Australia, Canada and the United States currently receive water which is of poorer quality than received by the residents of a third world city like Phnom Penh in Cambodia (Biswas, Sachdeva and Tortajada, 2020).

European Initiatives

Unlike the United States and Canada, the European Parliament approved plans on 23 October 2018 to increase the confidence of its citizens on the quality of the water they receive from their utilities. Concurrently, they took steps to promote the use of tap water in all the EU countries, and to ensure that all its inhabitants are provided with better, reliable and regular information on the water they receive. Tap water is safe and reliable in all the EU countries (European Parliament, 2018*a*).

The EU Parliament also took steps to reduce the use of single use plastic bottles for drinking water so that EU citizens can lower their use of plastics. Plastic water bottles are the most found single use plastic item on the EU beaches. This step would also contribute to reduction of litter found in the oceans. According to the estimates of the European Commission, reducing the use of water consumption from these plastic bottles could save the EU citizens more than 600 million Euros each year (European Parliament, 2019).

The legislation also reduces the allowable permissible level of lead by half as well as a further reduction in bacterial content of drinking water. It has, for the first time, introduced caps for certain endocrine disruptors, and requires monitoring of microplastics in all drinking water supplies. All these measures were taken not only to improve further the quality of water that all EU citizens receive but also to ensure that their trust and confidence in tap water would improve significantly. These steps were aimed at increasing the use of tap water and concurrently reducing the extent of use of bottled water.

The legislation further asks all member states to ensure universal access to clean water, especially for the marginalised and the vulnerable groups. It also encourages the EU states to set up free water fountains in public places where necessary and technically feasible. The countries

should also encourage restaurants, canteens and catering services to provide tap water, either free or for a low service charge.

On 18 December 2019, both the EU Parliament and the EU Council reached a provisional agreement to modify the existing EU Drinking Water Directive (European Parliament, 2018*b*). It added an upper limit for an endocrine disruptor, Bisphenol A, at 2.5 parts per billion. Two other endocrine disruptors, Beta-estradiol and Nonylphenol, will be included in its first watch list. The new Directive is expected to enter into force sometime during the summer of 2020.

With this new modified directive, the regulations to ensure good quality of drinking water in the EU countries will become one of the most stringent in the world.

Changing Global Perceptions, Trust and Confidence on Water Quality Following COVID-19

As discussed earlier, the management of drinking water quality in both developed and developing countries has left much to be desired during the past several decades. The issues related to drinking water quality and people's trust and confidence in it have become even more complex since December 2019, with the emergence of COVID-19. This new coronavirus, which jumped from animals to humans, has played havoc with human health and well-being.

The pandemic has created global crises not only in terms of health but also in financial, industrial, employment, social, and many other sectors, including food, water and transportation.

For the water sector, its impacts have been many, some known but others are still amorphous and not yet evident. What is certain is that COVID-19 will have many short, medium and long-term impacts on water quality. The extent, magnitude and duration of these impacts are likely to vary from country to country, depending upon how effective their efforts will be to manage the coronavirus pandemic, people's trust, confidence and reactions to government policies and actions, and a whole range of other factors, some known but others unknown and unpredictable.

From the perspective of the domestic water supply and wastewater management, COVID-19 has already made serious impacts on the

people's and the policymakers' perceptions and actions on water quality. People all over the world, for the first time, understood and realised the importance of frequent and proper handwashing with clean water and soap, and practice of good personal hygiene habits. In nearly all countries, people propelled by fear and uncertainties, for the first time, learnt how to wash hands properly with soap and clean water at frequent intervals. Earlier studies in many countries have indicated that most people, in both developed and developing countries, were not washing their hands properly or regularly. As a result, in reality, many of the germs were removed not by handwashing but during the process of wiping hands with paper or cloth towels. This is also one reason why coliform bacteria is widely present in the mobile phones of a significant percentage of the people, in both developed and developing countries. COVID-19 has changed the behaviour of the people, including their handwashing habits, at least over the near- and medium-term.

COVID-19 also has radically changed, positively, people's attitudes and perceptions of clean water and its importance and indispensability to maintain their health and also that of their families. The fear generated by COVID-19, for the first time, has forced a significant percentage of people all over the world to wash hands both properly and frequently, and to realise the critical necessity of having access to clean and safe water to maintain their health and well-being.

Unfortunately, up to now, water quality issues have received mostly cursory interest from policy-makers of most developing and developed countries. There has been considerable political rhetoric on the importance of access to clean water. However, actual and realistic implementable policies have often been conspicuous by their absence in nearly all developing countries and, to a certain extent, in many developed countries as well.

Further, sustainability of rules and regulations, and their strict enforcements, on a long-term basis, has been a serious constraint for many countries.

If one considers a highly developed country like the United States, one of its most successful policies has been the Clean Water Act. This was approved by the Congress in 1972, and then strengthened several times over the past four decades or so. The Act has been instrumental

in regulating and maintaining quality standards for surface waters. This Act, by all accounts, has been very successful in improving the quality of water that the American households have received over recent decades. However, the latest US Administration has started to chip away many of the restrictions that were imposed to maintain the quality of America's water bodies. This does not bode well for either the American people or the environment over the medium- and long-term.

In contrast to the US, the countries of the European Union, Singapore and China have been progressively tightening water quality rules and regulations to ensure the quality of water that their population receives continues to remain safe. The EU countries are somewhat advanced in this area. For example, they are among the very few countries that have imposed an upper permissible level on the presence of a known endocrine disruptor, as mentioned earlier, and monitor other such potential disruptors and as well as microplastics in drinking water.

Similarly, since 2019 Singapore has been monitoring 346 water quality parameters. As more and more pollutants are considered to be important, PUB, Singapore's National Water Agency, monitors them regularly. Figure 9.1 shows how the number of water quality parameters being monitored by Singapore has gone up very significantly during the 1963–2019 period.

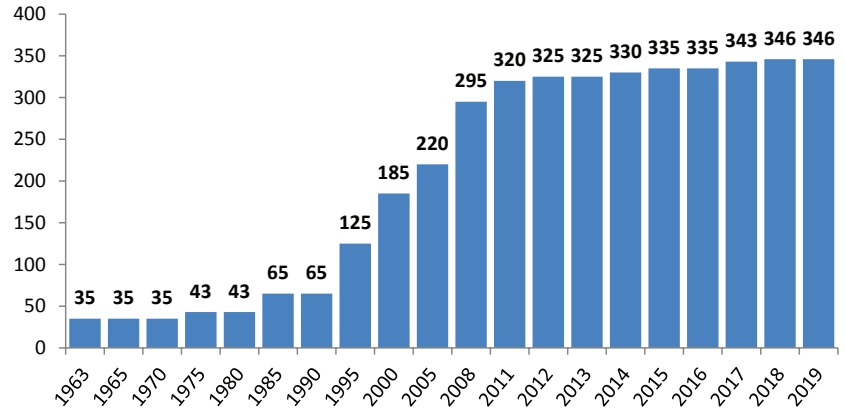

Fig. 9.1. Number of water quality parameters monitored by the PUB in Singapore, 1963-2019.

Source: Public Utilities Board, Singapore.

In 1963, PUB was monitoring 35 parameters. This number has increased to 346. This means the number of water quality parameters PUB is monitoring has increased nearly 10-fold during the past 56 years. The city-state also imposes significantly stricter rules and regulations, increasing penalties to industry for violating the norms, very strict enforcement of all laws, regulations, and institutional restructuring as and when necessary. This has significantly changed the water quality management landscape in Singapore. On the basis of trends of the last five years, one can predict fairly safely that the quality of its water sources is likely to further improve appreciably by 2030.

In the case of China, the country has been giving significantly greater attention in recent years to manage water quality. In order to ensure that Chinese households are receiving good quality water, the country recently nearly trebled the number of water quality parameters to over 110 that must be measured regularly. This is in sharp contrast to another major developing country, India. Indian utilities currently measure mostly 15–30 water quality parameters. This unfortunate situation, especially after the massive infections and deaths due to COVID-19, will most certainly further aggravate even the very limited trust and confidence in the quality of water that the Indians receive at present. This is likely to encourage most Indian households to see what they can do by their efforts to further improve the quality of water they are receiving from the utilities.

Meeting Sustainable Development Goals in Developing Countries

Even before the COVID-19 struck the world, progress in meeting various SDGs had slowed down perceptibly. For example, for the water and sanitation sectors, overseas development assistance (ODA) increased by 38% during 2016 and 2017. In 2018, ODA declined by 9% compared to 2017 (UN, 2020). After the unexpected massive expenditures in both developed and developing countries to combat the adverse impacts of the pandemic due to both health and financial crises, the funding gaps for meeting the SDGs in both water and sanitation sectors will increase very significantly in all counties of the world.

According to the UN Secretary General's latest report (UN, 2020), the situation in many parts of the world is bleak. The report claims that 2.2 billion people around the world do not have "safely managed drinking water", whatever this phrase means. However, if one asks the simple question how many people in the world do not have access to clean and safe water in which they have trust and confidence, it is likely to be at least four billion, more than half the population of the world!

The same UN report (2020) further notes that, in 2017, about 60% of the world's population had basic hand-washing facilities with soap and water at home. However, if the real question is asked, that is, how many people had access to clean and safe water that they trusted, in 2017, the answer has to be that the percentage was most certainly significantly higher, probably well over 90%.

Distressingly this report further noted that, in 2016, 25% of the global healthcare facilities did not have *even* basic water supplies, let alone access to clean and safe water; 20% had no sanitation services; and 40% had no soap and water for hand-washing. Equally, 47% of schools globally did not have handwashing facilities with soap and water. Our experience has been that the UN estimates of such figures, based mostly on data provided by the countries themselves, on various targets of SDGs, have invariably and consistently been overly optimistic. The real situation is much worse.

Clean water is a basic and critical requirement for ensuring the existence of good and functional health services. At least half of the global population currently lacks access to full coverage of essential health services. Clean water is also essential for poverty alleviation, food security, any form of electricity generation and extraction of all minerals, oil or gas.

Global poverty reduction rates were de-accelerating even before COVID-19 became a pandemic. After COVID-19, and based on current evidence, tens of millions of people in the developing world will be pushed back to absolute poverty in 2020 alone. An important exception is likely to be China which now appears to be approaching normal conditions. There is no doubt China will eradicate absolute poverty well before 2025, much earlier than the SDG deadline of 2030.

With climate change, extreme weather events like major floods and droughts as well as large hurricanes and tsunamis are becoming more frequent and severe. All these will affect both developed and developing

countries, but efforts to manage such disasters will vary from one country to another. The magnitude of losses will depend on the economic conditions, existence of functional institutions, good governance practices and advanced and effective disaster mitigation and adoption plans.

In 2018 alone, natural and disaster-related costs included 23,458 deaths and 2,064 people went missing, presumed dead. At least 39 million people were affected, and direct economic losses were estimated at $23.6 billion, 73% of which was from the agricultural sector. It should be further noted that major impacts of all natural disasters include lack of availability of clean water and proper sanitation. Unavoidability of clean water and proper sanitation leads to outbreaks of major diseases. These, combined with food insecurity and inadequate nutrition, kill many more people over the short- and medium-term, compared to the disasters themselves.

There is no question that COVID-19 has already contributed to an unprecedented global crisis that has significantly hampered progress in global social and economic development. It has further imperilled progress in terms of achievements of any or all SDGs, including those on water and sanitation. The probabilities of truly reaching the targets of all individual goals were never stellar. COVID-19 has now ensured that it will be a tremendous challenge for the world to reach even a few of these goals.

The British poet Lord Byron wrote a century ago: "Till taught by pain, Men really know not what good water's worth." COVID-19 and numerous deaths earlier due to poor water quality have inflicted enough pain on the world. One can only hope policy-makers finally realise the importance of clean water for everyone and take steps to ensure this happens globally by 2050.

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