

Transitioning to SDG 6: Climate Change Influence on Clean Water and Sanitation in Nepal

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1. Background

1.1. *Climate Change and Global WASH*

Climate change is among the critical challenges of the twenty-first century. An annual mean global temperature of 1.5 degrees centigrade (°C) above the pre-industrial global average is expected to be reached within a few decades; this is likely to impact natural and human systems (Intergovernmental Panel on Climate Change IPCC). With the temperature increases, changes in the precipitation patterns and frequent occurrences of extreme events, such as floods and landslides, start to show (Baidya et al. 2008). These consequences pose a threat to various sectors with a potential significant impact on water, sanitation, and hygiene (WASH). Globally, the impact on water supply comprises damage to infrastructure, decreased water at the source, and change in water quality. Similarly, the impact on sanitation includes damage to sanitation infrastructures and loss of services from climate-induced disasters, such as floods and landslides (Howard et al. 2016). Available studies in different parts of the world have shown increases in microbial contamination with the increase in extreme events (weather) (Hynds et al. 2012; Kistemann et al. 2002; Jung et al. 2014). A study conducted in Norway concluded that climatic activities, such as heavy rainfall, are likely to increase fecal microorganisms and potential pathogens in water sources (Tryland et al. 2011).

1.2. *Sustainable Development Goals—Emphasizing SDG 6 (SDG 6.1 and SDG 6.2)*

With the realized need for sustainability and evident climate change, Sustainable Development Goals (SDGs) have been implemented, which also include sustainability goals concerning water and sanitation (SDG 6). SDG 6 focuses on the universal and equitable access to safe and affordable drinking water, sanitation, and hygiene (SDG 6.1 and SDG 6.2) (UN Water 2018). Other targets in SDG 6 aim to improve water quality (SDG 6.3), improve water-use efficiency (SDG 6.4), implement integrated

water resources management (IWRM) (SDG 6.5), and restore water ecosystems (SDG 6.6) (UN Water 2018).

1.3. WASH and Climate Change in Developing Countries—Evidence from Nepal

The impact of climate change is realized on a global scale; its impact is prominent in developing countries as it aggravates the effect of increasing population, poverty, and rapid urbanization (Ludwig et al. 2007). The impact may be even worse among the poor and vulnerable populations of developing countries due to their low or lack of capacity to respond, or constraints in resources (McGuigan et al. 2002). It could be due to these constraints that water and sanitation are low priorities in developing countries. The low prioritized WASH is often accompanied by other constraints, such as lack of financial resources, lack of accountability, corruption, inefficient management, lack of enforcing water quality standards, and lack of proper monitoring guidelines (Howard and Bartram 2010).

Nepal, a developing country ranked fourth in the world in terms of climate change vulnerability (Maple Croft 2010), has a maximum temperature increase of 0.056 °C (Department of Hydrology and Meteorology DHM; Ahmad et al. 2019). Likewise, a 1.8 °C increase in annual average temperature was reported in Nepal between 1975 and 2006 (Dahal 2006; Karki 2004; Synnott 2012). This rate is higher than the global average. Nearly 80% of precipitation occurs in the form of summer monsoons from June to September (Department of Hydrology and Meteorology DHM). Rainfall trend analyses from 1971 to 2014 show that pre-monsoon rainfall in the High Himalayan areas has reduced by 0.74 mm per year (Department of Hydrology and Meteorology DHM). The changing monsoon pattern and the decreasing rainfall have also been widely evidenced in Nepal (Ahmad et al. 2019). The South Asian monsoon-dependent water sources of Nepal (Nepal Climate Vulnerability Study Team NCVTS) are consequently influenced by a range of effects, such as Glacier melt, snowmelt, rain-fed downstream spring, and groundwater recharge.

Though climate change impacts in various sectors are identified and noticed by the National Adaptation Plan of Action (NAPA) (Ministry of Environment MoE), the impact of climate on WASH is still a low-priority concern. This is apparent from the figures of the functionality and coverage of WASH. For instance, the national coverage for water supply of 87% (Budhathoki 2019) seems relatively progressive in terms of access; however, only 28.13% is functional (DWSSM 2019). Similarly, 97% of the population have access to sanitation, but this does not necessarily include improved sanitation facilities (Budhathoki 2019). The functionality and sustainability of WASH facilities and services are often disrupted by various climate change impacts.

In Nepal, which has completed the Millennium Development Goals (MDGs) and is transitioning towards Sustainable Development Goals (SDGs), climate change is expected to be a probable disruptive factor in attaining SDG 6 (National Planning Commission NPC). This chapter highlights the evident climate change impacts in terms of WASH facilities and services in the context of the country's transition to SDGs.

2. Methodology

2.1. Search Criteria

The basis for this chapter was a review of both published articles and published and unpublished gray literature. We reviewed the published data on water, sanitation, hygiene, and climate change over the period of 1980 to 2020 covering global, national and regional scales. Electronic databases—Google scholar and HINARI—were searched using the keywords transition, drinking water, sanitation, hygiene, climate change, temperature, precipitation, and Nepal. The searches for the published data were confined to the literature with abstracts in English. The full text of the relevant studies was reviewed, and all citations were imported into an electronic database, Mendeley.

Published (hard copies) and unpublished documents, policy briefs, reports, power-point presentations, web content, and primary data from Government of Nepal (GoN) departments, such as the Department of Water Supply and Sewerage Management, Sector Efficiency Improvement Unit, Ministry of Water Supply, and the Department of Hydrology and Metrology were also considered for this study. Most of the gray literature was in Nepali language, with some in English; the literature relevant to the study objective was considered for review and, where possible, only the relevant section of the gray literature was translated.

2.2. Inclusion and Exclusion Criteria

Documents were included if: (1) the study was conducted in Nepal; (2) the sample size was more than 50 participants; (3) they were policy documents, sectoral reports, development reports, or web-based information from authorized GoN institutions; and (4) the study provided information on WASH and the climate change scenario of Nepal with SDG 6. We excluded studies that primarily focused on engineering aspects of WASH, and climate change-related studies that exclusively focused on climatological parameters (e.g., glaciology).

In this chapter, Nepal—a developing country—is presented as a case to signify the scenario of WASH in terms of climate change. Nepal is a South Asian country which is geographically and topographically diverse. With an annual maximum temperature increase of 0.056 °C (Department of Hydrology and Meteorology DHM; Ahmad et al. 2019), Nepal is among the most vulnerable countries in the world. Climate change impacts on various sectors of Nepal are often reported (Ministry of Environment MoE). Therefore, Nepal was among the most appropriate study areas that can provide significant evidence on climate change in terms of WASH.

3. Results

3.1. Transition from MDGs to SDGs

Millennium Development Goals (MDGs) (2001–2015) for water and sanitation aimed to halve the proportion of the world's population without access to safe drinking water and basic sanitation by the end of 2015. The MDG target for drinking water was met by the world, while that for sanitation was not (United Nations 2015). Currently, learning from the past, the world is heading towards Sustainable Development Goals (SDGs) that are often criticized to be ambitious (Sadoff et al. 2020). Attaining SDG 6 in terms of water and sanitation has various challenges and hurdles. UNDP has also identified climate change-related water stress and financial constraints in poor and developing countries as one of the challenges in reaching SDG 6 goals (UNDP 2020).

A comparative analysis of the target and progress of SDG 6, with the current pace and evident challenges, shows that it will be challenging to meet SDG 6 by 2030 (Table 1) in Nepal. Starting from 2015, it aimed to provide 35% of the population with safe drinking water, but it was only feasible to reach 25% of the population by 2019, which clearly shows that SDG 6, in terms of safe water supply, is lagging. A similar figure is seen with the percentage of households with access to improved sanitation. The progress target was missed in 2019; only 62% was achieved against the target of 69.3% in terms of improved sanitation. The overall achievement is to be obtained by the end of 2030; however, the gap between progress target and progress achievement forces us to rethink probable challenges.

Table 1. MDG and SDG targets vs. progress for water and sanitation in Nepal.

		MDG 7 c		SDG 6		
		Target 2015	Baseline 2015	Target 2019	Progress 2019	Target 2030
Target 6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all						
1	Population using safe drinking water (%)		15	35	25	90
2	Household with access to piped water supply (%)		49.5	60.3	49.6	90
3	Basis water supply coverage (%)	73	87	90.2	88	99
Target 6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all						
1	Households using improved sanitation facilities which are not shared (%)		60	69.3	62	95
2	The proportion of population using latrines (%)		67.6	75.7	85	98
3	Sanitation coverage (%)	80	82	86.5	99	99

Source: Data from (National Planning Commission 2020).

3.2. CC and WASH: Impact on Water

The world has faced climate change-related water-induced issues, either in the form of water scarcity or water-induced disasters (Abbaspour et al. 2012). The drying up of water sources due to temperature increases (Abbaspour et al. 2012); water-induced disasters, such as flood and landslides, due to alterations in precipitation patterns and intensities (Ávila et al. 2016); and water contamination due to climate-induced disasters (Kohlitz et al. 2020) are among the water-related climate change impacts.

Impacts of the changing climate on water availability and quality are profound in South Asian countries. In Nepal, increasing temperature due to climate change has caused glaciers to melt rapidly, causing more critical floods in the lowlands of the Terai, along with slow-onset disasters, such as heat and cold waves (Ministry

of Environment MoE; International Centre for Integrated Mountain Development ICIMOD; Kaji et al. 2020). Each year, floods disrupt water supplies, sanitation facilities, and people's hygiene practices, exposing thousands of families to significant health risks in the Terai region. Furthermore, most water points, including boreholes and pumps, are either washed away or submerged due to floods in the affected districts, and water sources are contaminated (Suman Chapagain 2017).

While the low land is facing problems caused by climate-induced disasters, the mountains are facing the problem of reduced water flow in natural springs and sources (Poudel and Duex 2017; Adhikari et al. 2020). A study conducted in the mid-hill region of the mountains showed that 73.2% of the springs used as water sources now have a decreased flow and 12.2% have dried up over the past 10 or more years (Poudel and Duex 2017). With the decrease in water at the source, microbial contamination is increasing with increasing temperature. Evidence has shown a significant correlation between climate change and water-borne diarrheal diseases (Bhandari et al. 2020), which is the result of microbial contamination caused by reduced water quantity at the source.

3.3. CC and WASH: Impact on Sanitation System and Hygiene

Climate change has an impact on sanitation in two ways: (1) reduced functionality and increased environmental contamination due to climate-induced disasters, and (2) interruption in the operation and maintenance of sanitation facilities due to water scarcity caused by increasing temperature (Sherpa et al. 2014; Howard et al. 2016). A recent flood in the Gaur Municipality of Nepal in 2017 impacted sanitation significantly; an ODF campaign was also interrupted by the flood. The number of households (HHs) without toilets increased to 14.99% from 9.2% due to the damaged infrastructure and sanitation facilities (Suman Chapagain 2017).

In addition to the impact of climate change on sanitation facilities and services, it should be emphasized that sanitation is a source of Green House Gases (GHGs) emissions. On one hand, several efforts, such as the climate-resilient sanitation safety plan (CR-SSP) are currently being tested to reduce the impact of climate change on sanitation in the country. On the other hand, sanitation is causing greenhouse gas emissions, despite the rapid development and investment to achieve SDG 6 (Intergovernmental Panel on Climate Change IPCC). The IPCC stated that greenhouse gas emissions from onsite sanitation remain largely unquantified and, therefore, we need to conduct a robust study on this so that the trade-off can be carried out more systematically (Bates et al. 2008; Bogner et al. 2007).

3.4. CC and WASH: Impact on Public Health

Climate change factors, such as rising temperature, fluctuating precipitation, and climate-induced natural disasters, are found to be the main causes of prevailing impacts, which ultimately lead to various public health issues (Figure 1). Water-borne, water-washed, and vector-borne diseases are major issues of public health. The rising temperature certainly makes a favorable environment for disease-causing vectors (Oxfam 2009). Disasters and natural calamities are not to be mistaken for population casualties, but the after effect of those calamities is always the bigger threat and challenge—where again the aforementioned diseases are the major killers.

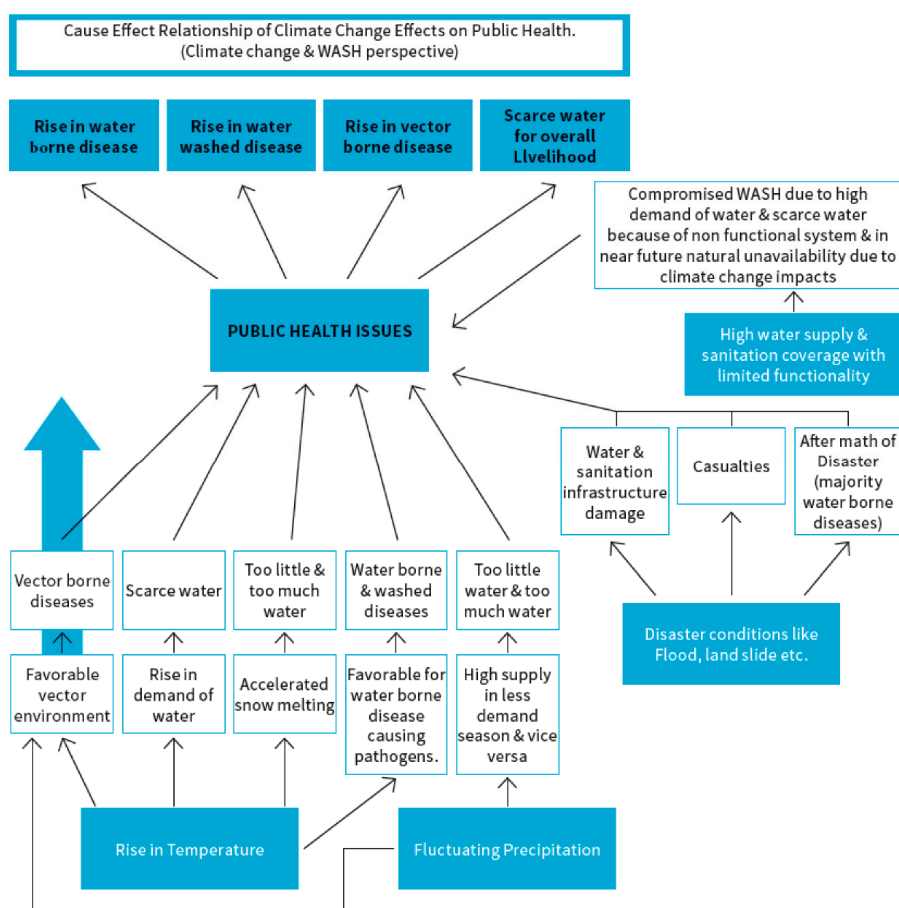


Figure 1. Cause and effect relationships of climate change effects on public health.
Source: Figure by authors.

Along with casualties, such as life, properties, and livelihood, climate-induced disasters, such as floods and landslides, have a major impact on WASH infrastructures, such as water supply pipes, intakes, reservoirs, and sanitation facilities (Oxfam 2008; Ahmad et al. 2019). As a result, the functionality of the WASH infrastructures is ultimately reduced, leading to compromised public health (Figure 1). In addition to public health, there are various other sectors, such as agriculture, livelihood, and economy that will be severely affected by the impact of climate change on WASH. As it is specific to Nepal, the effect of this could be more devastating, as revealed in a study (Baral and Chhetri 2014); the study concluded that local and district level stakeholders have very a limited awareness of issues related to climate change. However, there is no doubt that the impact climate change on WASH will directly or indirectly impact overall sustainability goals.

3.5. Adaptation Practices to Reduce the Impact of CC on WASH and Public Health

Globally, the Paris Agreement at Conference of parties (COP) 21 in 2016 provides a strong legal provision to strengthen the adaptation to global climate change. The agreement brings all nations together for a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries in these efforts (Falkner 2016). The agreement provisions for financial, technical, and capacity-building support to the countries with a focus on developing countries to adapt to climate change (Garrett and Moarif 2018). Despite such provisions to the parties to UNFCCC, in Nepal, WASH interventions have neglected climate change impacts and adaptation measures.

In Nepal, several efforts are required to adapt to the climate change impact on WASH. In countries such as Nepal, almost all WASH interventions have not considered climate and focused only on coverage; only in very few cases climate-resilient WASH is evident. A recent approach that seemed promising for reducing climate change's impact on WASH is the Water Safety Plan (WSP). WSPs are a comprehensive risk assessment and management approach, considered to be the effective means of consistently ensuring the safety of drinking water supply from catchment to consumer (World Health Organization WHO). An effective WSP will consider and prioritize all risks holistically as part of an overall system risk assessment (i.e., both climate- and non-climate related risks). It also locally addresses capacity building at the local level (Baidya et al. 2017). The Department of Water Supply and Sewerage Management (DWSSM) initiated the implementation of WSPs in all districts in 2008. Even after its implementation in almost 2000 water supply schemes, the sustainable implementation of WSP itself is affected by the factors

such as the depletion of sources, increased disasters, and decreased water quality. Therefore, with the same principle as that of WSP, Climate Resilient WSP (CR-WSP) was initiated with considerations for climate change in 2018 (MWSS 2017) under DFID/WHO-supported projects on building adaptation to climate change in health in LDCs via resilient WASH. DWSSM developed a comprehensive training package on CR-WSP and developed corresponding CR-WSP implementation guidelines to support the process in both urban and rural settings (MWSS 2017). Though most of the steps in WSP and CR-WSP are the same, CR-WSP has incorporated climate change issues in every step of the plan. For instance, for the formation of the WSP team, a member should be a person with knowledge of climate change. CR-WSP also gives priority to the documentation, monitoring, and verification of specific impacts to the system by climate change (MWSS 2017). The Sanitation Safety Plan (SSP) is another approach that has recently completed its piloting activities in Nepal. The effectiveness of this plan to combat the climate change impact is yet to be examined. Apart from CR-WSP and SSP, other local-level adaptation strategies to adapt to prevailing water stresses are water harvesting (small scale structures), harvesting of rainwater, artificial groundwater recharge, conservation ponds, irrigation channels, and drip water irrigation (Kumar Jha 2011; Adhikari 2018). A potential study of rain harvesting in the Arghakhachi district of Nepal concluded that proper rainwater harvesting technology can compensate for immediate water uses, such as domestic use, irrigation, and even recharge groundwater, and contribute to springs (Water Supply & Sanitation Division Office WSSDO).

Though the existing local adaptation practices and indigenous practices are currently being implemented at the local level, evidence has shown that they are not hazard resilient (Karki et al. 2017) either due to resource choices or low economical capacity, which need to be prioritized to build a resilient WASH system.

4. Discussion

Despite several efforts by various countries, progress to date is not satisfactory in terms of SDG 6 (Sadoff et al. 2020). In 2018, a UN report reviewing progress towards SDG 6 found that the world is not on track (Ortigara et al. 2018). Transitioning from the MDGs' focus on water supply and sanitation to the much bigger framework of 'sustainable water and sanitation for all' of the SDGs poses numerous challenges. These challenges include geographical barriers, inequality, climate change, lack of interorganizational coordination, and proper monitoring approaches (Sadoff et al. 2020; National Planning Commission 2020).

In mountainous countries such as Nepal, the geographical barrier may hinder the commitment to the universal accessibility to water and sanitation for installing and managing WASH infrastructures (Sarwar and Mason 2017; National Planning Commission 2020). It will be difficult to extend water supplies to more hilly and mountainous regions in comparison to the Terai region of the country (Sarwar and Mason 2017). Providing equitable access to water and sanitation is among the aims of SDG 6.1, which is again challenging in Nepal. Identification of the vulnerable population is only based on data from the central bureau of statistics; the bureau, however, does not provide disaggregated data. Unless the upcoming census, i.e., 2021, is strengthened and more detailed, “reaching the unreached” for access to water and sanitation is impossible; it will deviate the country from SDG 6 achievements. With the existing geographical and equitable challenges, the lack of coordination among WASH sector actors could be another factor to delay SDG 6 progress. However, another factor relates to the lack of awareness of parallel initiatives in the WASH sectors (National Planning Commission 2020). The country has many overlapping concerned departments; NGOs/INGOs; and many local-level committees, such as the Water and Sanitation User Committee’s (WSUC) working development of the WASH sector. It is a must that different actors, for instance, DWSSM, Department of Health Services (DoHS), and Department of Hydrology and Meteorology (DHM), coordinate and work together. This coordination can enable an integrated approach to meeting the sustainable water and sanitation goals.

Attaining ambitious SDGs can be critical as countries such as Nepal are in political transition: from the monarchy to federal democratic republic. Federalism may have created a dilemma in this transitional period where there is limited capacity and know how in the newly formed local system. The new system could have been an opportunity to address needs and new requirements, but the recent devastating earthquake, unstable politics, and now COVID-19 have seriously weakened the local government’s status. Poor accessibility to water and sanitation facilities and hygiene practices, further compounded by the lack of proper protective gear for different frontline workers, has made Nepal a high-risk country in terms of the spread of the virus. In a country such as Nepal where 52% of people do not have hand washing facilities with soap and water at home, the COVID-19 crisis highlights WASH challenges, such as increased water demand for hand washing (Wateraid 2020).

Regarding all the problems and challenges, evidence from various findings and research have come to a common consensus that climate change will cause a disturbance in attaining SDG 6. Climate change has been recognized by Nepal in

recent years; however, the government has very few plans and policies that actually consider climate change during the implementation of development activities.

Though the GoN has surpassed the MDG related to improved access to water and sanitation, huge disparities prevail among the regions, districts, villages, and communities reached. Only basic water supply and sanitation facility coverage increased, with no clear emphasis on the quality and resilience. Limited efforts have been made to address water quality issues. In a context where water supply and sanitation are poor, compromised drinking water quality poses multiple risks of morbidity. In such conditions, the synergetic effect of climate change immediately impacts WASH and public health with a range of effects, such as water- and vector-borne diseases, climate-induced disasters, the aftermath of disasters, and infrastructural damage. The emerging climate scenario is often linked to demands for climate-resilient infrastructures and interventions (Baidya et al. 2017). This overall scenario highlights the need and importance of climate-resilient WASH development.

5. Conclusions

SDG 6 appears ambitious, especially for developing countries such as Nepal where climate change is the biggest challenge; it can undermine the overall development goals of water and sanitation (SDG 6.1 and SDG 6.2). The timely realization and incorporation of climate-resilient WASH development with the proper coordination of different actors working on WASH can help to reduce the impact on WASH, and thereby make the transition to SDG 6 an achievement.

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