*International Research Journal of Environmental Sciences*_____ ISSN 2319–1414
Vol. **6(12),** 14-22, December **(2017)** *Int. Res. J. Environmental Sci.*

Review Paper

Climate resilience and water, sanitation and Hygiene (WASH) interventions in Nepal

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Available online at: www.isca.in, www.isca.me
Received 12th October 2017, revised 3rd December 2017, accepted 19th December 2017

Abstract

Realizing the linkages of climate change, Water, Sanitation and Hygiene (WASH) and public health, this study aims to comprehend if WASH interventions made in Nepal are climate resilient. Any interventions implemented by either government or non-government sector to enhance Water (quality, quantity, access); Sanitation (access, status, coverage); and Hygiene (personal and community hygiene promotion); was considered as WASH interventions. A trend analysis of temperature and precipitation data over a period of thirty years (1984-2013 AD) was performed. The temperature is increasing in faster rate in all Eco regions, especially in the Mountains. Mean annual precipitation shows no clear trend except for Terai, where it is in increasing trend. Effects of climate change vary differently in Nepal due to its ecological diversity. Meteorological trend possess double trouble for water quality and water quantity as well. WASH interventions till date are concentrated on the supply side. Systematic approach to address the issues of climate resilience is entirely missing. Coping capacity of current Water and Sanitation infrastructures with probable climatic effects is vulnerable. The emerging climate scenario demands climate resilient infrastructures and interventions. Designing Eco region based Water and Sanitation infrastructures with interventions in micro- catchment level can be climate resilient and sustainable. The Water Safety Plan can be a reasonable option for minimizing possible risks in WASH sector. Climate and disease vulnerable districts identified in this review document would be worth considering for building climate resilient WASH.

Keywords: Climate change, Intervention, Public health, Resilient, WASH.

Introduction

More than half of humanity relies on fresh water originated from mountains[1]. Mountains -"Water towers of Asia" are more sensitive to climate change. Climate sensitivity is concerned with the volume and timing of runoff, eventually affecting river discharge. In Nepal, climate change impacts two critical areas of water resources i.e. Glacial Lake Outburst Flood (GLOF) and variability of river runoff[2].

Himalayan mountain range and the South Asian monsoon influences Nepal's climate[3].Climate change effects are evident by substantial high trend of average temperature and unpredictable fluctuating precipitation. Nepal's temperature is rising at a rate higher than that of global average[4,5]. The precipitation trend is unpredictable[3]. Topography of Nepal have been classified into three eco-regions namely Terai, Hills, and Mountains. These eco-regions are distinct in character with distinct probable meteorological and climate change effects.

The most catastrophic impact of climate warming has been on water resources[6]. Temperature rise will have substantial impact on water balance and will reduce total water availability. Reduced glacier-ice-reserves results in water shortages due to demand and supply gap[7]. Water is especially scarce in non-monsoon seasons, although there will be water surpluses during on monsoon[7,8]. Disasters are also induced during both water surplus condition (eg. flood, landslide), and water scarce condition (e.g. drought). Water has both qualitative and quantitative dimension[9]. Alteration in any of the dimension due to various climate change effects can lead to series of public health impacts (Figure-1).

Human health is linked with fresh water quality (water for ingestion) and quantity (water for hygiene, food production). Hygiene and water quantity is directly related. Water use varies with water availability and climate of particular area[10]. Significant difference in per capita water use have been evidenced with regard to water accessibility[11]. Bradley observed that many "water borne diseases" like shigellosis, trachoma and scabies are actually "water-washed" diseases[12]. The causation was found mainly due to inadequate water for washing hands, food, laundry and cooking utensils. Coping with increasing water shortages, water demand and yet avail sufficient water for better health, hygiene, and sanitation is a critical challenge for near future.

Climate change impacts on Water, Sanitation and Hygiene (WASH) is often discussed but marginally addressed as compared to its vulnerability. The functional status of national

water supply system itself is in a vulnerable state[13], and climate induced impacts and disasters will surely accelerate for its poor functionality. Water scarce condition effects hygiene, sanitation, and overall functionality of water and sanitation infrastructures. Whereas, surplus water raises risk to run off contamination and again functionality of water and sanitation infrastructures. Apart from water imbalance, temperature rise also provides favourable condition for disease causing pathogens. Climate induced disasters causes series of damages like casualties, infrastructure damage and disease outbreaks. Thus realizing the fact that climate change could have both direct and indirect impact on WASH and ultimately public health, this study aims to comprehend if WASH interventions made in Nepal are climate resilient. The study attempts to make eco-region based findings and conclusions.

Methodology

A trend analysis of meteorological parameters over period of thirty years (1984-2013) was performed. Meteorological parameters were further anlyzed based on eco region. Nationwide meteorological data was assessed from Department of Hydorology and Meteorology (DHM)[14]. DHM being government's central department for meteorological assessment was considered most reliable source for assessing afore-mentioned secondary information. Desk review of WASH interventions was performed, where any interventions or activities performed by either governmental or non-governmental sector to enhance Water: quality, quantity, access; Sanitation: access, status, coverage; and Hygiene promotion activities was considered as WASH interventions. Those WASH interventions which were evidenced to be functional despite of actual extreme climatic events, or technically assumed to be functional with probable extreme events were considered to be climate resilient intervention. Here, primarily infrastructural interventions was considered for review rather than behavioural interventions like education, awareness etc. For hygiene promotion, interventions like functionality of hand washing facility, functional water supply for hand washing purpose etc. were considered. Published research articles, review articles, governmental and non-governmental project reports, conference papers, and case studies from the year 2000 to 2014 AD were compiled and reviewed. WASH interventions, Climate resilient WASH, Climate change and WASH, Sustainable WASH were the key words used for web searching. Membership report of Association of International Non-Governmental Organizations in Nepal was also reviewed to gather information regarding input from non-government sectors.

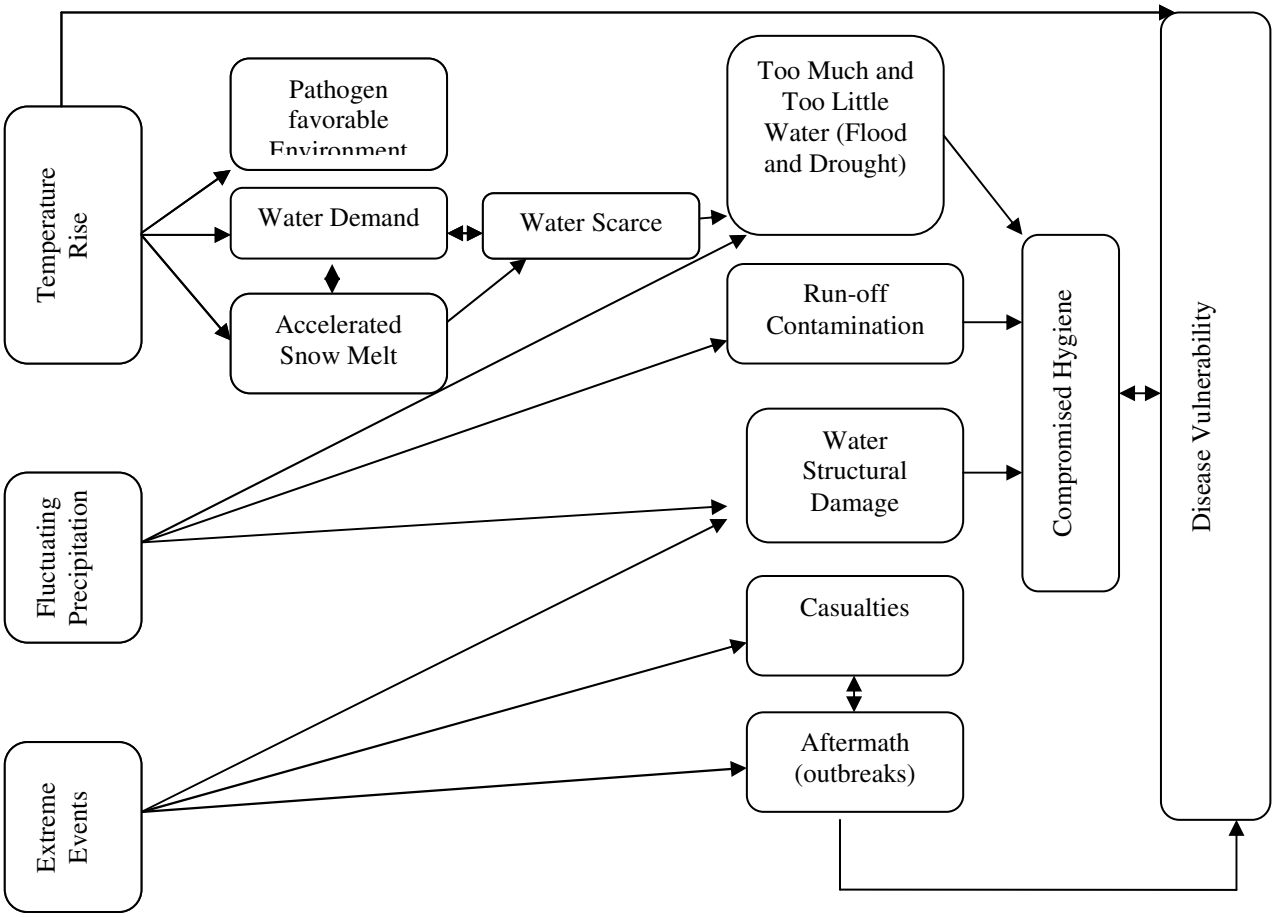
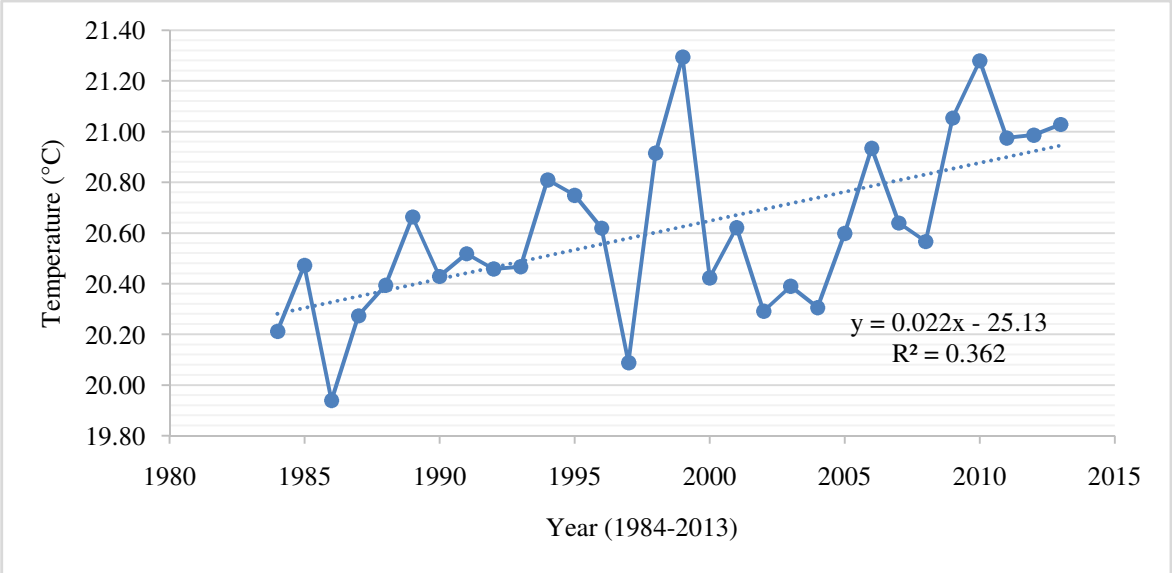


Figure-1: Climate change effects on disease vulnerability from WASH perspective.

Results and discussion

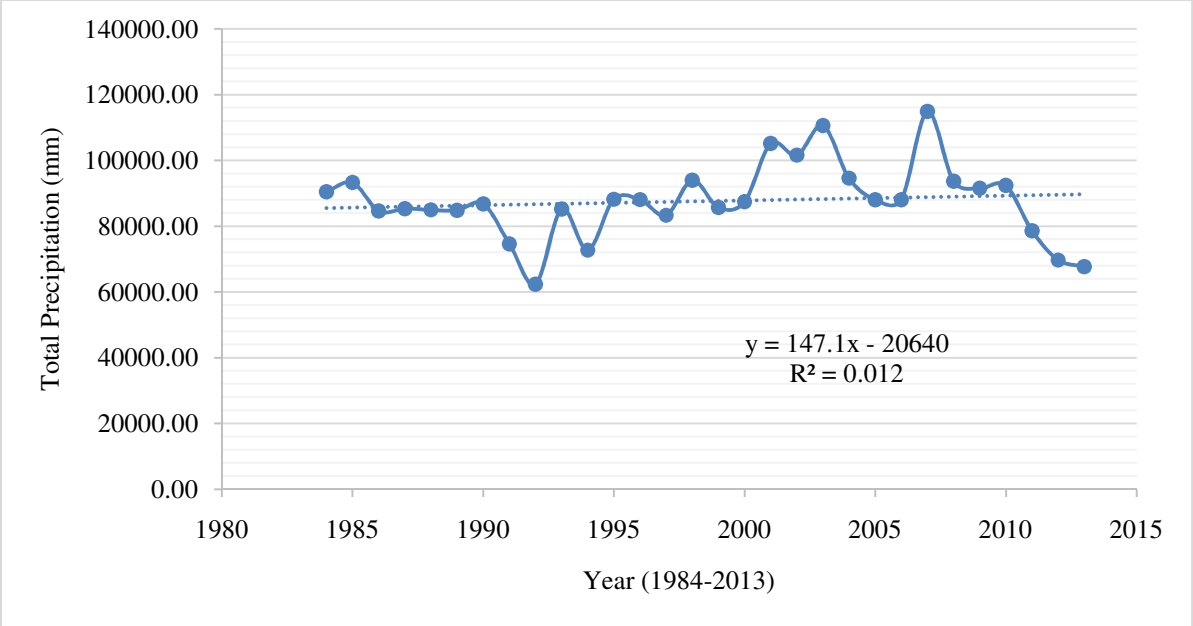
Temperature and Precipitation of Nepal: Annual average temperature is rising, whereas precipitation showed no specific trend. Annual average temperature and precipitation for 1984-2013 was 20.25°C and 87576.80mm respectively. Aforementioned trends are depicted in Figure-2 and 3.

Altitudinal variation apparently influences temperature, rainfall, flood and other climate related incidents in Nepal. The variation can merely be distinguished in three eco-regions namely Terai, Hills and Mountain. Realizing the variations and diversity, meteorological data was further segregated. Temperature is increasing at all eco-regions. It is to be noted that the temperature rise is extreme at Mountain region as compared to others. The lowest temperature recorded in mountain was 12.32°C in 1986, whereas highest recorded was 16.41°C in 2001. Whereas, precipitation trend is increasing in Terai and is in decreasing at hill and mountain. Details regarding eco-region based trend of temperature and precipitation is depicted in Table-1.



Source: DHM 1984-2013[14].

Figure-2: National Temperature trend from 1984 to 2013.



Source: DHM 1984-2013[14]

Figure-3: National Precipitation trend from 1984 to 2013.

Table-1: Meteorological description of Nepal as per Eco region.

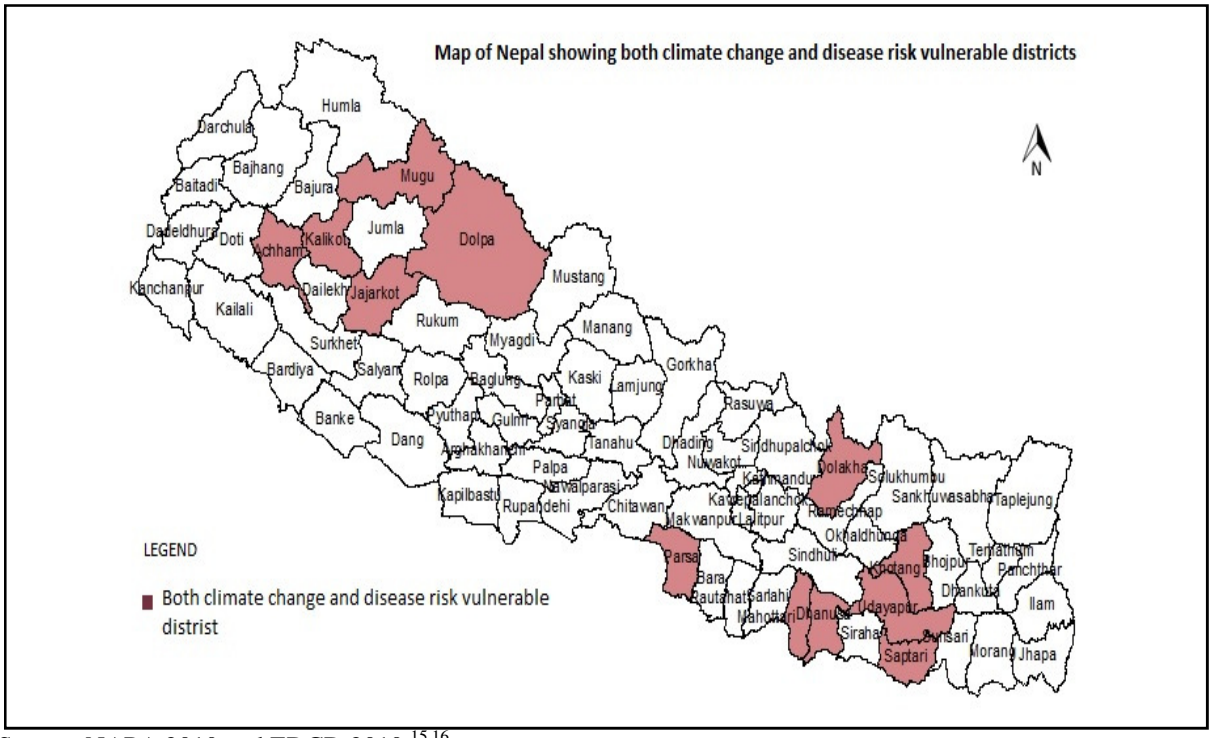
Eco region	Temperature Trend	Precipitation Trend
Terai	Increasing Highest 24.35˚C Year 1999 Lowest 23.03˚C Year 2011	Increasing Highest 40377 mm/ year 2007 Lowest 19657 mm/ year 2013
Hills	Increasing Highest 20.79˚C Year 1999 Lowest 18.58˚C Year 1986	Decreasing Highest59346mm/ year 2003 Lowest 36012 mm/ year 1993
Mountain	Increasing Highest 16.41˚C Year 2001 Lowest 12.32˚C Year 1986	Decreasing Highest10197 mm/ year 2007 Lowest 5612 mm/ year 2013

Source: DHM 1984-2013[14].

Climate change and public health: On the basis of exposure, sensitivity, and adaptive capacity; National Adaptation Programme of Action (NAPA) categorized climate vulnerable districts of Nepal. Similarly, Epidemiology and Disease Control Division (EDCD) categorized disease vulnerable districts on the basis of combination of remoteness and the percentage of marginalized people within the population; operational agencies in particular area; and trends of diarrhoeal diseases. For the sake of identifying districts with dual extreme vulnerability, those districts categorized as Very High or High vulnerability by NAPA and Category A-High risk categorized by EDCD was overplayed together[15,16]. Total 12 districts was identified in extreme dual vulnerable state (Figure-4).

WASH interventions in Nepal: Supply side WASH interventions was evidenced to be engrossed till date. Priority of interventions is driven by the South Asian Conference on Sanitation (SACOSAN) goals for 2017.Contextual grouping of WASH activities revealed that, WASH interventions till date can be catagoriesed broadly into eight categories. Identified categories are further divided into sub categories (Table-2). Hygiene interventions are limited to awareness programmes. It is also important to note that, community awareness is the only dominant intervention for addressing drinking water quality issues. Community water supply and sanitation coverage as an intervention holds the major ground.

Proliferating sanitation coverage is evidenced in recent years (70.28 per cent in 2014; 53.7per cent in 2012; and 43.3per cent in 2010). Sanitation coverage is significantly low in Terai as compared to other eco-regions. Water supply coverage is stagnant (83.59 per cent in 2014; 79.6per cent in 2012; and 80.4per cent in 2010). It is also important to note that, only 25.4per cent of water supply schemes are physically well functioning[13]. National and eco-region wise water supply and sanitation coverage is depicted in Table-3.



Source: NAPA 2010 and EDCD 2010 [15,16].

Figure-4: Both climate and disease vulnerable districts of Nepal.

Table-2: Categorization of WASH interventions in Nepal.

Category	Sub Category	Interventions/ Activities	Further Details of sub category
A-Water	A1	Water Supply Schemes in Community	Scheme Construction, Source Conservation, Chlorination at source
	A2.1	Trainings to community stakeholders	Capacity development for: (i) Water Supply scheme construction, (ii) Water distribution channel maintenance, (iii) water treatment and usage
	A2.2	Plan, Policy, Advocacy Lobbying	Concerned with Water supply access, usage, and quality
	A2.3	Community Awareness Program	Drinking water quality awareness program at community level
	A3.	School Water Supply	Drinking water supply scheme construction at School
	A4.	Institutional Water Supply	Drinking water supply for community, institutions etc
B-Sanitation	B1	Sanitation Coverage - I	Open Defecation Free (ODF) campaign support, Sanitation facility construction materials support at communities, household level.
	B2	Sanitation Coverage- II	ODF campaign support, Sanitation facility construction materials support at community institutions.
	B3	Skill Training for local community for Toilet construction	Capacity development (i.e. plumbing and mason) of local community's technical persons for toilet construction and maintenance
	B4	Plan , Policy , Advocacy Lobbying	Only concerned with Sanitation coverage and access
	B5	Community Awareness Program	Awareness programs concerned with Sanitation coverage
C-Hygiene	C1	Community Awareness Program	Hand washing awareness at community, institution level
	C2	Plan, Policy, Advocacy Lobbying	Only concerned with Hygiene practice (majorly hand washing).
D-Rain water harvesting	D1	Community Level	Rain water collection reservoir construction at community, household level.
	D2	Institutional Level	Rain water collection reservoir construction at institutions
	D4	Plan, Policy, Advocacy Lobbying	Advocacy, Lobbying for Rain water harvesting
E- Fog water harvesting*			
F- Retention and recharge ponds*			
G-Advocacy	G1	Only for project intervention area	Advocacy done at local level i.e. project district level
	G2	National level advocacy	Advocacy done at National level
H-Wash in disaster	H1	Disaster risk reduction only concerned with water	Concerned with water access and quality of drinking water for disaster area (short term)
	H2	Disaster risk reduction only concerned with sanitation	Concerned with temporary sanitation facility access at disaster area.
	H3	Disaster risk reduction only hygiene	Concerned with hand washing awareness at disaster area
	H4	Disaster risk reduction for both water and sanitation	Concerned with both water and sanitation aforementioned issue at disaster area.
	H5	Disaster risk reduction for all water sanitation and hygiene (WASH)	Concerned with overall aforementioned WASH issue at disaster area.

*No available evidence activities for sub category.

Table-3: Water and Sanitation Coverage as per Eco-region.

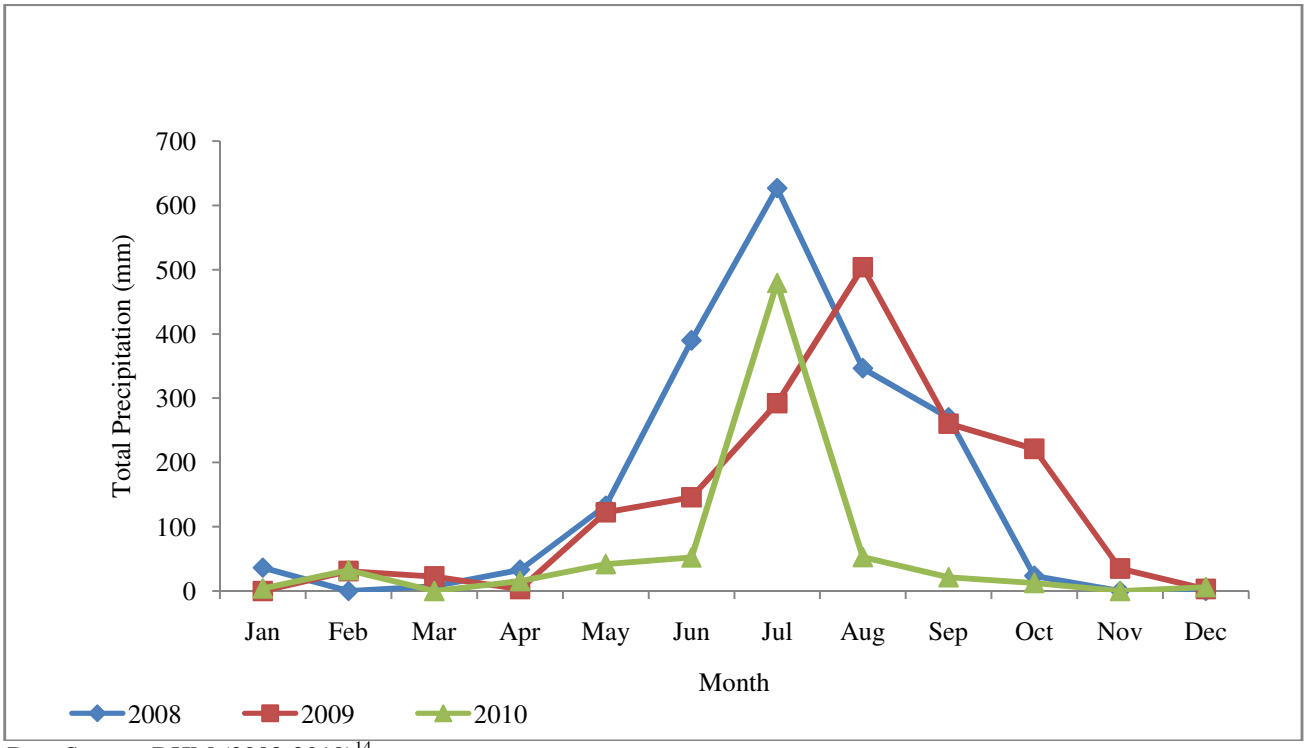
Eco Region	Water Supply Coverage (%)	Sanitation Coverage (%)
Terai	84.78	56.93
Hill	84.89	87.14
Mountain	80.19	74.48
National	83.59	70.28

Source: NMIP 2014[13].

Climate sensitive WASH interventions in Nepal: Attempt was made to explore quantitative evidences on analytical interpretation of climate sensitive WASH interventions. Limited organizational case studies and project reports were availed. Quantified evidences as per aforementioned quest were completely absent. Again, further exploration was made to understand if any distinct interventions were made on aforementioned twelve extreme dual vulnerable districts. Consideration was made to look into type of interventions for addressing both WASH and climate change issues. Mere usual WASH interventions with no distinct climate resilient WASH interventions were evidenced in aforementioned twelve districts.

An evaluation study analyzing community vulnerability of Terai to climate change impact revealed that, despite of disaster risk reduction WASH approach in particular project site the interventions were not effective enough. Physical status of sanitation facilities was at threat (plinths of homesteads weren't raised above highest recorded flood level), quality of water was completely overshadowed by drinking water supply based interventions, and awareness on water and sanitation related health issues were alarmingly low[17].

Case study-disease outbreak and weather pattern: In absence of quantitative evidence, a case study of Jajarkot diarrhoeal outbreak in 2009 was performed. We tried to understand if precipitation trend of Jajarkot had any miniature relation with particular outbreak. Diarhhoea being waterborne disease and usually at its peak in monsoonal season, assumption was made that precipitation could be the best meteorological variable for the case study. To understand probable relation, monthly precipitation trend of the district from the year 2008, 2009 and 2010 was assessed. The plotted graph revealed that usual trend of peak precipitation usually used to be in June/ July. While, in the outbreak year (August 2009) Jajarkot experienced shift in its peak precipitation trend. The shift was from June/July to August (Figure-5). It is to be noted that Jajarkot received comparatively less precipitation in outbreak period as compared to subsequent years. This particular finding yet alone can't rationalize causal effect for outbreak but shows that varying weather patterns may have an effect or even can be confounding factor for such outbreaks.



Data Source: DHM (2008-2010)[14].

Figure-5: Monthly variations in precipitation of Jajarkot district during outbreak.

National Response on Climate Change and WASH: Climate change initiatives in Nepal begun since 1992 i.e. after United Nations Framework Convention on Climate Change (UNFCC). The initiatives of 2001 Millennium Development Goals and Sustainable Development Agenda addresses issues of climate change to a certain extent. In the process of implementing the convention (2007 to 2009), Nepal prepared an action plan related to capacity building in order to implement the Rio Conventions. Further, Clean Development Mechanism (CDM) project was issued to benefit from the provisions of the Kyoto Protocol and NAPA started. NAPA is the first official initiative to mainstream climate change adaptation in national policies and actions. Six thematic working groups have been identified by NAPA, of which Public health and Water resources and energy are of direct concern for climate resilient WASH. However, these two thematic groups have no any (0 percent) funding provisions for adaptation [18]. In 2009 Government of Nepal (GoN) organized a Cabinet Meeting at Kalapatthar, and issued the "Kalapatthar Declaration", in which need of addressing climate change impacts on mountains was highlighted. In 2009 climate change appeared as national development agenda.

WASH sector development plan have also addressed Climate change and Environment protection issue to some extent[19]. SACOSAN first and second Joint Sector Review (JSR) emphasized climate change as an important component of WASH sector plan for sustainability of water and sanitation system. Second JSR/SACOSAN specified that, the disaster risk reduction and climate change adaptation fund allocation should be made by local bodies and used when and where needed[19]. While the 5th SACOSAN country paper completely overlooked climate change impacts on WASH and rather focused more on supply and coverage side[20,21]. First national conference on climate change and WASH was organized on September 2015, with key objective to review impacts of climate change on WASH, share experiences between stakeholders and explore concrete ways forward for climate resilient WASH in Nepal. The conference declarations were optimistic for future way out for sustainable climate resilient WASH and also amply addressed direct link between Climate change, WASH and Public health[22].

Discussion: It is complex to justify impact of climate change on Nepal's WASH sector and explaining if the WASH interventions made till date are climate resilient, when there is lack of evidences [21,23]. The trend of meteorological parameters indicates for definite climate change effect on water balance of Nepal[7,21]. Conventional sanitation facilities requiring a lot of water[19,24] needs to match up with twenty-five percent of functional water supply system[13]for its effective usage. This gap raises question on effectiveness and sustainability of recent achievement of sanitation coverage. It is to be noted that almost all national water supply systems are spring fed[13] which is reliant on precipitation. The fluctuating precipitation won't support in any manner for functional status of those spring fed water supply systems. A post completion study of Water Resource Management Programme (WARM-P) reported that five per cent of water supply schemes was found dried[25]. Other associated and cofounding factors (e.g. technological errors, anthropogenic activities etc.) also contributes for such scenarios. Nevertheless, precipitation does holds significant ground for source yield. Another study at all three eco regions discovered that, changing trends of temperature and precipitation hugely affected agriculture sector and declined water sources compelling community to opt for alternate source of water[26]. Here, the alternate source is undeniably an un-improved source with compromised water quality as well as quantity.

Sanitation coverage and meteorological variables of Terai indicates it is more susceptible to climate change impacts especially on WASH sector. Open defecation prevails due to low sanitation coverage. This mismatch of sanitation coverage and meteorological trend breeds possible run-off contamination making population of Terai more susceptible to WASH related health vulnerability. High precipitation trend also raises flash flood vulnerability and functionality of water and sanitation infrastructures.

The vulnerability of WASH infrastructures is very evident from design of sanitation facility and drainages at water distribution system[17,23]. Probable climate induced catastrophic effects is another threat. Such effects have already been experienced. A flash flood in Seti River of Kaski district on May 2012, effected the infrastructure of major water supply system to the Pokhara valley[27].

Social network is the only probable coping mechanisms against such catastrophic effects in community level. Some indigenous adaptation practices are not resistant enough, majorly due to limited resource choices and low economic capacity[27]. Integrating disaster risk reduction and climate change adaptation strategies while selecting structural construction site and resources management plan can minimize risk with greater sustainability[29]. Practice of participatory approach while mainstreaming such strategies fosters superior community acceptability and sustainability[30].

Climate induced effects are always uncertain. The effects in Nepal could be more devastating with limited awareness on climate change related issues at district and local level[18]. Needful measures by local bodies when and where needed[19], certainly won't work in harsh topography and resource limited settings. Locally adaptable preventive strategies could be more efficient and effective to manage climate induced probable disasters where resources are limited.

Nepal currently is at initial stage to address climate change effects on WASH sector. In such scenario, Water Safety Plan (WSP) can be supportive. WSP locally addresses disaster risk reduction and climate change adaptation strategies, along with capacity building at local level[21]. It also provides way to

structure and apply tools, methods and procedures by a Hazard Analysis Critical Control Points (HACCP) approach. HACCP refers to series of actions to be taken for ensuring safety of drinking water supply chain at critical control points following logical sequence which also enables system-tailored hazard identification and risk assessment and management. WSP is preventive risk management system for mitigating public health related hazards in everyday operating conditions and also in emergency situations. Due to uncertainties associated with understanding of climate change effects as per eco region, WSP can be considered as comprehensive guideline competent at local level at all eco regions. Stakeholder interaction enables and encourages local community to identify hazards and implement control measures[30], this also is embedded within WSP's logical sequence.

Conclusion

Effects of climate change vary differently in different eco regions. Temperature is increasing at all eco regions, especially in Mountains. Mean annual precipitation shows no clear trend. Precipitation is in increasing trend at Terai since 2007. The mismatch of sanitation coverage and meteorological parameter in Terai makes it more susceptible to climate induced health vulnerability.

National meteorological trends possess double trouble for water quality and water quantity. WASH interventions made till date are not climate resilient. Coping capacity of current Water and Sanitation infrastructures are at vulnerable state. The emerging climate scenario demands climate resilient infrastructures and interventions. Designing eco region based Water and Sanitation infrastructures and interventions can be effective and efficient. Climate and disease vulnerable districts identified in this review document would be worth considering for building climate resilient WASH.

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