Policy Brief

March 2019

Securing Dharan's water future under changing climatic conditions

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Why does Dharan struggle to meet water requirements?

Dharan, a historical commercial center and a modern hub of education and health in eastern Nepal, is situated on the *Bhavar* zone of the Himalayan foothill. *Bhavar* is known for its high permeability due to alluvial landscape built up by deposits of unconsolidated sedimentary materials. With mean annual rainfall of more than 2000 mm, the limited sources of surface water available in Dharan are characterized by seasonality having a skewed rainfall pattern with about 80% falling during the four monsoon months and the remaining spread over 8 months. A study conducted by SIAS in collaboration with the Dharan based Tribhuvan University's Central Campus of Technology using double ring infiltration method revealed that the soil equilibrium infiltration rates at city ranged between 9 and 400 mm/h with mean 124mm/h (124 L/m^2). This means the porous geology of Dharan support rapid infiltration however due to its steep gradient rainwater rapidly drains out leaving the city residents struggling to meet their daily water needs for much of the year.

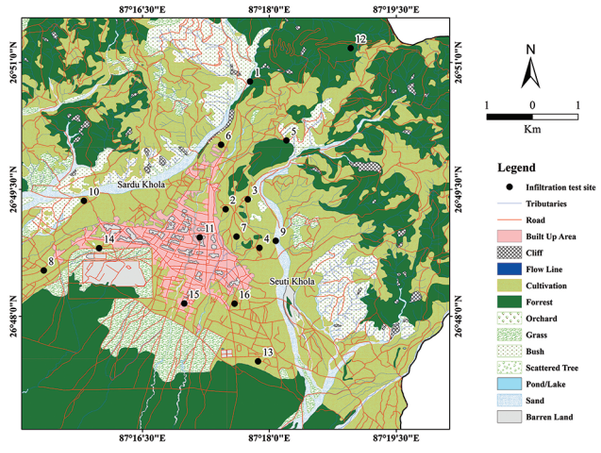

Fig.1: Soil infiltration measurement locations around Dharan sub-metropolitan city.

In addition, other factors keeping Dharan away from achieving its long term goal of water security are rapid population growth, haphazard urbanization, and climate change impacts. In the 10 years period from 2001 to 2011, Dharan's population increased by 41% (Central Bureau of Statistics, 2011). Because of its position as a gateway to the entire Koshi hills from the vast southern plain, Dharan once traditional market place has changed to the modern hub for education, health, culture, trade and tourism.

In addition to the natural setting of Bhabar, rapidly expanding populations and businesses have aggravated the challenge of water insecurity in Dharan, as they contribute to increased water demand against a declining supply capacity.

KEY MESSAGES

- Dharan is among the cities along the Himalayan foothills facing water insecurity typical of its triple sensitive character - geologically porous surface, high rainfall belt, and ecological connectivity between the plains and the mountains.
- As a rapidly urbanizing and expanding region, having the potential to merge with the populous southern towns of Itahari and Biratnagar, Dharan's internal problems of water insecurity and floods are a matter of wider concern in the highly populated eastern Nepal region.
- Our action research from 2016 to 2019 shows that promising solutions exist to significantly reduce water induced vulnerability and stresses – such as by promoting climate adaptive recharge pits (CARP) at the municipality level.
- The physical science aspect of ground water hydrology and aquifer status is not well understood; hence further research on this aspect is needed along with regular monitoring of ground water.
- In order to foster evidence-based dialogues and catalyse collaborative action at the local level, there is a need to institute mechanisms through which evidence and insights generated by the scientific community can be mobilized to inform and underpin local level planning and decision making systems.

Drivers affecting water supply

Currently, the water supply of Dharan through the system of Nepal Drinking Water Supply Corporation is between 10 and 13 MLD[1]. Due to high demand of water in the town, Dharan has dug three additional tube wells, with a further plan to withdraw additional 15.22 MLD from 8 new tube wells. However, this still falls short of the demand which is 30 MLD (Paudel, 2010) that covers 85% of households with piped connection. In spite of being surrounded by rivers, many neighborhoods face severe drinking water shortages during the dry season. Some residents acknowledged they have to travel as long as 10 km to find drinking water, and there are often fights at the communal water pump during the dry season (Sudmeier-Rieux, et al. 2012).

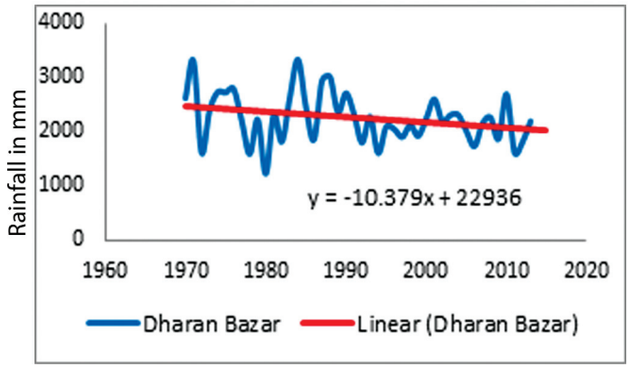

Fig. 2: Precipitation trend of Dharan sub-metropolitan city.

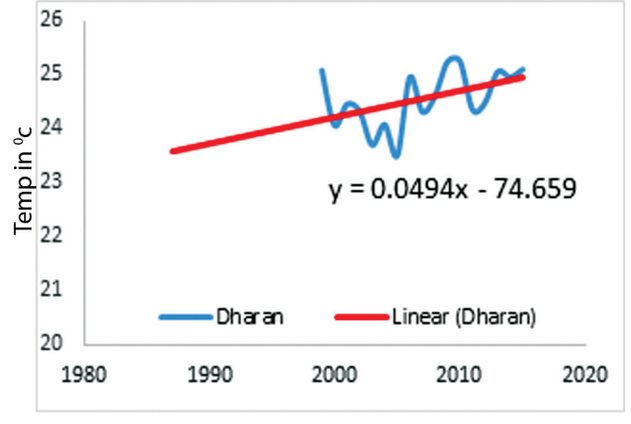

Fig.3: Temperature trends of Dharan sub-metropolitan city.

Apart from these publicly managed systems, large hotels and organizations, industries, and private water suppliers including water bottling companies are extracting a sizable amount of water through deep tube wells. For example, BP Koirala Institute of Health Sciences (BPKIHS) has its own 3 private deep tube wells inside its premises, at the lower part of the Campus.

In the year 2017, the *Chure* region and almost all of the southern part of the city saw flash flooding which submerged most of the urban area under excessive water. This happened when the two streams were swollen beyond their normal threshold. Such flash flooding is common in other cities located at the foot of this hills or further south in the plain of Nepal.

In recent years, the snowball effects of climate change have been more spectacular as reflected in the steadily increasing mean temperature and shifting precipitation patterns of various intensities in Dharan and its surrounding localities.

With urbanization the impermeable surface area has increased due to built-up areas and pavement (roads, sidewalks, buildings, etc.). This has subsequently led to increased surface runoff and decreased ground water replenishment as rain water cannot penetrate into the ground. In the meantime, high population growth and increased water demand have led to high ground water extraction.

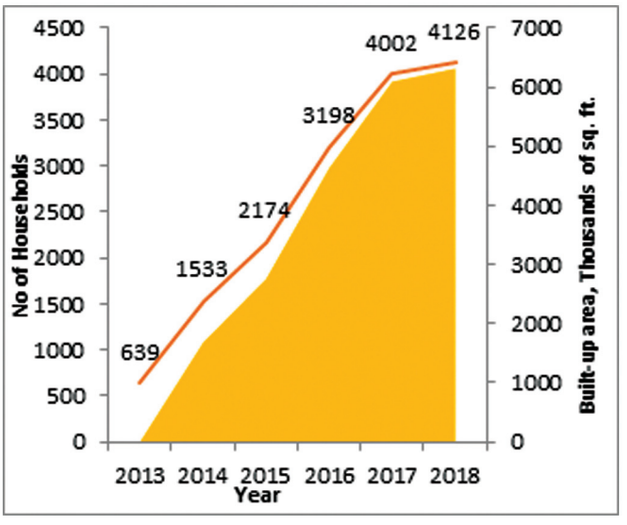

Fig. 4: Trend in growth of built-up area and the number of house-holds in Dharan from 2013-2018.*

Critical issues for achieving water security in Dharan

Sustainability of the water sources of Dharan, both the surface and groundwater, is critical from the perspectives of climate change risks and rapid urbanization. The credible sources from Sardu and Khardu streams are losing their significance due to extreme fluctuations of supply during wet and dry seasons. Although Dharan residents have pinned high hope on the recently built water supply system with ADB funding, some local leaders express doubts on their long term sustainability pointing to three reasons. They include climate change

[1] IEE report of water supply project, Dharan, 2011. Available at https://www.adb.org/sites/default/files/project-document/60994/42161-013-nep-iee-draft-02.pdf

* Only for initial two months

induced uncertainties, alarming growth of water demands with rapidly expanding settlements, and, high operational costs and infrastructural gaps.

Fig. 5: Children collecting water from drying river.

Way Forward

The study, undertaken since April 2016, has identified and tested some models of participatory planning and action that may contribute to achieve the water security of Dharan in the context of climate change and rapid urbanization. The three pilot models are briefly explained below:

Pani Chautari: This is a specialized discussion forum where diverse stakeholders, including all prominent water actors and business groups (who often have contradictory views and perspectives) are invited to discuss water issues and challenges that they confront in the city (Pandey and Bajracharya, 2017). In the Chautari, stakeholders discuss and co-produce knowledge on water related problems and explore solutions. Altogether six forums played important roles in identifying local knowledge and needs, facilitating participatory decision making, building stakeholder ownership, and finding innovation in managing the city water systems (Pandey and Bajracharya, 2017; Shrestha and Neupane, 2018). In the forum, stakeholders put their concerns on sustainability of groundwater based on which we shared option of constructing recharge pit, building on the already existing rain water harvesting structure in the city. According to the evidence our research team has gathered, the water forum endorsed promotion of technology with dual function of recharging groundwater and reducing volume of storm water. In broader sense, the Chautari has also contributed to building a community of practice around urban water security, informed by research works of SIAS and by empirical data gathered by various research and academic institutions located in the city.

Climate adaptive recharge pits (CARP): Tapping the benefit of porous geology and comparatively higher levels of rainfall in the town, Dharan Municipality adopted a policy of making groundwater recharge pit mandatory for new private and public houses. The recharge pit is known as Climate Adaptive Recharge Pits (CARP) and its shape, size and location are designed flexibly to suite the individual household needs. There was indeed a consensus among technical team of Dharan Sub Metropolitan city, building designers and faculty members of university campuses for making the CARP mandatory in Dharan. Orientation to local masons was provided so that they could offer services for constructing the CARP. The potential contribution of the CARP is presented in the schematic diagram below:

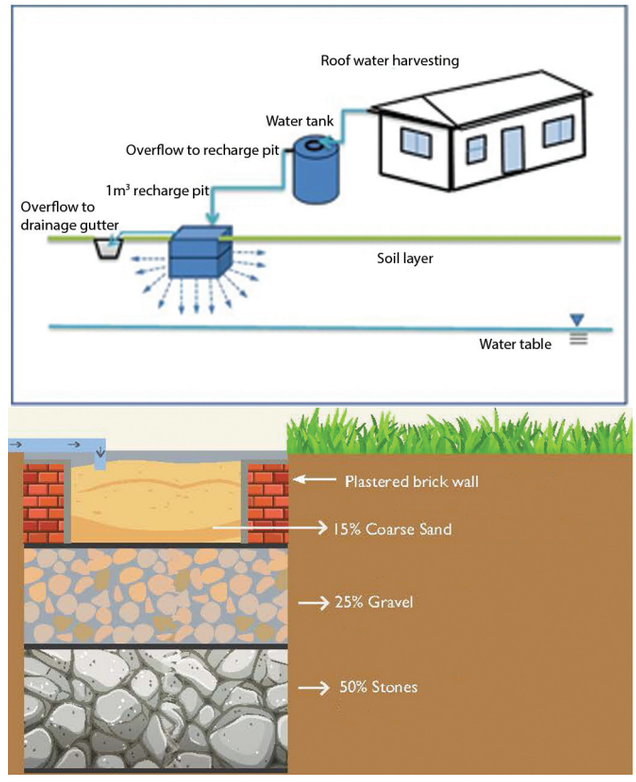

Fig. 6: CARP model with re-purposing of roof-water harvesting system.

Policy research panel: Promoting innovation through an approach of mobilizing expert panels aimed at studying, publishing and sharing research findings remains a critical gap at local government institutions. Study panels involving researchers both at local or national and even international levels can offer an opportunity to collate evidence, scientific insights, knowledge repository which can help city level planners and stakeholders to promote a culture of evidence based planning in various fields including water security. SIAS has very clearly identified this as an opportunity in Dharan where there are multiple national level research and academic institutions, with expertise in water monitoring, environmental planning, technological design, and social analysis.

Acknowledgements

Southasia Institute of Advanced Studies gratefully acknowledges the support of International Development Research Centre (IDRC) through the Climate Adaptive Water Management Plans for Cities in South Asia (CAMPS) project for enabling this pilot action research. We also extend our gratitude to the Dharan Sub

Metropolitan City, Dharan Water Supply Management Board, Central Campus of Technology, Hotel Association of Dharan, Women Network of Dharan and participants of Dharan Pani Chautari.

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Published by

SIAS

Southasia Institute of Advanced Studies (SIAS)
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Min Bhawan, Kathmandu
Phone: +977-1-4469801

Supported by

IDRC | CRDI
International Development Research Centre
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