37th WEDC International Conference, Hanoi, Vietnam, 2014

SUSTAINABLE WATER AND SANITATION SERVICES
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Low sustainability of drinking water schemes in India: a case study of water surplus north Indian state, Himachal Pradesh

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REFEREED PAPER 1905

Since the first five year plan India has spent a lot of resources for the provision of drinking water to its citizens on regular basis yet the results are not very satisfactory. In the performance audits and status survey conducted by the Government agencies have reported low sustainability of Rural Water Supply Schemes (RWSS). The planners in the country attribute this low sustainability to certain reasons mostly related to climate change, demographic changes and changes in monitoring practices. To understand this phenomenon of slipback, a case study on water supply status was conducted in the north Indian mountainous state, Himachal Pradesh, having average annual rainfall as 1111mm The survey of 3452 households revealed that low sustainability is due to deficiencies in planning, execution and operation methods/ practices. The planning and execution of RWSS need adaptation to climatic, demographic and social changes.

Introduction

Since the First Five Year Plan (1951-1956), Government of India and State governments have till end of 2010-11 spent about Rs. 1 350 000 million on rural drinking water supply. Despite this enormous effort the goal of providing safe and adequate domestic water to every rural person in the country still remains to be fully achieved (Brij Pal 2012, CAG 2008, Planning Commission 2011). While there has been a steady increase in coverage over the years, many fully covered habitations have been continuously slipping into ‘partially covered’ or ‘not covered’ status (World Bank 2008). According to the Eleventh Plan document (Planning Commission 2008), prior to 2005 about 95% of the total habitations in India have achieved fully covered status (receiving 40 liters per capita per day), yet as on 01st April, 2011, out of the total number of 1 664 186 habitations in India, the States reported that 28.69 % were slipped back to partially covered status (receiving 10 to 40 liters per capita per day) and 7.2 % habitations were water quality affected. As per the Ministry of Rural Development, Government of India (Planning Commission 2011) the reasons for this slipback include:

- Inclusion of newly formed periurban habitations.
- Slippage of covered habitations due to poor O&M and drying up of sources.
- Increase in population and growth of settlements.
- Increasing contamination of sources.
- Increased testing of sources and improved knowledge of quality affected areas.
- Changing norms of coverage adopted by the States.

Though there are several reasons for this, it is necessary that the challenges should be identified. (DDWS 2009).

Description of case study area and methodology

To understand the causes of slipback the authors conducted a household survey on the status of drinking water supply in Himachal Pradesh, a state located in the north of India, in the Himalayan mountainous region. The state comprises hilly terrain, perennial rivers, and significant forest cover. The state has abundant water resources (Asian Development Bank 2010). The average rainfall in Himachal Pradesh is1 111 mm, varying from 450 mm to over 3,400 mm.

A household survey covering 3 452 habitations was conducted with the help of staff of Himachal Pradesh Irrigation and Public Health Department in the year 2010 and 2011 to know the status of drinking water supply coverage. Out of total population of 6 856 509, about 90 per cent population resides in rural areas. As per census 1991 the state had 16 997 census villages (a census village is a group of habitations).. By March 1994 all these villages were covered with safe drinking water facility having supply level of 70 liters per capita per day (lpcd), a state norm for planning water supply schemes. Thereafter, the focus shifted from village to habitation. As per the water supply status survey of 2003(which was finalized in March, 2005), 51 848 habitations were identified. Of these, 20 112 were categorized as fully covered (FC) and 31736 habitations as not-covered and partially covered (9389 NC and 22347 PC). These 31 736 habitations have been categorized as slipped back habitations as per coverage guidelines, as the water supply status in these village has reduced below 70 lpcd. In 2013 the data has been compiled as per census 2011, where the total number of habitations increased to 53604. The coverage is now compiled and reported as per the household wise coverage instead of average supply level at the habitation level, about 29% habitations have again slipped back to partially covered status (MoDWS 2013).

Himachal Pradesh is largely mountainous with elevation ranging 250 meters to as high as 5300meters, geographically divided into three segments of high hills (altitude above 2000meters), mid hills (altitude 900meters to 2000meters) and lower foothills (altitude 250meters to 900meters). The high hills have very low density of population; most of the population in the state lives in mid hills and foothills. The state has been divided into12 districts, on cultural and linguistic basis. Two districts are located in high hills and have tribal population. Population density in these districts is 2 to 50 persons per sq. km., hence not included in survey. From remaining 10 districts, three districts from mid hills and three from foothills were selected for household survey. In the mid hills, water sources are available in plenty; hence the number of habitations covered by each water supply scheme is smaller as compared to those in the foothills where the water sources are sparsely located and water is carried long distances through larger water supply schemes covering more villages.

To cover almost equal number of households in each geographical segment, 93 Rural Water Supply Schemes (RWSS) from mid hills and 32 RWSS from foothills are selected. Total 3 452 households under 125 schemes are covered. All these households belong to habitations which once had fully covered status.The survey format was given to every household through the field worker (water guard) of Irrigation and Public Health Department and was collected back after about one week by the same person. About 45% households did not returned the survey format till three weeks, hence they were not included. The surveyed 125 RWSS were commissioned in years 1980 to 1990 to meet the coverage norms for villages falling under them. All of them have subsequently been remodeled/ augmented after 10 to 15 years to meet the latest revised norms of coverage, meaning thereby that all the habitations under these schemes have attained fully covered status.

Following are the key observations

- 60% households demand water supply at levels higher than the supply level of 70 lpcd, which is the adopted norm for designing the RWSS in Himachal Pradesh. Fig.1.
- Average water demand is 76 lpcd, if water demand for cattle is excluded. It is 88 lpcd if water demand for cattle is included. Fig 3&4.
- 61% households get water supply at 70 lpcd or above.
- The design of RWSS did not consider the water demand for cattle but 63% households have cattle, and these cattle are fed from the RWSS.
- 17% households do not have water supply point inside household premises. Fig.5.
- No household connection or community tap is having any flow measurement device.
- 32% households get water supply only on alternate days. Fig.6.
- All RWSS have been designed to supply water on 24x7 basis, yet the analysis of data. Fig. 2 reveals that only 3% households get water on 24x7 basis. This facility is available only in gravity flow schemes.
- 39% households get water supply for 2 to 3 hours per day. Fig.2.
- The staff deployed at habitation level for distribution/ regulation of water does not have any training in the subject. They do not have any knowledge about how much is the per capita water supply level, supply hours and the quantity of residual chlorine to be maintained.

Discussion on data collected

The analysis of survey data and the information on approved cost estimates of surveyed RWSS revealed following causes for slipback.

- Inadequate assessment of water demand
- Lack of measurement of equitable distribution
- Inappropriate population growth projections
- Difference between adopted design parameters and operation practices
- Inadequate source survey and land use regulations
- Technical capability of field staff deployed for operation of RWSS

Inadequate assessment of water demand and Lack of measurement of equitable distribution

Inadequate assessment of water demand and lack of measurement of equitable distribution together form a vicious cycle creating water shortage in areas at tail ends of distribution network. The water required for domestic activities varies with climatic conditions, lifestyle, culture, tradition, diet, technology and wealth (Glieck 1996, Schleich & Hillenbrand 2009). Yet the norm of supply level for designing RWSS is uniform for the whole state i.e., 70 lpcd. The survey revealed that 60% households require more than 70 lpcd water. These households do not waste any opportunity to draw water up to their self-assessed requirement. In the total absence of any flow measurement devices (water meters) these households draw water more than their allocation depriving the consumers down the network. Survey shows total absence of water meters as water supply is charged on monthly flat rate basis. With population growth in areas down the distribution network the deficit in supply increases. The survey shows that 83% households have water taps inside the household premises having large storages. Such households conveniently draw more water than those who collect water from public/community taps at a distance from their households. So 17% households do not get equal opportunity / access to water, although they have also been allocated equal share in water supply design. The level of water use varies with distance from water source and climate (Gleick 1996, Howard & Bartram 2003). Understanding that there are social differences within communities, which affects the access to water, it is clear that differently located access points cannot ensure equitable distribution of water in rural areas (UNICEF, FAO and SaciWATERs. 2013). The disparity in convenience to access water along with lack of measurement of equitable distribution pushes the disadvantageous habitations/households towards PC or NC categories.

Inappropriate population growth projections

While planning and designing a RWSS, depending on geographical features and population density, the population to be covered is divided into small zones or sectors for planning the location and sizes of sub storage tanks. Distribution network is designed for the population falling under each sub storage tank. As per the prevalent design practice, state level decadal growth percentage is uniformly applied to present population in all the sectors to get future population. This practice projects larger growth in densely populated sectors, whereas due to saturation in such sectors actual growth will be less. Likewise the sparsely populated sectors, where actually growth will be high, will get smaller sizes in distribution network. This practice of applying uniform growth factor to all the sectors is leading to inadequate design of distribution network, which subsequently leads to lesser water supply to the areas where future growth will be higher. So due to inappropriate allocation of future population growth to zones/ sectors with higher development potential have inadequate distribution network. Thus growth factor needs to be decided on the basis of development potential of a particular sector. The culture, traditions and lifestyle of population decides the density of population in the area, which is not taken in consideration while deciding the population growth of a particular sector or zone. Non-uniform distribution of water within a scheme will result in water scarcity in some areas and excess in other areas, the result of which will hinder the natural growth of the area. To plan a proper water management system or distribution system, it is essential to know the water demand in a spatial domain instead of computing demands as a whole. (Durga Rao 2005).

In case of Himachal Pradesh, decadal population growth rates have reduced in every subsequent decade since 1981. As the decadal growth rate of preceding decade is considered for population projection for future, all the estimates for RWSS has higher future population projections rates. The survey revealed that most of new settlements on the periphery of habitations are getting lesser water supply due to inadequate distribution network designs, despite of the fact that higher decadal growth rate is used in designing the network. The understanding of the Government that slipback is due to increase in population and growth of settlements is not correct, as it is not a primary cause but is an impact of wrong planning of a RWSS.

Difference between adopted design parameters and operation practices

Fig. 6 shows that only about 3% households have 24x7 water supply. Although all RWSS are designed for 24x7 supplies, yet schemes are not operated as designed. Most of the households get intermittent water supply, about 39% for 2to3 hours per day and about 38% for 1to2 hours per day. Since water is supplied intermittently by zoning the distribution system, more man power is required. Large sizes of pipe mains are required for strengthening the network to meet the hydraulic requirements. Such remodeling adjustments are made out of funds available for repair and maintenance of schemes. Inconvenient supply hours affect poor people. Large size of storage is required by the consumers. Also, it results in poor sanitation practices. Besides, due to uncertainty consumers store a large quantity of water and waste it before collecting fresh water again. These practices create water scarcity in the scheme area pushing the population to PC or NC status.

Inadequate source survey and land use regulations

- In 43% of surveyed schemes the percentage of source water tapped for RWSS is as high as 75% of the total water available at source.
- 75% RWSS had to be augmented from new larger water sources within the design period due to reduction in water availability at tapped source.

The analysis of approved estimates of RWSS show that availability of water at tapped water sources had been decided on the basis of one time lean period discharge measurement, only during the year of preparation of estimate. State does not have any record /history of availability of water in sources except for the major rivers. However the consideration of rainfall records and category of catchment along with one time discharge availability measurements could have helped in right assessment of dependability. State does not regulate the land use around the tapped sources. The uncontrolled mining of building material near the sources of 24% RWSS has been cause of quick reduction of water availability. Inadequate survey for source selection is one of the major reasons for low sustainability of RWSS.

Technical Capability of field staff deployed for operation of RWSS

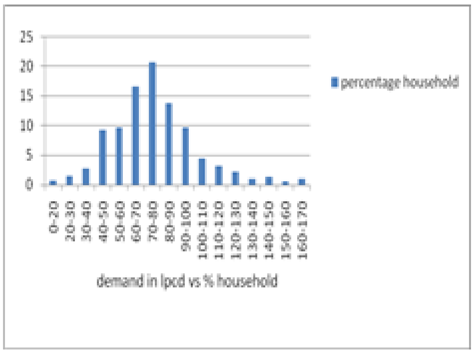
The equitable distribution of water has to be maintained at per capita level as per the design parameters assumed in estimates of RWSS. The staff deployed for the distribution operations at the habitation level has no knowledge of these parameters. They were not aware of daily per capita water quantity to be supplied and the daily supply durations. The distribution staff also does not know the quantity of residual chlorine to be maintained in the pipe network. They do not have chloroscopes for measuring residual chlorine. The influential consumers and households at advantageous locations continue to draw water more than their allocated share.

Conclusions

There are certain shortcomings in planning, designing and operation methods/ practices of rural water supply schemes due to which low sustainability or slipback in RWSS is continuing. The planning and operation of RWSS needs adjustments and adaptation to mitigate the impacts of rapid climatic, demographic and economical changes. The reasons for slipback, as considered responsible by the Ministry of Rural Development, are in fact impacts of environmental changes which need to be mitigated through correct planning and operation of RWSS. The phenomenon of slipback needs to be studied thoroughly to contain the low sustainability of RWSS in future. If this phenomenon continues, the resources spent to meet national goals as well as Millennium Development Goals may become infructuous due to low sustainability of RWSS'sHowever based on the results and lessons learnt in this case study following conclusions and recommendations can be made.

- Instead of adopting a statewide norm on lpcd basis, the water demand for a particular habitations be assessed considering the culture, lifestyle, climate and natural water availability in habitation.
- Provision of flow measurement devices is must for ensuring transparent and equitable distribution of water supply. Excess drawl of water by consumers at advantageous locations push other consumers towards lower water supply levels. Instead of flat rate based water tariff discharge based water tariff should be applied.

- The effect of development potential of a sector or zone on population growth needs to be considered while planning the zones and designing the distribution network, so that proper allocation of water supply can be ensured in all the zones.
- The RWSS must be designed as operated or operated as designed. The use of simulation softwares may help in deciding/ improving the operation/ designs.
- The hydro geological database must be developed and used for adequate selection of sources.
- Regulations and restrictions are required for protecting water sources against degradation and contamination. Government of Himachal Pradesh has recently banned mining/quarry within 300meters of water sources tapped for RWSS; this regulation would not help as first flood will erode the stream bed near the source to compensate the change in slope made by the mining beyond 300meters. Regulation must be decided on watershed basis.



The deployed at distribution duties must be trained in the distribution operations. They must have knowledge of daily per capita water supply levels, supply durations and disinfection dosages. They must be equipped flow measurement devices and chloroscopes.

Figure 1. Water demand in liters/capita/day vs percentage of household

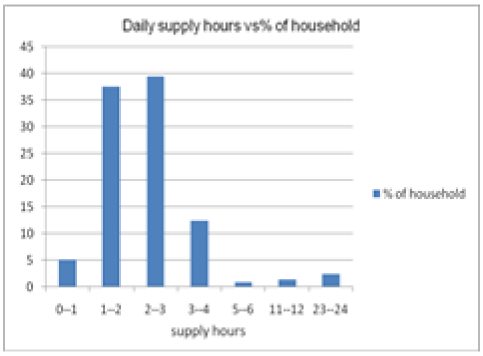


Figure 2. Supply durations

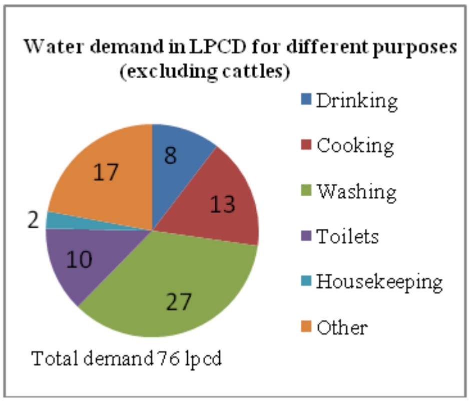


Figure 3. Water demand (excluding cattle)

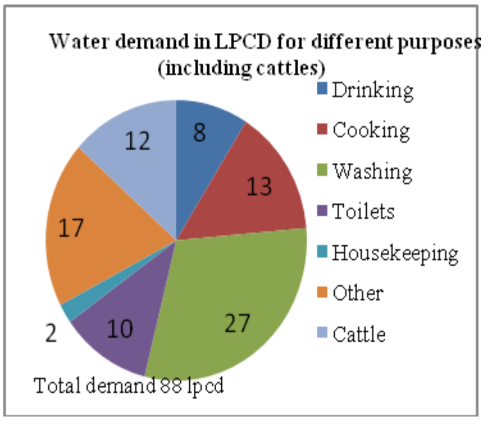


Figure 4.Water demand (including cattle)

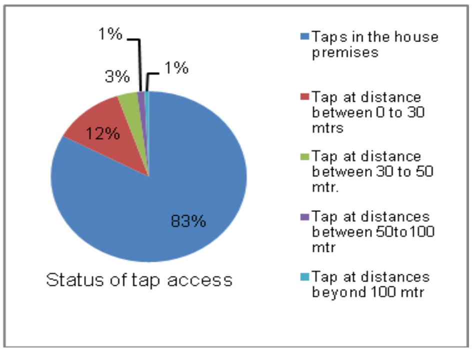


Figure4. Location of water delivery point

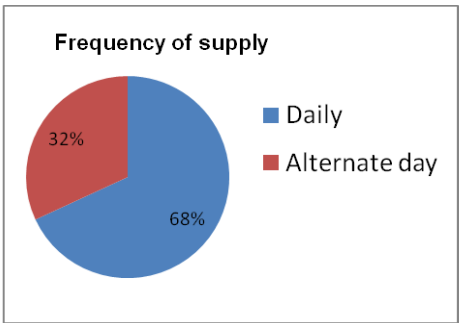


Figure 5. Daily supply frequency

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