

EXECUTIVE SUMMARY

Background of Research

Nearly half of the world's population, approximately 3.3 billion people, lives in rural areas, and 90% of those people live in developing countries. Rural areas in developing countries like India are characterized by a dependence on agriculture and natural resources; high prevalence of poverty, isolation, and marginality; neglect by policymakers; and lower human development. Water security is an emerging concept and has been mainly studied at national or transboundary scales. Though research on drought and water scarcity in rural areas are quite prevalent, studies on human-focussed concept of water security is significantly absent, more specifically for rural areas.

In light of such pressing issues affecting a majority of human population, it is important to assess water insecurity in rural areas, their causes, and ways in which they affect rural communities' lives. Rural areas are a multi-layered superimposition of dynamic systems in which local people live, work and interact, both animate and inanimate, for the material, sentimental and spiritual pursuits of the individual and the collective. Moreover, lives of rural people revolve around water for their daily sustenance. If the functions and resources are not adequate and appropriate in a rural area to support its inhabitants to pursue their individual and collective goals, then there will be loss of livelihood, increased hunger and poverty, migration and conflicts of use. Policy planning regarding water security is highly overlooked in rural areas. In doing so, this research proposes a methodology to assess the scale of prevailing water security in rural areas, mainly in developing countries, and formulate a localized and need-based framework to ensure water security that will work towards sustainability of water resources as well as overall upliftment of the rural people.

Research Objectives and Questions

The main objectives of this research are outlined below:

- To assess the existing status of water security in the rural area under study.
- To examine the determinants of household water consumption and the influence of socio-economic conditions on water consumption.
- To analyze the changes in local climate and their plausible impacts on rural livelihood.
- To investigate the strategies practiced by local rural communities to cope with water insecurity and climatic variability.
- To develop Rural Water Security Framework that strengthen and ensure water security.

To attain the research objectives, attempts have been made to answer the following research questions:

- How water secure is the rural area under study?
- What are the different determinants that control household water consumption and how does water consumption vary across different socio-economic conditions of the households?
- Is there any changes in the local climate, mainly rainfall, in the rural area? If yes, what are the possible impacts of these changes on local livelihood?
- How does the local communities perceive and respond to the different status of water insecurity and climatic variability?
- How can water security be ensured and strengthened in rural areas?

Research Methodology

The **first step** of the methodology involves collecting *Block* level data and applying it suitably to formulate Rural Water Insecurity Index (RWII) for the study area being analyzed. A questionnaire survey based on 3 dimensions, 17 attributes and 21 variables is carried out with *Block* officials to collect the required data. Principal Component Analysis (PCA) is used to weigh the variables and construct the index. ArcGIS® 10.3 has been applied to spatially segregate the blocks based on their scale of water insecurity. Based on the findings from step one, household level questionnaire survey is carried out in different *Blocks* in **step two**. Multiple regression analysis has been carried out to analyze the determinants that impact household water consumption. Other statistical techniques like ANOVA and post hoc tests are used to assess how household water consumption varies with household socio-economic status. **Step three** aims at analyzing the actual changes in local climate variables including rainfall, temperature and relative humidity of the study area. The data for the same has been collected from Indian Meteorological Department (IMD) and trend analysis using both parametric and non-parametric statistical tests is carried out to identify increasing, decreasing or no trends in the variables, mainly rainfall. In **step four**, different Participatory Rural Appraisal (PRA) tools have been applied in the study area to understand how local communities, including village elders, farmers and women, perceive the changes in local climate and water security, their causes and impacts, and how they cope or adapt to these variations. The **fifth step** mainly involves Focus Group Discussions (FGDs) with local communities and semi-structured interviews with local leaders who represent the local government and local administrative officials to outline the prioritized actions that can be undertaken to ensure water security, both

agricultural and household. Simple descriptive analyses are carried out to assess the collected data. The findings from all the above analyses are used to develop Rural Water Security Framework.

Purulia, located in the eastern part of India, is a rural drought-prone district with higher level of poverty. The district experiences inherent water scarcity and the population is mostly dependent on natural resources for their livelihood. Application of different research methodologies and the findings in the proposed study area is hoped to bring in universality in testing the hypothesis, and pose interesting situations which can then be used to amend the initial hypothesis to make it robust.

Key Findings of the Research

Principal Component Analysis of the variables under each of the three dimensions revealed the variables that needs immediate prioritized attention to ensure water security in the study area. Supply driven water security is found to be highly compromised due to lack of consistent and reliable piped water supply. Unavailability of adequate groundwater also contributes to the supply driven water insecurity in the study area. Water demand due to irrecoverable losses like evapotranspiration and surface outflow, and increased groundwater withdrawal to meet domestic and irrigation needs are found to exaggerate demand driven water insecurity. Adaptive capacity, the third dimension, is found to be mostly influenced by larger forest areas, higher female literacy rates and higher work participation by the local communities. Impact of increased rural-urban migration demonstrates the lack of adaptive capacity and narrow coping ranges of the rural people. Spatial mapping of water insecurity displays a wider spatial variation with only 10% of the *Blocks* being relatively water secure. Though water supply and demand are the basic dimensions that play a significant role in water availability, adaptive capacity is found to minimize the impacts from insecurity due to water supply and demand provisions.

Next to segregation of the *Blocks* as per different scales of water insecurity, it is imperative to understand the extent of water insecurity at household scale. Water consumption of only 1.52 % of the sampled households are found to exceed the basic water requirements recommended by the Sphere Project for humanitarian emergency situations (7.5-15 lpcd) (The Sphere Project, 2011). Out of this 1.52%, only 4 households (0.22%) are reported to consume domestic water above 20 lpcd i.e. the recommended basic water requirement for non-emergency conditions (The Sphere Project, 2011). The availability and accessibility to water is much below the satisfactory level denoted by the higher collection time, longer collection distance, dominance

of community water sources, use of unimproved water sources and dependence on single source of water. On an average, the collection time increased 7 times when the collection distance increased from less than 200 m to more than 2000 m. A decline in the collection distance (one-way trip) from more than 1000 m to less than 100 m is found to result in a 13% increase in per capita household water consumption. Per capita household water consumption was found to be influenced by demographic, economic, social and agricultural characteristics of the households along with water availability, accessibility and local conflicts etc. In addition, household socio-economic status, measured by ownership of assets, demonstrated a higher water consumption rate for well-off households compared to households with low socio-economic status. In summary, household water security, denoted by household water consumption, is found to be largely compromised in the study area.

Rainfall is the sole source of water in the district and livelihood of local communities are wholly dependent on timely availability of rainfall. An increasing trend in annual and pre-monsoon season rainfall and a decreasing trend in monsoon and winter season rainfall is noticed in the district. In addition the post-monsoon season rainfall demonstrated a highly variable increasing trend. This variability in rainfall trends, when correlated with various growth phases of paddy, is expected to heavily impact crop cultivation in the study area. Average maximum temperature also demonstrates an increasing trend in the study area.

Until now, the status of rural water security, based on data collected at different scales, is clear to a larger extent. Understanding the perception of local communities becomes imperative to recognize if the local communities can identify the causes and impacts of water insecurity in the study area. All the three communities, village elders, farmers and women, perceive the water supply scenario to be far from satisfaction. All the communities identified that significant proportion of the water supply and storage infrastructures does not function or functions much below its design and potential and fail to meet the needs of the rural people. In spite of identifying various natural factors like low yielding capacity of aquifers, lower water retention capacity of soil and undulating topography, local communities emphasize that the management factors play a havoc in lowering the water security of the study area. In addition, the perceived changes in local climate is found to match the actual changes in climate variables, mostly rainfall. The practiced coping strategies are found to outnumber adaptation strategies demonstrating the limited capacity of the local communities. The strategies practiced by village women aim at arranging water for household use whereas household level strategies mainly focus on alternative livelihood options or income sources that can assist in overcoming the loss

incurred from disturbed livelihood and lack of adequate income due to water insecurity and climate variation. The strategies are found to be largely reactive and unsustainable. Water conservation or water efficient farming is found to be largely missing in case of farm level strategies.

As the problem areas get identified, the present study aims at exploring the possible solutions that can ensure water security in the studied rural area. Various prioritized actions are identified at three different levels - local communities, local government (*Gram Panchayat*) and local administration (*Block*) - that can contribute towards improving and attaining water security in the studied district. Community level prioritized actions are mainly identified to be supply based like building check dams, ponds, wells, hand pumps etc. In addition, a higher percentage of responses at community level also emphasized on the repair and maintenance of the existing water sources. Both local administration and local government level responses prioritized more on construction of new water sources i.e. mostly supply based provisions to ensure both agricultural water security (like check dams, irrigation wells and irrigation ponds) and household water security (like installation of piped water supply and hand pumps). Lack of adequate finances is identified to be one of the major barriers by both the local government and administration in addition to lack of technical and human capacity and natural hindrances like hard rock terrain, undulating topography and difficult hydrogeology of the area. *Gram Panchayats* were identified to be the main implementing agencies for all the prioritized actions proposed at three different levels with local administration and district administration identified as the main funding agencies. In summary, the prioritized actions proposed by communities are found to be quite different from the proposed actions suggested by local government and local administration. Demand-side approaches and emphasis on sustainable adaptive strategies are noticeably overlooked by the respondents. The prioritized actions are not found to be resilient to seasonal insecurity and are mostly unsustainable.

In lieu of the above findings, a local framework for attainment of water security in rural areas is proposed (Figure E.1). Considering the research findings, Local Government or *Gram Panchayat* including cluster of villages under its boundary is proposed as the boundary of implementation for the proposed framework. There are two core segments of the framework – process cycle and support system. The process cycle consists of four main components – resource assessment, source sustainability, operation and maintenance, and adaptation strategies. Resource assessment mainly includes investigating the existing status of water resource in rural areas. The methodology followed in the present research contribute

significantly to the resource assessment phase. Many of the problem areas identified in the present study like frequent failure of water sources, siltation of water sources and depleted water quality can be rectified through prior survey, uptake of different software inputs (like rainwater harvesting, community awareness on need for recharge etc.) and hardware inputs (like structures that capture rainwater, surface runoff and groundwater for recharge purpose).

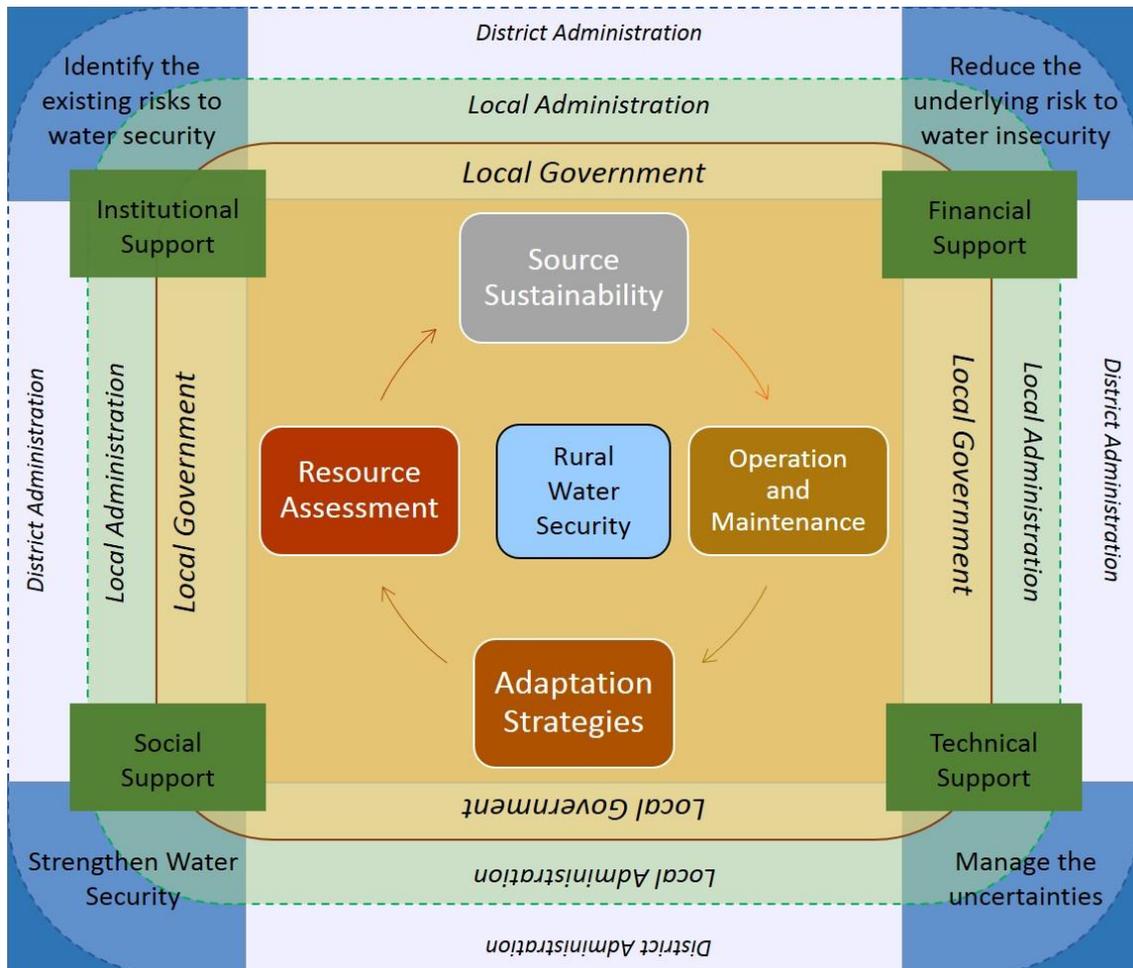


Figure E.1 Proposed Rural Water Security Framework

As source sustainability mainly suggests the provisions that should be taken care of before the construction of any new water sources, operation and maintenance phase principally emphasizes on the repair of existing water sources. This phases focusses on how the local communities can be empowered or trained to repair and maintain the water sources so that they don't have to depend on administrative personnel to come and repair them. This will help in overcoming the barriers due to lack of technical and human capacity. To help the small holder farmers, characteristic of the study area, as well as local communities overcome the challenges posed by uncertain climate variability and water insecurity, adaptation strategies are proposed in the process cycle. The support system mainly delineates the various assistances like

institutional, financial, social and technical supports required for the framework to function effectively.

The framework proposes the formation of community level **Beneficiary Committee** as well as creation of **Community Fund** to aid the proper functioning of the framework. The framework also presents various options to channelize funds that may help in addressing the financial constraints. The framework proposes **outsourcing** various forms of scientific expertise that may contribute to effective functioning of the framework. **Social Audit** has been identified as a viable option to monitor the progress of the proposed works and strategies under the framework. It will also help in maintaining transparency in the whole process of implementation of the framework. Most of the propositions have mainly focussed on the modification and capacity building of the existing system in the district to avoid complexity, time and effort needed to create new support system. The proposed Rural Water Security Framework, derived from the results of the present research, is first of its kind that aims at attaining and strengthening water security in rural areas and can be taken up for consideration and implementation in other rural areas also.

Conclusion and Way Forward

The status of existing rural water insecurity, their causes and impacts on livelihood, poverty and well-being of the local communities as well as investigation of actions that can contribute towards attainment of water security have been explored using a 5-step methodology, spanning meso and micro spatial scales as well as quantitative and qualitative data analysis. Each of these five steps has useful applications towards ensuring water security in the concerned rural area. The steps 1 and 2 of the methodology involving the development of Rural Water Insecurity Index (RWII) at the provincial scale and assessment of household level water security has resulted in the identification of the water insecure provinces (*Blocks*, in this study) and the determinants of household water security by measuring per capita household water consumption. This has proved that scale of water security is significantly low in the studied rural area and household water security is highly compromised. Also, the current research proved that concept of water security is more people – oriented than resource – oriented. Step 3 of the study involving assessment of local climate variables confirmed their uncertainty over time, mainly rainfall and this significantly impacts the small holder farmers in the study area who are solely dependent on rainfed agriculture. The 4th step provides a detailed explanation about the causes and impacts of water insecurity in the study area from the perspective of local communities. The local communities are found to effectively perceive the changes. However,

lack of adaptive capacity restricts their responses to them through sustainable adaptation strategies. This proves that adaptive capacity of the local communities, if developed, can substantially contribute towards attainment of water security in the rural areas. The 5th and final step is the identification of prioritized actions specified at different spatial scales – from meso scale to micro scale. The prioritized actions, specified at all three levels, are mostly supply side provisions and demonstrate the lack of community engagement. In summary, this research methodology and findings can find wide application in the assessment of rural water security and local level planning initiatives through a framework targeted at attaining water security in rural areas.