

Taikichiro Mori Memorial Research Grants 2021
Graduate Student Researcher Development Grant
RESEARCH ACHIEVEMENT REPORT

Research Project Name: Bridging the future water supply-demand gaps in Nagpur region (India) through WEAP modelling

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BACKGROUND

The doctoral research of the ‘Project Leader’ is focused on the specific case of Nagpur (India), wherein the rising concerns of urban-rural water conflicts have been mainstreamed. For the finite stock of shared water resources, it has been uncovered that water users in Nagpur region are not only facing competition at the cross-sectoral level but also at the transboundary-level. Through analyzing a specific set of secondary data associated with the water utilization trends of multi-purpose Pench Project (key water source of Nagpur city, illustrated in Figure 1a), it has been uncovered that the lately diminishing water inflow (due to upstream developments and changing climate) has not only been impacting the water supply for rapidly urbanizing Nagpur city, but has also been raising water-energy-food (WEF) nexus-based concerns for irrigation, industries, and other sectors, implicitly enhancing the pressure on groundwater resources. To further uncover the local household preferences and their willingness to pay for improved water management, household surveys were also conducted in Nagpur city, through which it is revealed that more than 75% respondents express clear willingness to monetarily contribute for water management projects, with preferences to tech-based solutions to minimize water losses, rainwater harvesting, and wastewater reuse and recycle (Figure 1b).

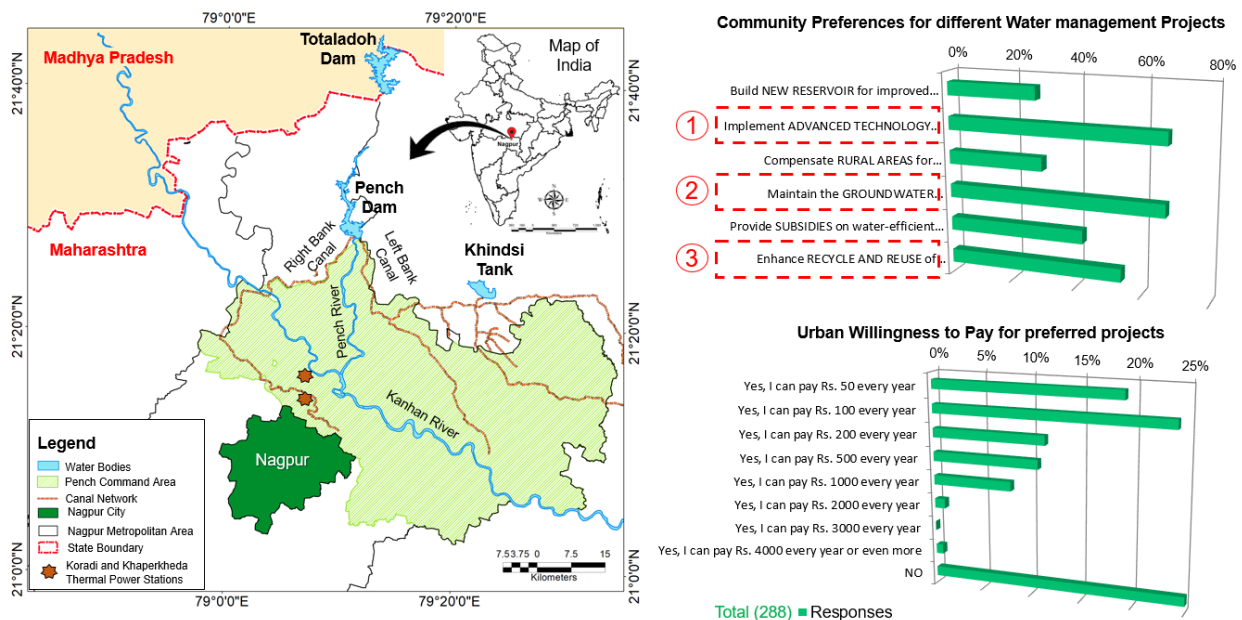


Figure 1: a) Spatial description of Pench Project in Nagpur; b) Household survey results from Nagpur city.

In the backdrop of growing water conflicts at local level and the intensifying hydrological phenomenon, finding better ways to govern and manage the limited freshwater resources has become indispensable for long-term sustainable development in Nagpur. A genuine need has been recognized for balancing the water supply and demand in future, to realize which a variety of decision support systems, like Water Evaluation and Planning System ‘WEAP’ (a software developed and distributed by the Stockholm Environment Institute), have now been developed. Capable of hosting various environmental and ecological considerations, WEAP is increasingly being utilized by development practitioners, as it allows for scenario analysis and potential assessment of various solutions (like wastewater reuse, technological advancements, etc.) for meeting the future water demands (in due consideration to factors like water allocation priorities, groundwater, streamflow, etc.). WEAP, thus, provides a flexible medium to model, analyze and optimize the water use in Nagpur, taking due account of the locally preferred water management strategies, which have been revealed through the applicant’s earlier research.

RESEARCH OUTLINE

Bringing forward the applicant's doctoral research in Nagpur, the WEAP-based hydrologic modelling in the proposed research is intended to not only highlight the comparative importance of various water management alternatives, but also to predict their long-term potential for bridging the future water supply-demand gaps (until the year 2030 and 2050). The three key objectives of this research project are:

1. To collect the necessary secondary data (hydrological, meteorological, etc.) for setting up a comprehensive WEAP model of Nagpur region in India.
2. To estimate the future water supply and demand quantitatively, considering the scenarios of business-as-usual and various additions to the existing supply systems (mainly the three local preferences of tech-based solutions, rainwater harvesting, wastewater reuse and recycle).
3. To suggest evidence-based actionable strategies for enhancing water security in Nagpur, in consultation with local stakeholders.

RESEARCH ACTIVITIES & PRELIMINARY RESULTS

1. WEF Nexus Mapping & Secondary Data Collection: Building on the pre-established understanding of the Pench project in Nagpur (shown in Figure 2a; through the applicant's doctoral research), a basic WEAP schematic (nodes, grids and transmission links of water supply-demand) has been prepared (Figure 2b). However, to further enhance the effectiveness of the WEAP model, additional secondary data is being collected to duly take into account the other small- and medium sized- reservoirs in Nagpur, and water users across different sectors.

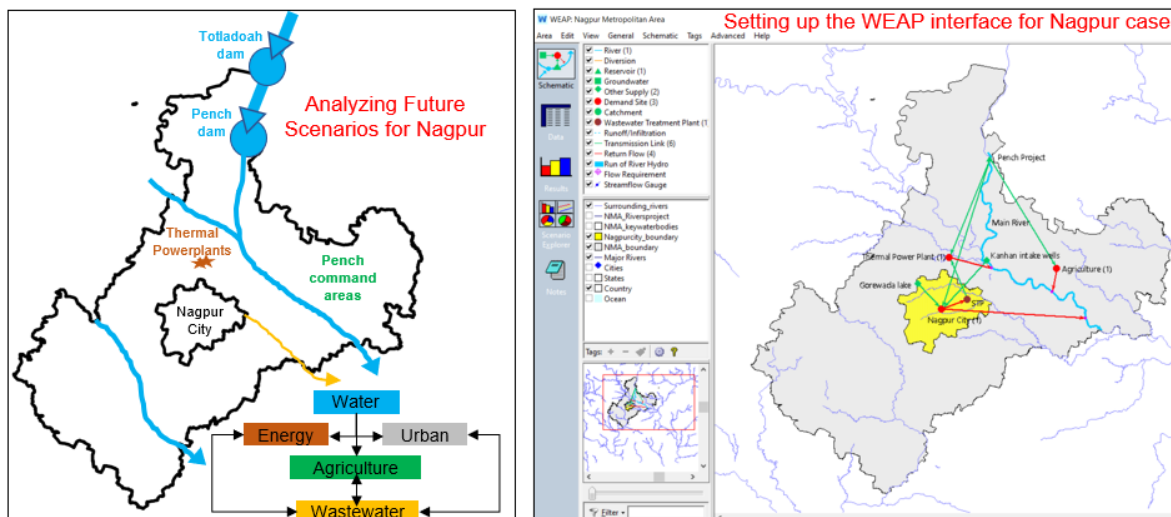


Figure 2: a) Visualizing the WEF interlinkages through Pench project in Nagpur, b) Basic WEAP schematic

While the uncertainties due to the ongoing COVID-19 pandemic and associated travel restrictions have constrained the necessary fieldwork in Nagpur, emphasis has been put to collect the required secondary datasets for WEAP modelling (hydrological, meteorological, and socio-economic) through mobilizing the pre-existing connections with local stakeholders in Nagpur. The key datasets collected, so far, include the water use trends in Nagpur city, rainfall, area under different crops and crop yield in Nagpur region, list of industries, list of thermal power plants, thermal power generation capacity, etc. Nonetheless, certain datasets at river basin level are still to be obtained (due to difficulty of access and need for on-field application), and the development of final WEAP model of Nagpur is currently under progress.

2. Land Suitability Assessment: Taking due account of the fieldwork constraints and the available datasets, the project leader has simultaneously focused on conducting land suitability assessment for Nagpur which suitably complements the WEAP modeling outputs, especially towards determining the potential of water harvesting in meeting the future water demands. Herein, the GIS-based multi-criteria evaluation approach has been executed for identifying the suitable water harvesting sites. The collected spatial (hydrological, meteorological, topographical) information of Nagpur is integrated in the GIS platform (using weighted overlay method). Eight key parameters have been defined for the land suitability analysis, and the Basic guidelines of Integrated Mission for Sustainable Development are referred for identifying suitable water harvesting sites and structures. Through the research results, more than 67% of Nagpur Metropolitan Area's land surface is found to be highly suitable for rainwater harvesting. Through the overlay of drainage networks on the land suitability map, a total of 60 potential water harvesting sites have further been identified (through visual interpretation), the practical feasibility of which need to be further cross-validated through field investigations.

FUTURE WORKS

Although the ongoing COVID-19 pandemic has delayed the field research and data collection activities in Nagpur, considerable progress has been made towards the achievement of three set objectives. As a next step, after collecting and feeding in the required datasets to updated WEAP model, the three defined scenarios will be considered, apart from the business-as-usual, for modelling the future water supply and demand in Nagpur. After comparing the values (eg. unmet demand and coverage of demand) obtained for different scenarios with the normal scenario, the most promising solution will be identified, and their feasibility for implementation will be determined through a series of meetings with local stakeholders.

RESEARCH OUTPUTS

Conference Presentations: Vibhas Sukhwani (Presenter) and Rajib Shaw. "Assessment of Rural Water Security and System Sustainability in Nagpur Metropolitan Area, India." 2nd International Symposium on Disaster Resilience and Sustainable Development – 24 June 2021.

Journal Publications:

1. Vibhas Sukhwani, Rajib Shaw (2022) "Stakeholder Perception of Addressing Water Stress in Nagpur, India- Lessons for Enabling Participatory Governance." *Keio SFC Journal* 21(2).
2. Priyanka Mitra, Rajib Shaw, Vibhas Sukhwani, et al. (2021) "Urban–Rural Partnership Framework to Enhance Food–Energy–Water Security in the Post-COVID-19 Era." *International Journal of Environmental Research and Public Health* 18(23), 12493.
3. "Assessing the Land Suitability for Water Harvesting in Nagpur (India) through Multi-Criteria Analysis and GIS Modeling" (currently under progress).

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