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# Sustainable Solutions for Water Management in India

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## ABSTRACT

India has a territory of 328 million hectares, which receives an average annual rainfall of 120 cm, this is among the highest for a comparable geographical area in the world. Despite India's vast water resources, droughts and famines are a common occurrence in many parts of country. This paper briefly surveys India's river-basin systems, drought-prone areas, hydrogeological systems, groundwater potential and utilization in light of water-quality constraints, and environmental pollution in India. This paper concludes by clarifying the main actions required to ensure a sustainable development of water resources in India.

**Keywords:** Water; Office building; AHP; Delphi; Management; India

## Introduction

Water resources sustainability index that makes it possible to evaluate and compare different water management policies with respect to their sustainability. The sustainability index identifies policies that preserve or improve the desired water management characteristics of the basin in the future. This index is based on a previous sustainability index with improvements in its structure, scale, and content to make it more flexible and adjustable to the requirements of each water user, type of use, and basin. The Rio Grande transboundary basin is used as a case study demonstrating the use of the index. Tailor-made sustainability indexes are defined for water users in Mexico, the United States, the environment, and for meeting system requirements (international treaty obligations). Group sustainability indexes are calculated to summarize the results for groups of water users of each country, the environment, and the basin as a whole. Sustainability indexes by subbasins are calculated to identify areas of potential improvement and regions at risk.

Traditionally, water resources like rivers and lakes have provided many important functions for societal developments. Rivers and lakes have different social, ecological and economical demands made on them at different periods of societal development and that made them vulnerable to change. In modern times many economic, social and ecological demands are met by these water resources. One of the ongoing discussions in water resource governance in India is the revival of the once degraded river and lake systems to fulfill the social, ecological and economical values of the urban infrastructure. The new water-system based infrastructures are proving to be the connectors in the current societal (urban) developments as they did in the time of traditional water management and old settlement pattern.

Sustainable water management (SWM) requires allocating between competing water sector demands, and balancing the financial and social resources required to support necessary water systems. The objective of this review is to assess SWM in three sectors: urban, agricultural, and natural systems. This review explores the following questions: (1) How is SWM defined and evaluated? (2) What are the challenges associated with sustainable development in each sector? (3) What are the areas of greatest potential improvement in urban and agricultural water management systems? And (4) What role does country development status have in SWM practices? The methods for evaluating water management practices range from relatively simple indicator methods to integration of multiple models, depending on the complexity of the problem and resources of the investigators. The two key findings and recommendations for meeting SWM objectives are: (1) all forms of water must be considered usable, and reusable, water resources; and (2) increasing agricultural crop water production represents the largest opportunity for reducing total water consumption, and will be required to meet global food security needs. The level of regional development should not dictate sustainability objectives; however local infrastructure conditions and financial capabilities should inform the details of water system design and evaluation.

Water is at the foundation of sustainable development as it is the common denominator of all global challenges: energy, food, health, peace and security, and poverty eradication.

India had an urban population of 221.979 million in 1991, 410.204 million in 2014 and is projected to increase to 814.399 million by 2050. The rate of urbanization in India has increased from 26% in 1991 to 32% in 2014 and is further projected to increase to 50% by 2050. This increase in urbanization is expected to put a strain on the available water resources resulting in increased pressure on water supply and sanitation services. As per the Ministry of Housing and Urban Affairs, the population residing in urban areas is witnessing rapid growth showing a shift from rural to urban areas. This change is evident from the Census of India 2011 data which shows that the urban population increased from 27.79% in 2001 to 31.16% in 2011and MoHUA also projects a rise to 38 % by 2026.

In order to cater to the demand urban population, cities need to take steps to become sustainable or develop their capacities to endure natural as well as anthropogenic water challenges. The lack of effective implementation policies and the dearth of sustainable practices in place may hinder these cities' ability to optimise water quality and quantities. The challenges that cities face can be further exacerbated by changing circumstances such as climate change, extreme events as well as other disrupters.

It is important to recognize that sustainability is not only limited to the quality and quantity of water, but social, economic and institutional challenges are also interconnected with the sustainability of water for cities. Cites have to manage water assets sustainably for long term advantage. Therefore, there is a need for an integrated tool to monitor the success, impacts of interventions and prioritize investments and thus need some measurable indicators.

Though India has service level benchmarksand draft indicators for achieving SDG as well as other for indicators to help data based decision-making for water in India such as the Composite Water Management Index, it was found that they are limited and fragmented. Indicators should guide cities in making sustainable development meaningful and operational.

**Case for indicators for Amaravati**

Amaravati is an upcoming capital city of newly formed state of Andhra Pradesh in India. The Government of Andhra Pradesh has decided to establish a green field capital city as a livable, environmentally sustainable and people's capital. For this purpose, the location of the capital was identified between Vijayawada and Guntur cities on the upstream of Prakasam Barrage on the river Krishna, with an area of 217.23 Sq Kms, which is covering a current population of 97960 in 25 villages (As per Primary Census Abstract Tables Census 2011). The proposed capital city is being planned to accommodate a population of 4.5 million by 2050. The city has projected a municipal water demand of 864 MLD and industrial water demand of 203 MLD by 2050.

The low lying areas of the capital city development area are inundated two to three time annually lasting for a period of 5 to 7 days during each spell of heavy rain. Out of 13,500 acres of the flood prone area, about 10,600 acres falls within the capital city development area.[7]

Considering that large parts of the city lie in flood prone areas and the considerable strain that the demand will put on the existing water resources there is a need for a set of indicators to help guide the city towards its goal of becoming a Smart, sustainable and climate resilient city.

**Sustainable water indicators for cities**

The 'three pillars' of sustainable development- social, economic and environmental aspects also needs to consider governance as a fundamental part of sustained development as the 'fourth pillar'. The benefit of sustainable development indicators lies in their ability to depict physical, social and institutional data into manageable units of information that can provide timely and accessible information for use by decision makers and other stakeholders at various levels. Though these indicators should be simple enough to be understood, they also need to be robust and reliable to be used for planning and policy decisions. The indicators should be relevant, valid, representative, measurable, consistent, reliable as well as accessible and affordable to monitor and compile.

The indicators should encompass aspects of environment, economy, gender & social perspective, governance/ institutional, quality of life, and resilience to change. Efforts to monitor sustainable water indicators should be progressively up-scaled in other cities and replicated, in order to institutionalize a comprehensive monitoring mechanism towards achieving the target of cities with sustainable water resources.

GRIHA for CITIES (**CI**vic bodies governing **T**owns, **I**ndustries, **E**xisting and new **S**ettlements) rating is currently being developed by GRIHA Council, the rating body administering the indigenous GRIHA rating.

Sustainable development is commonly defined by the Brundtland Report as meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. “Needs” include economic, environmental and ecosystem service delivery, and cultural goals including identity and subjectively defined values. Together, these are commonly referred to as the sustainability triple bottom line. Sustainable development is the combination of sustaining the natural environment, resources, and community, and development of the economy and societal goals.

Sustainable water management (SWM) is a critical component of sustainable development, and accounts for similar issues as sustainability. Mays define SWM as meeting current water demand for all water users without impairing future supply. More specifically, SWM should contribute to the objectives of society and maintain ecological, environmental, and hydrologic integrity.

The definition proposed by Alley etc for groundwater management cites protection of the components in the sustainability triple bottom line: environment, economy, and society. A more holistic objective is provided in Agenda 21 which ensures that “adequate supplies of water of good quality are maintained for the entire population of the planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and to combat vectors of water-related diseases.”

Definitions of SWM present challenges for adoption because of the widespread use of subjective language and lack of detail. Most definitions offer only a broad conceptualization of the sectors or environments to consider. The language in most SWM definitions is usually qualitative and often normative. For example, sustainability entails “the design of human and industrial systems to ensure that humankind’s use of natural resources and cycles does not lead to diminished quality of life due either to losses in future economic opportunities, or to adverse impacts on social conditions, human health, and the environment”. This definition uses “diminished quality of…” and “adverse impacts on.

Integrated sustainability assessment is the part of a new paradigm for urban water decision making. Multi criteria decision analysis is an integrative frame work used in urban water sustainability assessment. The cities are facing range of dynamic pressure including rapid population growth, urban sprawl, and industrialization and climate change results into exploitation of available natural resources. Therefore ecological footprints of cities are growing rapidly in many developing countries. The sustainable urban water management is concerned with not only functional aspect of urban water management but also environmental, economic, social and engineering aspects of sustainable development. Therefore it is required to undertake holistic analysis of entire urban water cycle by setting up relatively simple model with reasonable accuracy. Today, municipalities are facing great challenge for managing urban water systems. Therefore, effort is put forward by making a simple model to find out loopholes in the water management system and to find the potential in the system where chances of improvement lies which makes system sustainable for future. The data were collected from Surat Municipal Corporation and sustainability index is found by developing simple additive weightage model.

One of the ongoing discussions in water resource governance in India is on the revival of the river and lake systems. The new water-system as infrastructures are proving to be the connectors in the current societal (urban) development as they did in the times of traditional water management and old settlement pattern. Rivers and lakes have different social, ecological and economical demands made on them at different periods of societal development and that made them vulnerable to change. One of the core challenges documented in the governance of rivers and lakes in India is addressing the rapid changes in these value systems. Effectively addressing the change (or priority) in the values of water systems and urban systems linked to the governance can be a major step towards sustainability of these systems. There is still limited understanding of how the values of water resource systems are progressively linked to changing urban systems and how upward and downward causation linkages occur within the systems as well as across diverse sectors and scales of governance. The PhD research on ‘Sustainability of urban lake systems in India’ is an attempt to look at the interactions and outcomes of the spatial and temporal dynamics of urban systems and lake systems especially the values that sustain the institutional and ecological memory. The paper highlights the relationship and the role of values between urban lakes systems (ecological systems) and governance (social systems) and identifies that sustainability of both the systems is the key towards sustainable cities. The multitier framework for analyzing the socialecological systems is used as the foundation to elaborate the link of the values with urban lake systems and governance in the context of Ahmedabad city. Vastrapur lake development in Ahmedabad is studied to elaborate few roles of values.

## Conclusion

Engineering index is very less and it has high potential for improvement. According to the collected data metered connection is only in the area of 0.41% of Surat city which brings down engineering index. Water losses can also be minimized by installing efficient devices and conducting water audit. Environmental index can be raised by implementing water reusing system. The energy consumption contributes 66% of total water management cost so, it can be reduced to some extent by implementing energy efficient technique or renewable energy sources should be used. There is huge variation between area covered under pipe network & percentage population covered before & after extension of city limit. This is because of transition stage of extension of city limit. It takes time for establish infrastructure facilities which represents a drop in population & area coverage. Apart from that important issue is riparian right for water withdrawal capacity hence it is urgent need for sustainability of system to develop rainwater recharging and harvesting system, Reuse of water and waste water and water meter should be implemented to minimize water losses.

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