Understanding Water Auditing: A Powerful Tool in Sustainable Water Management

- Dr. Snigdha Goel

1. Introduction

Water is the elixir of life, a fundamental resource that sustains ecosystems, agriculture, and human existence. Water stress and scarcity continue to be significant global issues in 2023. By the year 2025, it is projected that approximately 1.8 billion individuals will reside in nations or areas facing "absolute" water scarcity, defined as having access to less than 500 cubic meters of water per person per year. Additionally, two-thirds of the global population may experience "stress" conditions, with available water resources ranging between 500 and 1000 cubic meters per person per year. This scenario will be further intensified as rapidly expanding urban centers exert significant strain on nearby water reservoirs and supplies (FAO 2024[1]. The natural ecosystems that provide clean water and alleviate floods and other risks — such as forests, mangroves and wetlands — are degrading and disappearing at alarming rates. Alarming data from Aqueduct reveals that by 2050, $70 trillion in GDP, representing 31% of the global GDP, will be exposed to high water stress, a substantial rise from the $15 trillion recorded in 2010. Notably, India, Mexico, Egypt, and Turkey emerge as pivotal players, collectively accounting for more than half of the exposed GDP in 2050 (Kuzma et al., 2023). To avert such a situation, a 56% increase in global water supply or an equivalent reduction in demand by 2030 would be required (Lakshman, 2023). In India, there is a noticeable surge in water requirements across various sectors due to rapid shifts in both economic and demographic landscapes. The demand for water in India is also expected to grow at a 2.8% Compounded Annual Growth Rate (CAGR) from 2010 to 2030, facing a supply gap of 50% by 2030. With global warming-induced drought increasing, planning for effective water management and distribution is vital to ensure reliable access to sufficient, safe water in India.

Water Demand in Built Area

In 2023, the real estate segment of construction industry comprising of residential offices, hotels, retail, leisure parks etc is valued at USD 20.71 billion and is expected to grow at a CAGR of 21.20% during 2023-2028. The construction sector presents contributes 9% of India's GDP which is quite significant. A growth rate high as 21% implies there is a huge demand of accommodation in urban cities leading to immense strain water supply and sanitation systems. For 1 square meter of wall construction, an average of 350 liters of water gets used. With such copious amounts of water being needed at every stage of construction, built up area is becoming more and more water intensive. The ramification of urbanization will be severe. Recent study by TERI found that the groundwater abstracted in Delhi in the period 2005-2016 (−18.75%) is greater than the amount of total groundwater recharge (14.67%). Thus, increased urbanization will lead to reduced groundwater recharge, increase in surface water runoff and evaporation, and changes in impervious area.

The most vulnerable to water stress is the socio-economically weaker section. With a growing population and higher per capita consumption, water resources are increasingly being taxed to meet the demands of agriculture, industry, and households and

1. https://www.fao.org/land-water/water/water-scarcity/en/

the socio-economic backward section comes last in the priority. Thus, water shortage will exacerbate its negative effects, reinforcing poverty, slowing economic development, and widening social inequalities (Israilova et al., 2023).

To ensure India's continued economic growth, it's crucial to address these problems. In recent years, the idea of water resource management has emerged to treat water as an economic and public good (Hellegers 2002). We need to prioritize maintaining and upgrading existing infrastructure, improving water management, and implementing effective stormwater and wastewater treatment solutions.

Although some approaches exist for more precisely managing urban water, such as water footprint (Ene et al., 2013; Long et al., 2022); life cycle evaluation (Ma et al., 2018); and water pinch analysis (Liu et al., 2019), they have not yet provided the best guidance for establishing a connection between water use accounting and organization's benefits. Additionally, these techniques are only employed from an accounting perspective, without further research and targeted improvement efforts, so it is challenging to develop an effective and ongoing management plan (Lyu et al., 2023)

In this respect, water audit has emerged as a potent tool for addressing urban water challenges like water scarcity and mismanagement. Water auditing is a systematic process of assessing, analyzing, and optimizing water usage within various sectors, offering a pathway to unlocking efficiency and sustainability. This paper will delve into concepts of water audits in detail discussing real life examples of how it has positively impacted the water availability in an organization.

2. Importance of Water audit

A water audit—also called a water evaluation or assessment—is a comprehensive analysis of the current water use of a building or campus, and the subsequent development of a strategy to increase water usage efficiency and identify alternative water resources. The goal of a comprehensive water audit is to reduce the demand on freshwater resources. It provides a better understanding of customer water use patterns, characteristics, and consumption. The data gathered during a water audit will also assist in establishing a baseline for various customer segments and for future strategic and policy planning. By meticulously examining water consumption patterns, identifying areas of inefficiency, and recommending targeted solutions, water auditing empowers organizations to make informed decisions that not only conserve precious water resources but also yield substantial economic benefits. Auditing can also mitigate conflicts over water usage, promoting equitable distribution, and safeguarding the interests of all stakeholders. By embracing water auditing as a cornerstone of sustainable water management practices, India can chart a course towards resilience, prosperity, and environmental stewardship in the face of mounting water challenges.

3. Review of Literature

In the literature, there are several frameworks integrating urban planning with water management. For instance, a study by Koc (2022) build an integrated Urban Water Management framework that connects water supply, sanitation, rainwater and wastewater management with land use planning and economic development, aiming to achieve sustainable economic, social, and environmental objectives. Another study by Puchol-Salort et al., (2022) presented a CityPlan-Water framework to achieve water neutrality at a city scale. The interventions include retrofitting existing homes with water-efficient appliances, water reuse systems, and implementing rainwater harvesting and Blue Green Infrastructure in new urban developments and existing households.

A study by Barrington et al., (2013) investigated the use of water auditing techniques to examine water flows within a petroleum refinery, concurrently identifying practical ways for achieving water conservation. The work demonstrated that, even in a refinery with processes considered highly efficient within the industry, many opportunities existed to improve water conservation through technical, cultural and behavioural adaptations. Neelofar et al., 2023 highlighted major challenges faced by water resources management in India and illustrated how well-planned water auditing and water recycling can be used as effective tools for the management of water resources in the country. The authors concluded that if water audit is promoted on the lines of financial audit in the country, it has the potential to revolutionize to the large extent the reforms that will encourage this practice of water audit in all sectors thereby leading to wise and judicial use of water for safeguarding water resource.

3. Who needs water audit?

Water audits are essential for a broad range of organizations, no matter their size or industry. Water audits provide an accurate picture of the organization's water usage. Auditing in water boards is extremely

beneficial to estimate the quantity delivered and lost during the process. They are also useful for companies looking to minimize financial costs associated with water, businesses that want to ensure that they comply with environmental regulations, and those seeking green business certifications. In India, SEBI has introduced new reporting requirements on ESG parameters called the Business Responsibility and Sustainability Report (BRSR). As per the BRSR format, details like surface water, Ground water, Desalinated water, Power consumed in pumping and Total volume of water consumption (in kilolitres) are to be furnished on year-on-year basis. Thus, water auditing will become important to fulfill the ESG compliances and sustainability KPIs as well[2]. Because water auditing demonstrates a commitment to resource efficiency and environmental responsibility, they can provide important data for certifications such as LEED or ISO 14001 that require a comprehensive sustainability report as a part of the application process.

4. Types of Water Audit

Broadly water audit is conducted categorically in two systems, resource audit or supply side audit and the other one as consumption audit on demand side. Supply-side water audits shift the focus outward, examining the external sources and systems that supply water to an organization. These audits assess the revenue and non-revenue water, metered and non-metered water supplied. On the other hand, demand-side water audits focus on analyzing and optimizing the consumption patterns and behaviors within an organization. These audits delve into internal processes, infrastructure, and user practices to identify opportunities for reducing water usage and increasing efficiency.

In the realm of business, demand side water audits come in various forms, each tailored to meet specific organizational needs and objectives. Whether aimed at achieving sustainability goals, enhancing operational efficiency, or complying with regulatory requirements, businesses can choose from a range of audit types to suit their unique circumstances.

Comprehensive water audit: Provides an extensive view of water usage, any risks, and opportunities for improvement within the organization. This type of audit is helpful for companies seeking high-level green business certifications or serious about their sustainable business practices and achieving their sustainability goals.

Irrigation systems water audit: Focused specifically on outdoor water consumption, including irrigation and landscaping activities, this audit type targets businesses with significant outdoor water usage. By scrutinizing irrigation practices and identifying inefficiencies, companies can optimize water usage in landscaping while minimizing waste, thereby promoting environmental sustainability and cost savings.

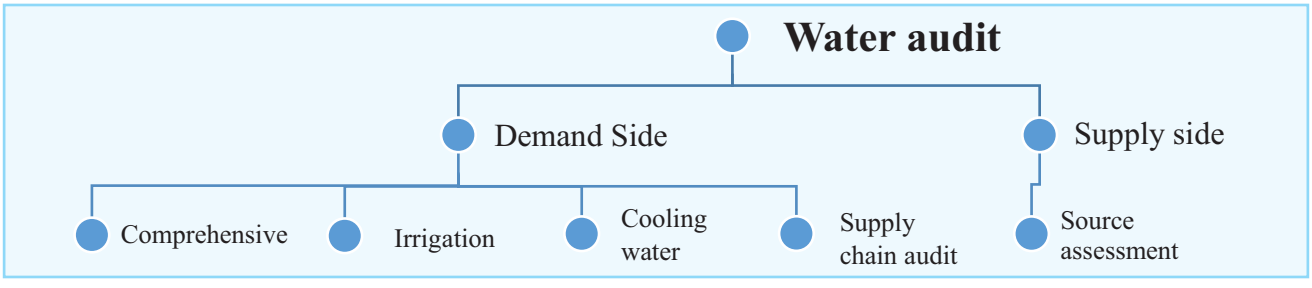
Cooling water audit: Essential for businesses relying on cooling systems, such as data centers or HVAC units, cooling water audits assess water usage associated with cooling processes. This audit type helps businesses identify opportunities for reducing water consumption, improving cooling system efficiency, and mitigating environmental impact.

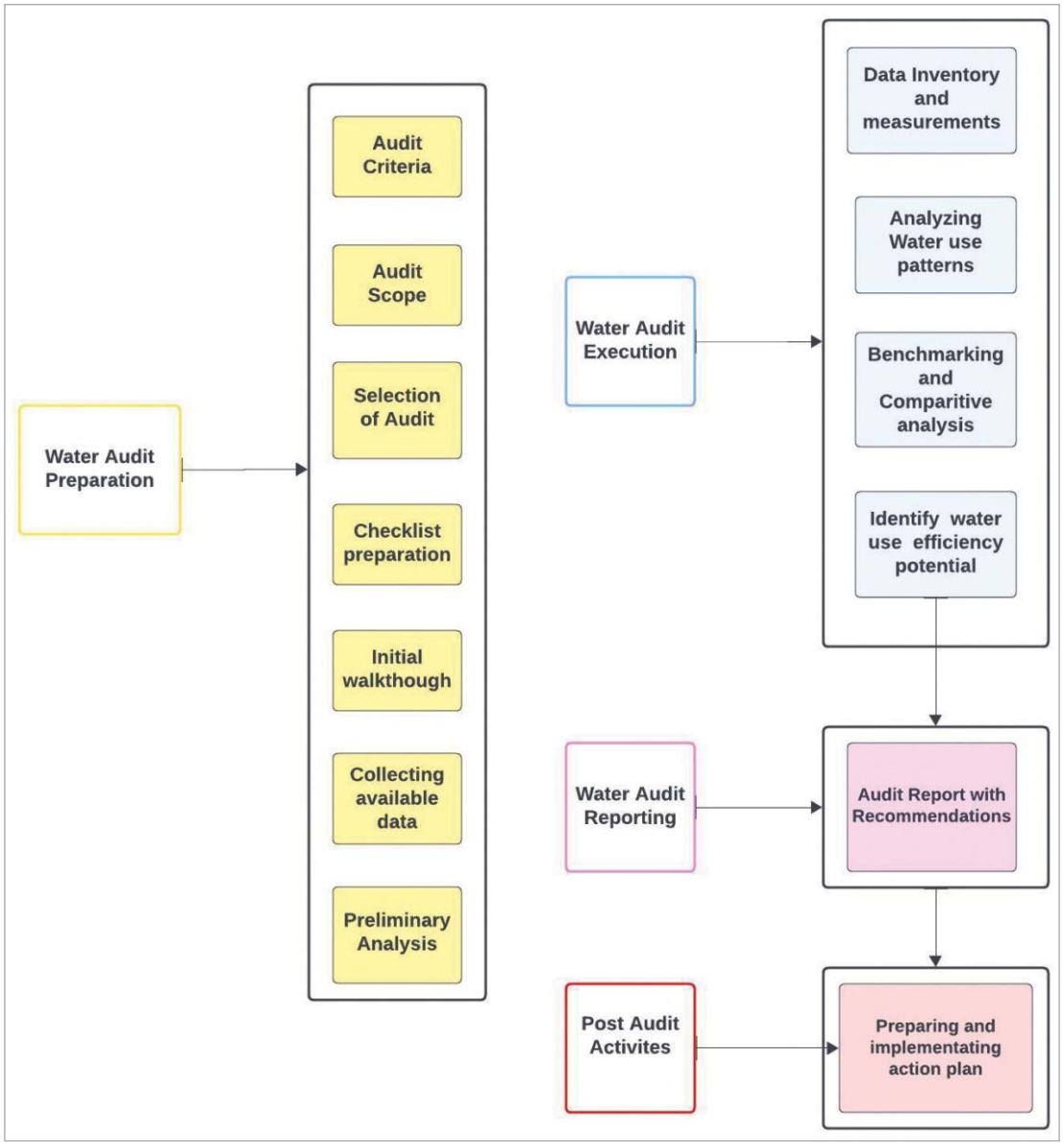
Supply chain water audit: This evaluates the water utilities along the supply chains. This is also important for ecommerce companies as their most significant areas of impact often lie along their supply chains.

5. Methodology

A thorough water use audit is the basis of a water use efficiency improvement plan and sets the foundation for the entire effort. The approach used for Water Audit, should be that all water is "accounted for" and quantified as either a component of beneficial consumption or wasteful loss by measuring (metering) or estimating water quantities. The process involves the following phases:

- Water audit Preparation (Pre-survey information and data collection, Site survey)
- Water Audit Execution (Analysis of the data collected)
- Water Audit Reporting (Documentation of results obtained)
- Post Audit Activities (Formulation of water-saving solutions and implementation)





6. Case Studies

In this section, real-world examples of water conservation projects that have successfully implemented water-efficient strategies and sustainable water management practices are discussed:

CASE STUDY 1: Water efficiency and conservation at a training institute in Alwar district, Rajasthan[3]

Overview: The Anil Agarwal Environmental Training Institute (AAETI), covering 10 acres (4.04 hectares) in Nimli village, Tijara block, Alwar District in Rajasthan, is a fully residential institute for training and capacity building on thematic areas related to environment and sustainable development. The site is not connected to the municipal water supply or sewerage network. The site draws about 76 KLD of groundwater during non-rainy season at its full capacity for all its potable purposes. Hence, annually the site will need about 22,155 KL of freshwater from the ground. The AAETI campus is a planned intervention means that adequate measures have been taken to ensure that groundwater levels are not depleted or contaminated, water consumption/demand is reduced, treated wastewater is locally reused as an alternative source of water in addition to the rainwater that is harvested.

3. Suresh Kumar Rohilla, Chhavi Sharda and Mahreen Matto, 2017

The following table tabulates the measures taken at the site to reduce demand for freshwater:

Table 1: Interventions for reducing water demand in AAETI Campus

In-situ water augmentation		
Intervention	**Details**	**Quantity of water**
Reuse of treated wastewater	Reuse for flushing and irrigation wastewater generated from cafeteria and housing blocks is treated using soil biotechnology, wastewater generated from the administrative block is treated through a decentralized wastewater treatment system (combination of settler, ABR, planted filter bed and polishing pond)	9,125 (25 KLD during days when it doesn't rain)
Recharge of harvested rainwater and storm water	Recharge well—Recharge of rainwater through rooftop RWH (rainwater from all rooftop areas except from canteen's rooftop) Tapping water from the storm water stream that flows through the site for recharge	25,000 KL
RWH for direct use	Storage of the harvested rainwater from the canteen's rooftop into RCC tanks for usage • Space cooling • Drinking water in canteen	780 KL (freshwater requirement was reduced from 76 KLD to 64 KLD)
Water efficient measures		
Reducing water consumption	• Usage of water efficient fittings and fixtures for toilets, bathrooms, kitchen and laboratory. • Reuse of treated wastewater for flushing	
Water-efficient landscaping and evapotranspiration (ET) controlled irrigation system	• This will reduce losses through the irrigation system • Using native plant species for landscaping	

Results

- Water supply is planned at 135 litres per capita per day (lpcd). Water demand will be reduced from 135 lpcd to 86 lpcd by using water-efficient fixtures, rainwater harvesting and reusing treated wastewater.
- The site will recharge about 25,000 KL per annum through different RWH and SWM technologies in comparison with annual freshwater withdrawal of 22,155 KL.

Case Study 2: Case Study 1: Sustainable Water Management in a Commercial Complex, City Center Commercial Complex, Anytown Nebraska, USA[4]

Overview: The City Center Commercial Complex is a bustling urban hub comprising multiple office buildings, retail spaces, and a food court. With a high volume of daily visitors and occupants, efficient water management became crucial to reduce the facility's environmental impact and operational costs.

Water Conservation Measures Implemented:

1. **Low-Flow Fixtures:** The complex replaced conventional faucets and toilets with water-saving fixtures to reduce water consumption significantly. Low-flow faucets and dual-flush toilets were installed in all restrooms, achieving a 40% reduction in water usage.
2. **Rainwater Harvesting:** To augment non-potable water supply, rainwater harvesting systems were installed on the rooftops of selected buildings. The

4. https://www.linkedin.com/pulse/water-conservation-strategies-efficient-plumbing-denismarie-uche/

collected rainwater is treated and stored for irrigation purposes, helping to reduce reliance on municipal water supply.

3. **Smart Irrigation System:** An advanced smart irrigation system was implemented in the complex's landscape areas. The system utilizes weather data and soil moisture sensors to optimize irrigation schedules, avoiding water waste and ensuring plants receive just the right amount of water.

Results: Through the combined efforts of low-flow fixtures, rainwater harvesting, and smart irrigation, the City Center Commercial Complex achieved a remarkable 30% reduction in water consumption. The initiative not only conserved water but also significantly lowered operating costs and contributed to the complex's sustainability goals.

7. Challenges

Water has always been considered as a free and unlimited resource. Any new policy or regulation regarding water conservation is not welcomed with open arms by the consumers. As of now, Govt. of India has made it mandatory for the industries to conduct periodic water audits within their premises. However, there are no guidelines or BIS Code for water audit in the country. Central Water Commission took the lead role and prepared "General Guidelines for Water Audit" that covers three aspects viz. irrigation, domestic and industrial.

Despite these efforts, widespread adoption of water auditing remains elusive, necessitating heightened awareness among commercial and residential water consumers. Numerous challenges impede the effective implementation of water auditing. Foremost among these challenges is the difficulty in obtaining accurate and comprehensive data. Inaccuracies in measurement and reporting can significantly undermine the efficacy of auditing endeavors, underscoring the importance of investing in advanced monitoring technologies and standardized data collection methods.

Moreover, the absence of benchmarks tailored to commercial sector buildings poses a significant hurdle. Lack of financial incentives to invest in water-efficient infrastructure further dampens enthusiasm for conservation measures, especially given that the cost of water is often lower than that of energy. Furthermore, there is a notable absence of guidance and strategic frameworks for managing the risks associated with water auditing.

Addressing these challenges requires a multifaceted approach, including targeted educational campaigns, the development of industry-specific benchmarks, and the formulation of policies that incentivize water conservation investments. Only through concerted efforts can the nation effectively address its water conservation imperatives and ensure the sustainable management of this vital resource.

8. Policy Implications

While auditing at the scale of individual developments can play a vital role in achieving water conservation or more sustainable water usage, systemic changes will be essential to achieve significant improvements in water efficiency. Top-down supportive policy and stricter legislation is necessary to take this agenda forward, as we observe with carbon neutrality. Governments can play a pivotal role in promoting water auditing by mandating regular audits for businesses and industries. This policy can drive awareness, encourage compliance, and ultimately lead to more efficient water use. In addition to national policy and central government, local councils can also play an important role in driving water neutral development forward at the ground level. They can encourage developers to work with other stakeholders to adopt water conservation measures such as integrating reclaimed water systems and water-efficient devices as part of the planning process for new development within the city or district (Makin et al., 2021). Incentive programs, such as tax breaks or grants should be encouraged to invest in water-saving technologies and implement the recommendations arising from water audits. Further, collaboration between governments, non-governmental organizations, and private entities can facilitate the sharing of expertise, resources, and technology, promoting a holistic approach to water management.

9. Conclusion

The year 2023 marked the launch of Green Credit Programme to incentivize various stakeholders like individuals, communities, private sector industries, and companies take voluntary actions across diverse sectors of which one important sector is water conservation. The widespread adoption of water auditing exercises stands out as a significant pathway to earning green credits, while also propelling us closer to the goal of achieving water security by 2047. This paper has delved into the intricate considerations surrounding water auditing, examining its significance, challenges, and policy implications in our collective pursuit of sustainable water management.

Following are some recommendations and suggestive activities:

a. Use of advanced remote sensing and metering technologies

b. Use of open access global and regional databases reduce costs and make it easier to share information

c. Actively engage stakeholders in accounting and auditing processes as it contributes significantly to the accuracy, relevance and adoption of water auditing findings, outputs and recommendations.

d. Treat water auditing as a cyclical learning and information sharing process to keep a check on the process efficiency and infrastructure[5]

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