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Sustainable water resources in drinking water development and trends

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Abstract
"Water Resources and Sustainable Development," highlighting the pressing need of environmentally responsible water resource management in view of rising demand, the effects of climate change, and pollution. This issue explores the complex interplay between water availability, quality, and use, as well as the socioeconomic factors that influence these factors. It emphasises the need for new, well-rounded approaches that address the needs of society, the economy, and the environment. Hydrochemical property and water quality comprehension, anthropogenic impact evaluation, water resource management strategy, and technological innovation application are the four main foci of the research presented in this Special Issue. All of these studies add up to a better understanding of sustainable development and water resources, and they highlight how important it is to keep researching this area. Looking forward, these editorial highlights the significance of continuous research and development in these critical areas, with an emphasis on gaining a better knowledge of the consequences of climate change, reducing the effects caused by humans, improving water management practices, and making the most of technology advances. Prompting global efforts to achieve comprehensive water security and sustainability is its main goal.

Keywords: Water resources, management, climate change, human activities

Introduction

According to the United Nations General Assembly, "sustainable development is development that meets the needs of the current generation without compromising the opportunities of future generations to meet their needs." The 2030 Agenda for Sustainable Development has the Sustainable Development Goals, which are an essential component of it. Further information was provided about the notion of sustainable development, including the identification of precise targets for each objective and the framework for implementing these goals.

Figure 1 displays the entire number of Sustainable Development Goals (SDGs), which is 17. The provision and sustainable administration of water and sanitation, the focus of this study, are two of these factors that are crucial to sustainable development. Assuring access to and sustainable management of water and sanitation for everyone is the sixth aim, which is strongly connected to the goals of infrastructure, cities and human settlements, and climate change.

Rapid urbanisation and the expansion of cities are happening right before our eyes, and sometimes people don't stop to think about how these changes will affect the environment and space-time continuum. This is because more water is drawn down from the sky as surface runoff in urbanised regions with residential structures and paved or asphalted surfaces. This growth is caused by a rise in the leakage ratio, which is directly related to the pattern of land use. When it comes to natural surfaces, it's little (0.15-0.35), but when it comes to artificial surfaces, it's greater (0.90-0.95 for asphalted surfaces and roof surfaces). So, urban areas experience flood waves from precipitation that are both much bigger and concentrate for much shorter periods of time.

If water infrastructure facilities (such as river control, water supply and sewage systems, drainage, and irrigation systems) are not expanded in tandem with urbanisation, then river floods will become more common in urban areas. These issues, together with the effects of global warming as shown by more intense rainfalls, are now pressing concerns on a national and international scale. Accordingly, this research article aims primarily to demonstrate the difficulties encountered by capable policymakers and planners when tasked with the management of water resources. By examining the urban portion of the city's water usage from every angle, including potable water, water supply, wastewater, flood protection, and irrigation, this case study aims to examine the extent to which the sustainability goals pertaining to the management of water resources have been implemented in Gostivar.

In light of the new realities, both scientists and people are realising that water resource management must be sustainable if we are to achieve sustainable development. Up until recently, only water engineers were tasked with managing water resources. Water, however, is a community good, and its preservation is the shared duty of all citizens. It is time to set new standards that will allow for the sustainable management of water resources; for a long time, those in charge of these resources have used a variety of methods to benefit humans, such as constructing infrastructure, regulating river flows to prevent floods, and constructing power plants.

Literature Review

Mrs Sasmita Mohanty et.al (2023) [1] Water shortage, water contamination, and ineffective use of water resources are complicated problems that India is trying to solve. Sustainable water management strategies are being widely acknowledged as important. We provide a synopsis of the main points of sustainable water management in India in this post. The country's water supplies are under more stress than ever before due to its varied climate, growing

population, and fast urbanisation. Reforms to policies, new technologies, community involvement, and strong infrastructure development are all necessary to solve this problem. Improvements in water usage efficiency, conservation efforts, and the revitalisation of bodies of water are the goals of government programs like the National Water Mission. Reducing the massive water impact of agriculture requires sustainable agricultural methods such as watershed management and precision irrigation. Smart water technologies, such as rainwater collecting and efficient wastewater treatment systems, are being used more often in urban areas to reduce the strain on freshwater supplies. To cultivate a water-conscious culture, it is essential to engage the community, launch awareness initiatives, and educate people. Strict laws and joint efforts are required to address ongoing challenges, such as water conflicts between states and industrial pollution. In order to achieve sustainable water security in the face of changing climate and increasing needs, India must embark on its water management journey with a combination of governmental measures, technology developments, and public participation.

Odangowei Inetiminebi Ogidi (2024) [2] A plentiful and vital resource, water is essential for all forms of life on Earth and has a pivotal role in humankind's economic and social development. Population expansion, urbanisation, industrialisation, and agricultural innovations have all contributed to a dramatic rise in demand for it, especially in the South of the world. About 80% of the total water requirement is for irrigation, whereas just about 10% is for home use. So, water use is growing faster than the population is. Additionally, water availability varies greatly from season to season and year to year. Additionally, agriculture, which uses the most water of any industry, is no longer benefiting from the current trends. This is because both commercial and domestic water use are on the rise. Therefore, a difficult situation will most certainly emerge soon to meet the essential water needs of people and animals while reducing environmental damage. Sewage water is discharged directly into rivers, lakes, and coastal waterways at a rate of 90%, which is a major cause for worry since it reduces the availability of potable water. In order to improve water resources and efficiently manage their use in emerging nations, a clear and all-encompassing plan is required. It is critical to execute all-encompassing plans to increase the production and value of water in the Global South. Groundwater recharging and runoff harvesting are two aspects that should be considered when evaluating the water balance as part of these techniques. Furthermore, public knowledge may help manage water consumption according to sensitivity and requirement. The treatment of wastewater and the subsequent reuse of cleaned water are two more important water uses that must be encouraged.

Grace K C Ding et al (2017) [3] Everyone needs water to stay alive, yet it's a limited supply. Freshwater supplies have been steadily declining, and certain parts of the globe are experiencing serious water scarcity as a result. Rapid population expansion and urbanisation have worsened the water scarcity, which is exacerbated by climate change's effects on precipitation patterns and amounts. Consequently, there is a critical water scarcity that both humans and the ecosystem must contend with. To ensure continued economic development for present and future generations, sustainable water management entails boosting water supply and controlling our use of freshwater in a manner that doesn't deplete it. The current condition of water resource management, including the development of indicators to detect water shortage on a global scale, is the focus of this article. Sustainable water management at the community size is discussed in this article, along with case studies that illustrate the many technologies that have been created for this purpose.

Dinabandhu Samanta et.al (2024) [4] The production of food is dependent on water, which is why it is considered an essential resource for farmers. Urgent and sustainable water management methods are especially needed in the agricultural environment in light of challenges like water shortage, which are worsened by urbanisation, population increase, and climate change. We must address the impact of climate change on water supply and quality by implementing integrated water management strategies. An essential strategy for conserving water and ensuring its quality for future generations is sustainable water management. Sustainable water management in agriculture may be enhanced via the use of cutting-edge irrigation technology, agronomic methods that save soil moisture, rainwater collection, and water quality control procedures. But getting to sustainable management isn't easy. Major challenges include a lack of knowledge, regulatory gaps, socioeconomic conditions of farmers, and a number of technology limitations. But there are a number of integrated and comprehensive methods that are paving the way. Sustainable water management in agriculture has the potential to improve water security, strengthen food sovereignty, and make agricultural systems more resilient and sustainable globally.

Michelle C. Hamilton et.al (2014) [5] The goal of this working group at the NATO conference on Sustainable Cities and Military Installations was to develop new ways to manage water resources, and the results are presented in this chapter. This chapter highlights various topics related to sustainable water resource planning. These include: (i) the idea of water, energy, and materials being combined to form a net zero; (ii) using risk, uncertainty, and future scenarios as various planning criteria; (iii) interactions on different scales, both spatial and temporal; and (iv) applying the second law of thermodynamics to ecological systems.

Sustainable Development and Water

The goal of sustainable development is to improve people's lives in all aspects of society, including the economy, ecology, and social cohesion. Effective management of water resources is fundamental to sustainable development since water is essential to all forms of life. Various techniques and tools may be used to achieve this goal.

Making clean water and sanitation accessible to everyone by 2030 is the sixth of the seventeen Sustainable Development Goals. This objective is interdependent with other objectives that are fundamental to human existence. If carried out correctly, they ensure that everyone has access to clean water, good sanitation, and hygiene practices, as well as better water quality, far more efficient use of water, preservation of ecosystems connected to water, and integrated management of water resources at all levels. Within three years, 59% of all household wastewater was securely treated, thanks to the work made on target 6. A high likelihood of future water shortage is indicated by 22

nations with water stress levels exceeding 70%. Nearly half of the world's 157 nations have adopted some kind of integrated water resource management. However, there are still far too many people who do not have access to clean water and proper sanitation.

The European Water Framework Directive (WFD), a strategic framework for sustainable water resource management in metropolitan areas within the European Union (EU), came into effect in 2000. "The WFD lays out a plan for the EU's water management and protection". Each European country's river basin management plan is a part of this framework, which aims to enhance and safeguard the environment while also improving people's quality of life. In order to accomplish the objective of sustainable water management, the member states of the European Union (EU) need to work together and share best practices. The European Water Policy's WFD is based on the following principles: managing river basins; ensuring that all waterways are in excellent condition by a certain date; setting fair pricing; including the public; coordinating actions; and protecting all waters, surface waters, and groundwater. These regulations have been supplemented throughout the years by four more that aim to "ensure the good status of Europe's waters": The Urban Waste Water Directive, the Bathing Water Directive, the Nitrates Directive, the Drinking Water Directive, and the Floods Directive.

Implementation of sustainable management of water resources in r. of n. Macedonia

This section uses Gostivar as an example to examine the actions and policies implemented in R. of North Macedonia to ensure the long-term viability of the city's water supply. Additionally, the issues and potential remedies are detailed. A framework for the conservation and sustainable management of water resources is guaranteed by the Law on Waters (2013) in the Republic of Macedonia. Each of the six ministries—the Ministry of Environment and Physical Planning, the Ministry of Transport and Communications, the Ministry of Agriculture, Forestry and Water Economy, the Ministry of Economy, the Ministry of Education and Science, the Ministry of Health, and the Republic Institute for Health Protection—is responsible for certain tasks and has the authority to make decisions in these areas.

The National Water Strategy of RM (2012), the Master Plan for Water (unfinished), and River Basin Management Plans (only part of these plans have been created) are the major strategic documents for SDG 6, which control and address all of the goal's aims.Following an examination of the policies put in place to achieve the goals in the Republic of North Macedonia, it has been determined that the aims of goal 6 now provide a challenge to the country. Despite the existence of prioritised plans and strategies that align with SDG 6, there is no assurance that specific goals will be met,

In its evaluation of water sector progress, the EU Country Progress Report for Macedonia (2018) notes the following: the development of specific implementation plans for the Urban Waste Water Treatment and Drinking Water Directives; the creation of a national investment program for the water sector; the development of river basin management boards; and the implementation of the new pricing methodology, based on full cost recovery, in municipalities with more than 10,000 inhabitants. Efforts need to be made to decrease water that does not generate money, improve enforcement and cooperation across institutions, and bring groundwater and water quality standards in line with the Nitrates and Bathing Directives, which are also in the early stages of translation. Much of Macedonia's plan to achieve SDG 6 is also a prerequisite for the Republic of North Macedonia to join the European Union.

Drinking Water Development, Trends and Coverage in Developing Countries

Background information on water resources, trends, and coverage in the world's drinking water supply is the goal of this chapter. Educate the audience on the fundamentals of the water supply industry's jargon and practices. Determine why it's critical for underdeveloped nations to have easier access to water. Focusses on a few major points in the worldwide plan to improve water infrastructure. In addition, the water sector's stakeholders and their duties will be highlighted, the water supply financing mechanism will be discussed, and the obstacles to expanding access to drinking water and the difficulties in building, operating, and maintaining current facilities in sub-Saharan Africa will be examined.

Global water resource

Among the most precious commodities on Earth is water. All living things, from plants to animals, need it. Figure 1 shows that the oceans comprise 97% of the Earth's saltwater and that just 3% of the water on the surface is freshwater. In terms of freshwater storage, 68.7 percent is in icebergs and glaciers, 30.1% is in groundwater, 0.3 percent is accessible on the surface, and 0.9 percent is in other places. The majority of the world's surface water is located in lakes, with a small percentage in bogs and rivers (2%).

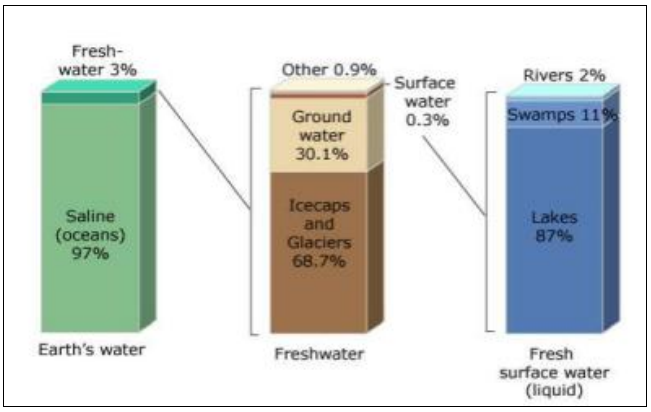

Fig 1: Distribution of earth water resources (Source: Gleick, 1996)

Global freshwater demand

Worldwide, 70% of freshwater supplies are used for agricultural purposes, 20% for industrial activities, and a meagre 10% for household usage (UN-Water, 2016). In terms of the damage it might do to society, the water problem is the top global risk (World Economic Forum, 2015). On the other hand, emerging nations' increasing demand has driven freshwater withdrawals up by about 1% year worldwide since the 1980s (Gleik, 2000). From an estimated 3.6 billion in 2011 to 6.3 billion in 2050, the number of people living in urban areas is expected to almost double, as per (UN DESA, 2011). There will likely be an additional 3.3 percent growth in the global population from

7 billion in 2011 to 9.3 billion in 2050. As a consequence of this change, freshwater supplies throughout the world will be under more pressure than before. Consequently, there is a pressing need to address both the increasing demand for drinking water and the need to do so in a sustainable manner, as the global population continues to expand.

Milestones in global water supply development agenda

There has been a concentrated push to expand access to water supplies across the world over the previous half-century. In order to attain universal coverage, water sector stakeholders on a national, regional, and international scale have formulated policies and established institutional frameworks. A number of national, regional, and worldwide declarations, resolutions, and policies have been draughted to promote better access to clean drinking water on a global scale. Even while the world has come a long way, some are worried about the long-term viability of the facilities that have been built, especially in poorer nations.

Financing water supply

Factors such as water resource availability, historical legacy, official coverage of water services, and the degree to which services are decentralized determine how water supply funding differs from nation to country (Trémolet and Rama, 2012). According to GLAAS (2014), there is a general division between public and non-public sector finances when it comes to water funding (See Table 1.). The investment and flow of funds for water service delivery

Table 1. Water supply funding mechanism

Public sector financing agents	Non-public sector financing agents
• National authorities • Regional authorities • Local authorities • Public • Regulators	• Bilateral and multilateral donors • Private providers • NGOs • Community-based organizations • Households

Importance of Drinking Water Supply

Ensuring that everyone has access to clean water for drinking has been a long-standing objective of international development. There is strong evidence connecting better water infrastructure with broader goals of ending poverty, improving health and nutrition, boosting education and gender equality, promoting sustainable economic growth, and improving sanitation and hygiene (United Nation, 2014). Improved water supply has far-reaching effects on people's health and quality of life, as discussed in Sections 2.7.1-2.7.5.

Health benefits

Poor water and sanitation conditions are associated with up to 80% of infections in many underdeveloped nations (UN, 2003). According to estimates made by UNEP and UN-HABITAT in 2009, water-related diseases account for half of the world's hospital beds. Jefferson *et al*. (2009), Luby *et al*. (2005), and Rhee *et al*. (2008) found that there was a significant decrease in newborn mortality and acute respiratory infections when people had access to decent water facilities. Better sanitation and hygiene may limit the spread of water-borne infections, according to research by Cairncross and Valdmanis (2006). Curtis & Cairncross (2003), Fewtrell *et al*. (2005), and Clasen *et al*. (2007) found that practices including hand washing, sanitation, water treatment, and safe drinking water storage may lower diarrhoea rates by 30–40%.

Providing a safe water supply, as shown in Figure 2, may enhance hygiene and sanitation, which in turn can reduce the likelihood of illness and infections. Everyone needs access to clean water for drinking, cooking, and personal hygiene. However, there are serious health hazards associated with insufficient water supplies due to factors such as poor quality or accessibility, unreliability, high costs, or complex management. According to Hunter (2010)

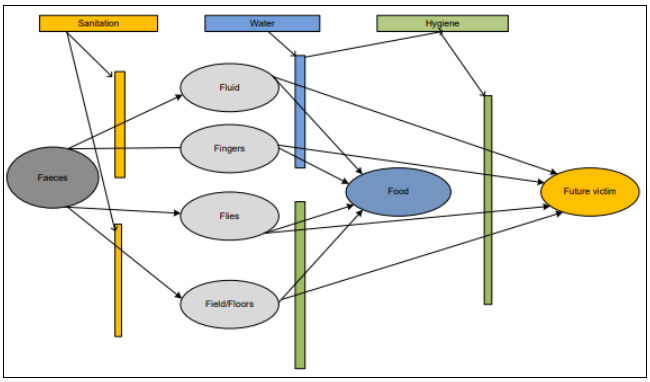

Fig 2: Faecal oral transmission route

The World Health Organisation (2014) reported that due to improvements in maternal health, care for newborns, and a decrease in cases of diarrhoea, millions of children have been spared the premature death and illness caused by water-borne diseases and malnutrition. Additionally, adults nowadays enjoy longer and healthier lives.

Improved general wellbeing

Reducing the time spent gathering water and resolving the health issues caused by insufficient water supply, sanitation, and hygiene would have a significant effect on the lives of the world's poorest and most marginalised people, according to Barbara (2014). A lack of clean water and proper sanitation may make women feel bad about themselves and give them little hope, according to a UN-Water assessment called the Global Assessment and Assessment of Sanitation and Drinking-Water (GLAAS) (GLAAS, 2014).

Conclusion

The BAWRA model has been used to estimate the best way to manage integrated water resources. It takes into account (a) the amount of water available in the Brahmani River basin and eight sub-basins (Tilga, Jaraikela, Panposh, Gomlai, Rengali, Samal, Jenapur, and Delta) as well as the water demand from different sectors, such as irrigation, households (both urban and rural), industries, and the environment. The Brahmani River Basin and all of its sub-basins show encouraging outcomes.

The user is given the opportunity to evaluate cautious estimates of water availability (supply) and maximize the usage of water demand for diverse purposes by means of the model's efficiency and coefficients. By adjusting the coefficients, the model may be applied to other basins and simplified when certain variables are removed. Alternate futures may be imagined by expanding agricultural,

industrial, and household sectors, together with their corresponding needs. Using factors including terrain, land use, soil, and more, satellite data was useful in identifying areas that may support agricultural, industrial, and urban/rural growth. Data derived from NDVI research shows that there is now a scarcity of arable land and rabi crops. Thanks to the model, we now know what factors contribute to lowering manufacturing costs and boosting benefits, and we've been able to utilise that knowledge to our advantage. In order to boost agricultural output, aquaculture, and industrial growth, the Brahmani River basin must implement integrated water resources management. As things are, the idea of consumptive usage is nonexistent, and relatively little water is being used for various reasons.

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