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REVIEW PAPER

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A STUDY OF RAINWATER HARVESTING FOR SUSTAINABLE WATER RESOURCE MANAGEMENT IN NAGALAND, NORTHEAST INDIA – A REVIEW

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ABSTRACT

Water is universally perceived as one of the most valuable natural resources. Global warming, changing climatic conditions, and population growth have necessitated more effective planning and management of water resources. Water is critical not only for agriculture, but also for industries and daily household activities. The overall rainfall pattern has shifted dramatically over the last two decades. Individuals, communities, industries, and governments occasionally faced uncertainty due to the heavy reliance on rainfall. It affects the socioeconomic environment, consumption patterns/capacity, and job creation, among other things. Countries such as Israel have succeeded in making optimal use of their water resources. Water scarcity results in drought, while an excess of water results in flood-like conditions, resulting in human and economic losses. Due to imbalanced rainfall, conventional water sources such as wells, rivers, and reservoirs are insufficient to meet water demand. As the rainwater collection system investigates a new water source, it can be viewed as a tool for managing water resources effectively. It places a premium on water storage and utilisation in a systematic and scientific manner. The purpose of this study is to determine how rainwater harvesting can contribute to sustainable water resource management in Nagaland by meeting diverse requirements and overcoming water-related challenges.

Key words: sustainable water resource management, rainwater harvesting, Nagaland, water management

INTRODUCTION

Water is critical for feasible watershed development and the protection of all natural resources; water plays an extremely vital role in people's lives. Water's presence or absence clearly dictates a community's way of life and development, as well as a healthy economy. People have considered water as a resource that may be used without limit for many years. Consequently, many individuals do not consider or limit their water consumption. This perspective is severely problematic and must be modified: The demand for water should be regulated, and individuals should utilise water sparingly. Rapid growth, unsustainable development, the consumption of natural resources, and climate change have all contributed to the depletion of the region's water resources, as well as the loss of biodiversity and ecosystems. In India, rain is the only natural source of fresh water. Generally, the percentage of total rainfall that recharges ground springs ranges between 5% and 20%. This is dependent on the territory, the soil's condition, subsurface development, and rainfall patterns, among other factors. The total amount of fresh water available on the planet far outweighs human interest.

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In any case, numerous regions throughout the world are perpetually water-scarce. Not long ago, it was believed that water was abundantly available in a portion of the flowing water-scarce areas. Water scarcity occurs for a variety of quantitative, subjective, and qualitative reasons (Bhattacharya, 2015). Quantitatively, the available water is not similarly appropriated. As a result, there are concerns about water being delivered in the wrong location, at an inopportune time, and in the wrong quantity. Low-quality freshwater limits its beneficial uses, resulting in scarcity. For example, water for consumable purposes is also required, and certain mechanical applications require the highest quality, though peripheral quality water can be used exclusively for irrigation purposes. Indeed, even irrigational water use persists when salinity exceeds the allowable limits of agricultural harvests. The growing population, combined with intensified urbanisation and industrialisation, has a quantitative and subjective effect on freshwater availability. A larger population increases quantitative interest in freshwater. Urbanisation and industrialisation contribute to the deterioration of freshwater's natural state through the release of toxins, jeopardising quantitative accessibility. Water resource managers and water-use organisers on numerous sides of the world have extended that in the following 20 years, the complete accessibility of freshwater will miss the mark regarding needs if the current trend continues unabated. The Central Water Commission has assessed India's total yearly surface run-off as 188 million hectare meters (M ha·m). In any case, just 36% (68 M ha·m) of the total run-off is used because of geographical restrictions and the current situation with innovation to bridle water sources economically. Notwithstanding the surface water sources, as indicated by the Central Groundwater Board, the utilisable groundwater is around 45 M ha·m. Accordingly, the nation's total annual utilisable water asset is assessed as 113 M ha·m (Singh, Singh & Devi, 2018). Representation of a rooftop rainwater collection configuration in its ideal state, depicted in Figure 1.

While the quantitative accessibility of the country's freshwater remains genuinely steady, the interest in water for different formative purposes like drinking, industrial, irrigation and so forth is on the ascent. The interest during the year 2000 (75 M ha·m) has been well inside the accessibility. However, the Ministry of Environment and Forests' projection shows that the yearly interest will increment to 105 M ha·m constantly in 2025. This implies that from the second quarter of the current century, not just that all accessible water assets of the nation should be used; however, new sources likewise must be identified to stay up with the expanding request. If sufficient and suitable water asset methodologies are not detailed, the declining accessibility of utilisable freshwater sources may weaken all future developmental endeavours of the country. Subsequently, the solitary alternative is to reap and monitor this valuable endowment of nature by logically planned water-reaping structures. Rain-

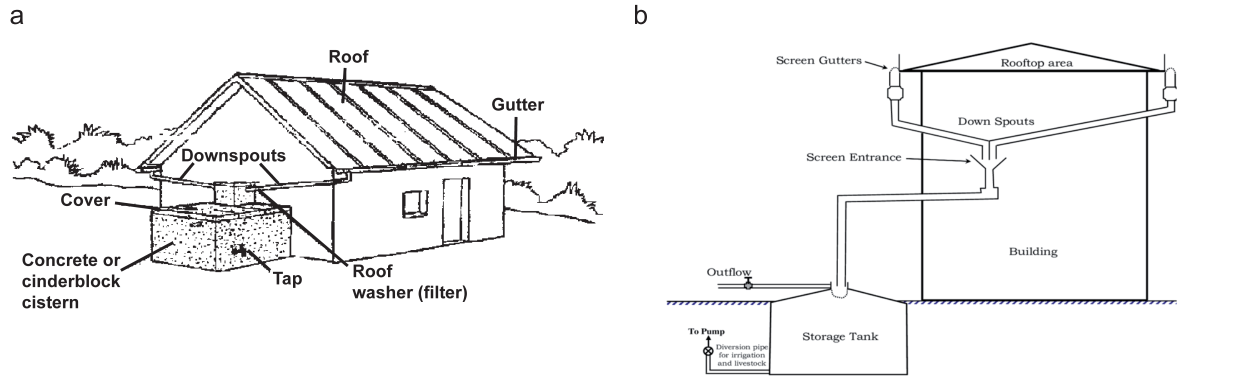

Fig. 1. Schematic diagram of a rooftop rainwater harvesting structure (a) in its ideal state (b)

Source: Chowdhury, Ray, Meena, Namei and Deka (2016b).

water harvesting is the craft and science of collection and productive usage of overflow from housetops and ground surfaces, just as from intermittent watercourses (Hiese et al., 2011).

Rainwater harvesting, however, a well-established practice, is arising as another worldview in water asset advancement because of the new endeavours of both government and non-legislative associations to advance water collecting and groundwater recharge in urban and rural regions. The principle of rainwater harvesting is to monitor water where it falls as per needs and geophysical conditions. Rainwater harvesting (RWH) can be done at the individual household level and at the community area level in both metropolitan and country territories. At the family level, gathering should be possible through rooftop catchments and at the local area level through ground catchments. Contingent upon the amount, area and proposed use, harvested rainwater can be used quickly or after capacity. Other than as a water supply, RWH can be established with flood control and soil erosion control goals. As per recent examinations by Assam State Public Health Engineering Department (PHED), the groundwater table has not been extraordinarily influenced by the ebb and flow of drought; later, there are possibilities of significant exhaustion. Also, researchers are occasionally giving alerts that the groundwater table has fallen every year in the northeastern urban areas in view of the great groundwater extraction. Several urban settlements from various states of the northeastern area are, as of now, confronting an extreme shortage of consumable water. Against this scenery, rainwater harvesting gives off an impression of being a solitary arrangement that could give some relief. The practice of rainwater harvesting in lakes and reusing the stored water for life-saving irrigation of crops and, furthermore, for domestic purposes has been predominant in India since ancient times (Chowdhury, Ray, Kumar, Meena, & Rajkhowa, 2016a). One can discover effective water administration in the region in traditional farming systems like the ʿZabo arrangement' of the Nagaland (Fig. 2) and bamboo trickle water system of Meghalaya (Fig. 3), and rice and fish cultivating in the Apatani Valley of Arunachal Pradesh (Fig. 4).

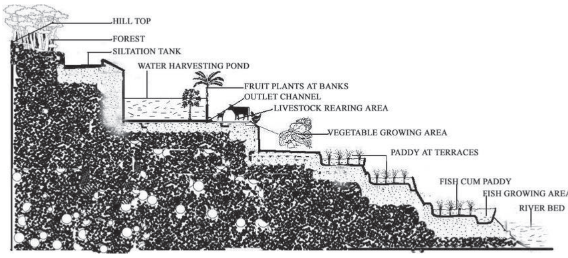

Fig. 2. ʿZabo arrangement' of the Nagaland

Source: Singh, Singh and Rajkhowa (2012).

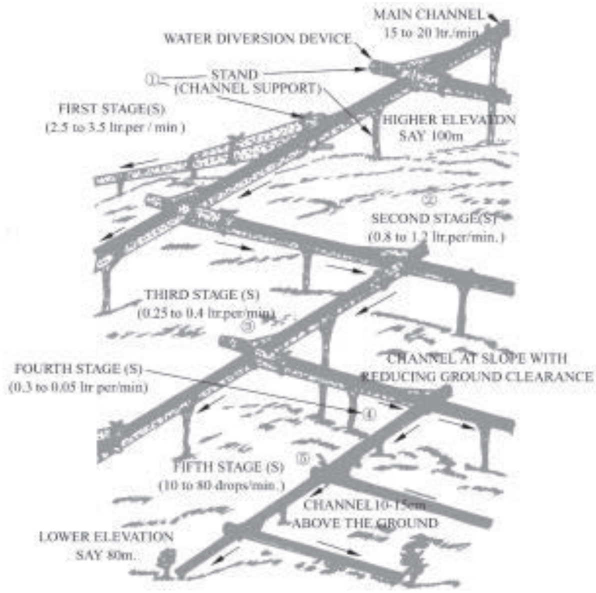

Fig. 3. Bamboo trickle water system of Meghalaya

Source: Borthakur (1992).

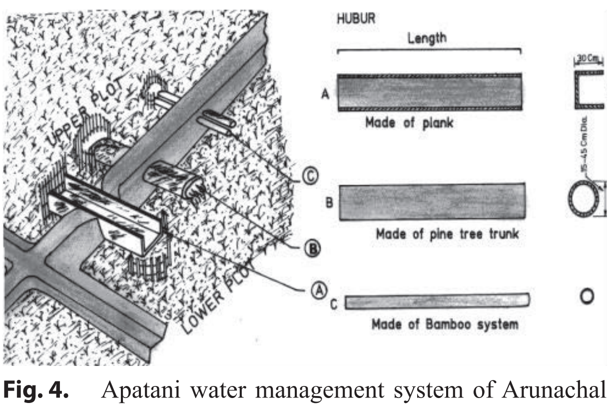

Fig. 4. Apatani water management system of Arunachal Pradesh

Source: Singh (1999).

Practically every one of the realms had lakes, and so forth around their castles for security, a water system, fishery, and recreation. It is a typical scene in Tripura, Manipur, Assam, and different states, particularly in fields where each family has, at any rate, one ranch lake. Water from such lakes is the existing line for their everyday exercises like homegrown uses, cleaning, limited scope water system, and drinking purposes. By carrying out the current study, the researcher aims to understand the rainwater harvesting practice followed in Nagaland for the purpose of sustainable water resource management.

OVERVIEW AND PURPOSE OF THE ARTICLE

An investigation is underway in Nagaland, North East India, to examine rainwater harvesting for sustainable water resource management. This aims to close the gap between demand and sustainable water resources by enhancing sustainable resources. The linchpin of this would reduce demand and facilitate the development of new water technologies likely to improve the sustainability of water resources. To learn more about the role that rainwater harvesting can play in the long-term management of water resources. An evaluation of the rainwater harvesting methods and techniques used in Nagaland for long-term management of the state's water resources. Rainwater harvesting impacts Nagaland's water resources and its relevance for long-term planning.

RAINWATER HARVESTING GROWTH

The North Eastern Region of India, involving the territories of Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Tripura, and Nagaland, is a colossal rambling landmass comprised of innumerable broad slopes and precipitous landscapes that ascent in the north to snow-covered statures of the Himalaya and is the jungle gym of the strong stream the Brahmaputra – viewed as probably the biggest waterway of the world and its feeders. According to the findings of Chowdhury et al. (2016a), where the researchers explored the different techniques of rainwater harvesting, the locals of Kikrüma town in the Phek area of Nagaland have received a strategy for harvesting rainwater predominantly for the water system of paddy fields and furthermore for use as a wellspring of drinking water. The framework is to harvest water in water-gathering lakes built locally, and tap the run-off water through channels. The technique is basic; however, it is exceptionally effective. The method includes the development of a channel corresponding to the slope. This training has had wide exposure since numerous spaces covered under the framework are by the side of highways. All the locals have trailed the system for as long as 150 years (Ngachan, 2011). The water resources of Nagaland contain mostly three hydro-meteorological systems, for example, (1) surface water regime; (2) groundwater regime and (3) rainwater system. Rain is the solitary everlasting resource that is in acceptable measures. India gets a sufficient measure of precipitation yearly through the four distinct sorts of climate wonders, viz., southwest monsoon (74%), northeast monsoon (3%), pre-monsoon (13%) and post-monsoon (10%). India's average rainfall is 1,170 mm, yet it changes individually from 100 to 12,000 mm in western deserts toward the upper east area. In a year, usually, over half of the precipitation happens in around 15 days and under 100 h. There may be only about 5 rainy days in deserts and up to 150 rainy days in northeast India. Harvesting rainwater is divided into two major categories, as shown in Figure 5.

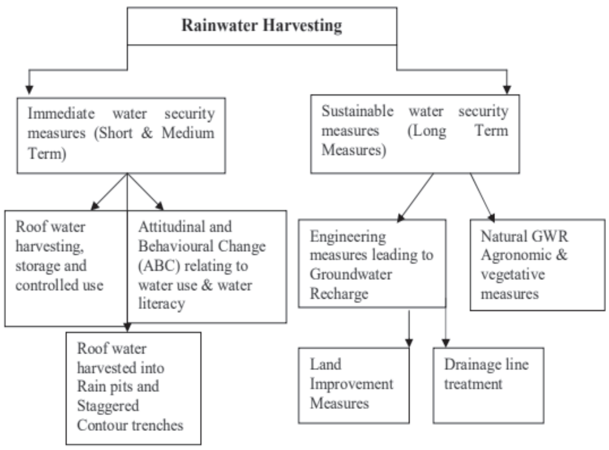

Fig. 5. Harvesting rainwater grouped into two major categories

Source: Ngachan (2011).

The rainfall distribution is generally lopsided and differs broadly. The information on complete precipitation and its circulation over time is significant for effective farming planning of space. Water is the absolute most significant possible wellspring of soil dampness for agribusiness. For agricultural purposes, water is the most important source of soil moisture. Slopes, where only 10% of the land area is covered by an aquatic system and harvest yields are entirely dependent on rainwater harvesting, may use precipitation as the deciding factor in the success of downpours that take care of agriculture. The North Eastern Region is the highest rainfall zone in the country. The yearly variety in precipitation is wide, starting with one spot and then onto the next and its span is most uncertain (Zhimo, Imchen & Rawat, 2018).

NECESSITY OF RAINWATER HARVESTING

Water is a natural necessity and, furthermore, of extraordinary economic importance. Water assets are at the core of sustainable development. Appropriate preparation for the advancement, and ideal usage of water assets has principal significance for socio-ecological advancement, which can give a premise to dynamic supportable economic growth. Regardless of the way that Nagaland is supplied with sufficient water assets like springs, enduring streams, and groundwater springs, the state is confronting danger because of a shortage of fresh water. Considering the consistently developing interest, water – a limited asset – will become a significant restricting component in the financial turn of events, except if an early move is carried out. The seriousness of the situation calls for the most elevated need to be given to the advancement and the executives of water assets in Nagaland. Although Nagaland is honoured with such abundance ordinarily, accessible water is not saddled and used productively. The reasons credited to these gaps might be diverse. The circulation of water has not had due consideration previously.

The burdening of water resources has become a significant problem. The growing demand for new water and competing demands for water supplies in densely populated areas are crucial concerns for the majority of Nagaland. Water, the executives, is most likely the greatest test for meeting the daily freshwater needs of rural and urban residents in Nagaland by providing a safe water supply of the optimum quality and quantity. We need an effective, trustworthy water supply framework to be carried out by embracing innovation just as guaranteeing the quality and craft, proficiency and satisfactory site examination and circumstance evaluation, appropriate and proficient plans and arranging, legitimate establishments, development and management are the fundamental standards to be managed all the more circumspectly in the days to come to convey forward the status of rural and metropolitan water supply areas to a superior one. The accessibility of surface water as streams joined with mountainous topography has offered incredible possibilities for the water system and the generation of hydropower in Nagaland. Hydropower is one of the significant frameworks for monetary improvement whose potential has not completely been exploited in the state. The water from the repositories/dams and downstream of the dams can be utilised for a huge and limited water system scope. Advancement is innovation-driven, and power is the premise of all innovation. The current force age in Nagaland is unimportant, i.e., just 1.39% of its all-out prerequisite. The state is in dire need of progressive foresight, effective management, and optimal utilisation of water resources. The geographical location of the study area is demonstrated in Figure 6.

The practice of collecting water in lakes and recycling the stored water to preserve the water system of crops and, additionally, for homegrown produce, has been widespread in India since ancient times. One can discover productive administration of water in the upper east locale in a conventional cultivating framework like the Zabo system of Nagaland. In Nagaland, where the water system area is poor, water gathering can become viable innovation for inspiring the financial states of individuals, which is vital for the development of agriculture. The improvement of feasible, confined water system offices that defend natural and social concerns and the presentation of ecologically stable and practical techniques. Past investigations show that means agribusiness on slopes could be effectively changed into a benefit-acquiring undertaking by tapping and using water resources. Rainwater harvesting is not being utilised at all for groundwater

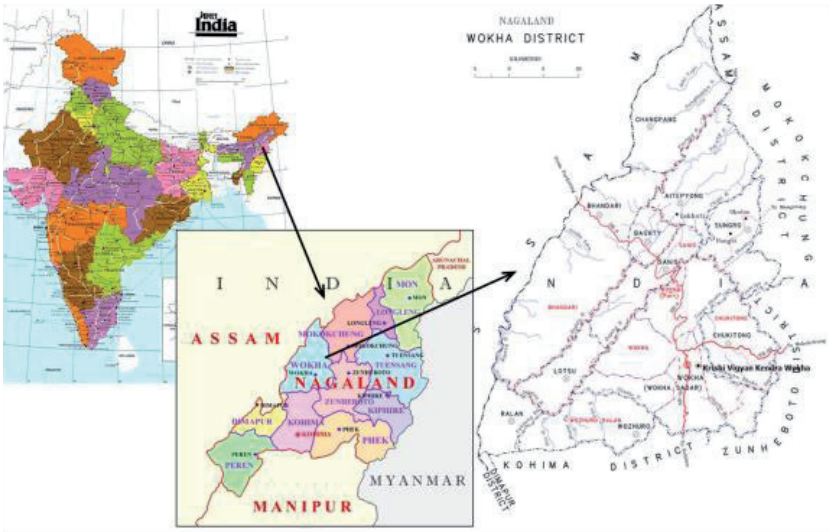

Fig. 6. The study area's geographical location

Source: Singh et al. (2018).

recharge because of an absence of attention to groundwater assets, furthermore, it is significant in Nagaland. The current land use in Nagaland and its administration over recent years have concerned the issues of ecological corruption coming about in diminishing profitability of land as well as its continuous obliteration by floods, avalanches, sped-up disintegration and decreasing water assets. Freshwater is a scant asset for improving personal satisfaction (Jatiyai & Hosokawa, 2004).

RAINWATER HARVESTING SYSTEM CHARACTERISTICS

The availability of water resources, management, and distribution of people, families, and networks among various user groups is significant. Rainwater harvesting, regardless of the innovation utilised, basically implies reaping and putting away water for long stretches of time for use on lean days. Storing of rainwater should be possible only through (i) storing in artificial stockpiling and (ii) in the soil as groundwater. The former is all the more explicitly called rooftop water collecting and is somewhat an impermanent measure, zeroing in on human requirements giving prompt alleviation from water shortages, while the latter can possibly give practical alleviation from water shortages, tending to the requirements of all living classes in nature. The water or run-off water as a spring or stream can be reaped in RCC/ferro-concrete/plastic/fibre tanks or different kinds of basic lined lakes for use in lean periods.

Studies point out that the locally versatile advances for water reaping can be carried out as a reasonable option in contrast to the regular water system and drinking water supply plans, thinking that any land can be utilised to collect water. The Government and nearby networks must recognise it as a viable measure to battle the issue of tracking down a useful innovation choice for the moderation of dry spells, saving the groundwater holds, blocking soil disintegration, forestalling saline interruption and giving a reliable wellspring of drinking water and irrigation water. In the Zabo system of rainwater harvesting, woodland covers the territory on the ridge, which is the catchment space of water. This territory is not harmed by cutting trees. As this space is incredibly steep, water streams descend and are gathered in water harvesting tanks (Isselhorst, Berking & Schütt, 2019).

Water harvesting tanks comprise a siltation tank and the fundamental stockpiling tank. These are earthen tanks, the lower part of which are slammed and compacted with mud and straw to stay away from drainage with a limit of 300–600 m^3 contingent upon the catchment territory. Beneath the timberland cover, siltation tanks are available. Soil and natural issue gather in these tanks before the water enters the principal tank. These tanks are refined yearly, and the natural issue is utilised in the paddy field to increase fertility. These advances are easy to introduce and work with. Nearby individuals can be prepared effectively to carry out such advances, and development materials are promptly accessible. It is advantageous as it gives water at the mark of utilisation, and relatives have full control of their own frameworks, which extraordinarily decreases activity and support issues (Kithan, 2014). Albeit provincial or other local factors can adjust the neighbourhood climatic conditions, water can be a consistent wellspring of water supply for both rural and poor areas. The feasibility of rainwater harvesting in a specific area is exceptionally subject to the sum and intensity of rainfall. Different factors, like catchment territory and the kind of catchment surface, for the most part, can be changed by household needs. Rainwater harvesting seems, by all accounts, to be quite possibly the most encouraging option for providing new water despite the expanding water shortage and heightening requests in the metropolitan and rural areas. The pressures on rural water supplies, more prominent ecological effects related to new tasks, and expanded resistance from NGOs to the improvement of new surface water sources, just as disintegrating water quality in surface repositories previously built, compel the capacity of networks to fulfil the need for fresh water from customary sources, and present a chance for expansion of water supplies utilising technological interventions (Sreeja Mole et al., 2021).

CONCLUSIONS

The conclusions drawn from this study are as follows:

– Although the North Eastern Region of India is characterised by heavy precipitation, the concentration of precipitation is primarily confined to the months of May through September.
– Due to the hilly terrain, the majority of precipitation is lost as run-off, and significant soil erosion also occurs.
– These spatial and transient varieties in water assets accessibility present incredible difficulties for putting away and directing the utilisation of the water resources in the region. There is no itemised logical assessment accessible yet for Nagaland's water resources.
– The paper examines the water resources of the examination region upheld with the difficulties and openings for water collecting to accomplish a feasible turn of events. There is no logical assessment yet for the water resources of Nagaland.
– The various indigenous soil and water conservation techniques developed in the region (in some pockets) by the indigenous population are based on local conditions and resources. They have existed in the region since the beginning of time and are socially accepted and adapted to local conditions.
– The current work will fill the gap in the water resources assessment with respect to the topic of rainwater harvesting.
– This work will likewise work with productive security, development, planning, management and wise use of water on an environmentally sustainable basis to serve all individuals of North East India and Nagaland specifically.

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Authors' contributions

Conceptualisation: L.H. and D.S.V.; methodology: L.H.; validation: L.H. and D.S.V.; formal analysis: L.H. and D.S.V.; investigation: A.S.; resources: A.S.; data curation: A.S.; writing – original draft preparation: Y.Y.; writing – review and editing: A.S. and D.S.V.; visualisation: A.S.; supervision: A.S. and D.S.V.

All authors have read and agreed to the published version of the manuscript.

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STUDIUM DOTYCZĄCE ZBIERANIA WODY DESZCZOWEJ W RAMACH ZRÓWNOWAŻONEGO ZARZĄDZANIA ZASOBAMI WODY W NAGALAND (PÓŁNOCNO-WSCHODNIE INDIE) – PRZEGLĄD

STRESZCZENIE

Ogólnie wodę postrzega się jako jeden z najwartościowszych zasobów naturalnych. Globalne ocieplenie, zmiany klimatu i wzrost zaludnienia stworzyły potrzebę bardziej efektywnego planowania oraz zarządzania zasobami wody. Woda jest czynnikiem krytycznym nie tylko dla rolnictwa, ale też dla przemysłu i codziennych czynności w gospodarstwach domowych. Ogólny wzorzec opadowy zmienił się znacząco w ciągu ostatnich dwóch dekad. Ludzie jako jednostki lub wspólnoty, przemysł i rządy od czasu do czasu stają przed niepewnością będącą skutkiem dużej zależności od opadów deszczu. Skutkuje to między innymi zmianami w środowisku socjoekonomicznym, we wzorcach i możliwościach konsumpcji oraz tworzeniu miejsc pracy. Kraje takie jak Izrael odniosły sukces w optymalizacji wykorzystania swoich zasobów wody. Niedobór wody skutkuje suszami, a nadmiar wody – powodziami przynoszącymi straty ludzkie i ekonomiczne. Z powodu zakłócenia równowagi opadów konwencjonalne zasoby wody, jak rzeki, studnie i zbiorniki, są niewystarczające do zaspokojenia zapotrzebowania na wodę. System zbierania wody deszczowej bada nowe źródła wody, więc można go wykorzystywać jako narzędzie do efektywnego zarządzania zasobami wodnymi. Stawia on na pierwszym miejscu magazynowanie wody i jej zużycie w sposób usystematyzowany i naukowy. Celem artykułu jest określenie, jak zbieranie wody deszczowej może przyczynić się do zrównoważonego zarządzania zasobami wody w stanie Nagaland dzięki spełnieniu różnych wymagań i sprostaniu wyzwaniom związanym z wodą.

Słowa kluczowe: zrównoważone zarządzanie zasobami wody, zbieranie wody deszczowej, stan Nagaland, zarządzanie wodą