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Authors:



Saketh Shetty
AJIET



Sakshi Dhumale



Amba Shetty



Sintayehu Yadete Tola
National Institute of Technology Karnataka

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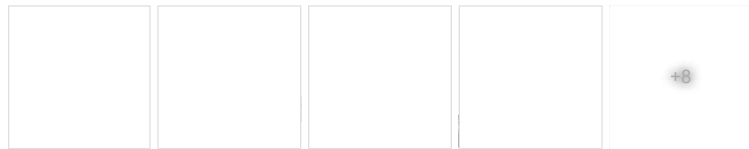
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Abstract and Figures

Groundwater recharge is pivotal in addressing diverse water needs in rural India, like water supply, irrigation, and domestic requirements. A significant amount of recharge happens through lakes. However, minimal research has been conducted to evaluate the status of extinct lakes and their potential contributions to nearby unconfined aquifers. This study aims to bridge this gap by assessing critical aspects of groundwater recharge and investigating the role of an extinct lake in this process. Sixteen strategically positioned monitoring wells facilitated data collection, enabling a comprehensive analysis of the groundwater dynamics. The study revealed a substantial increase in built-up areas from 25.66 to 37.59% between 2004 and 2021. The rainfall-runoff relationship was found to be strong, with runoff levels varying from 703.8 to 3426 mm. Using the Korkmaz method, it was determined that around 48% of precipitation naturally replenishes unconfined aquifers. Soil samples near the monitoring wells have varying hydraulic conductivity values of 77.76 to 570.24 m/day, indicating their suitability for water storage. Lake restoration and bund construction emerge as a transformative intervention, positively influencing consistent water levels in wells, redirecting water flow, and enhancing 16.38% increased crop productivity. This emphasizes the lake's significance in replenishing nearby wells, establishing its crucial role in groundwater recharge. These insights are vital for informed water resource management, particularly in sustaining the region's water and agricultural needs. Understanding and harnessing the potential of extinct lakes emerge as imperative measures for ensuring long-term water security in rural India.

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Study area Schematic diagram of... Location of wells in the lake... Representation study procedur... Land use land cover maps of t...

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Water Conservation Science and Engineering (2024) 9:15
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RESEARCH

Characterization of the Surface Lake and Evaluation of Its Benefits on Unconfined Aquifer Interaction—A Study on Coastal Karnataka Lake, India

Saketh T. Shetty¹ · **Sakshi Dhumale**² · **Amba Shetty**² · **Sintayehu Yadete Tola**³

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Abstract

Groundwater recharge is pivotal in addressing diverse water needs in rural India, like water supply, irrigation, and domestic requirements. A significant amount of recharge happens through lakes. However, minimal research has been conducted to evaluate the status of extinct lakes and their potential contributions to nearby unconfined aquifers. This study aims to bridge this gap by assessing critical aspects of groundwater recharge and investigating the role of an extinct lake in this process. Sixteen strategically positioned monitoring wells facilitated data collection, enabling a comprehensive analysis of the groundwater dynamics. The study revealed a substantial increase in built-up areas from 25.66 to 37.59% between 2004 and 2021. The rainfall-runoff relationship was found to be strong, with runoff levels varying from 703.8 to 3426 mm. Using the Korkma method, it was determined that around 48% of precipitation naturally replenishes unconfined aquifers. Soil samples near the monitoring wells have varying hydraulic conductivity values of 77.76 to 570.24 m/day, indicating their suitability for water storage. Lake restoration and bund construction emerge as a transformative intervention, positively influencing consistent water levels in wells, redirecting water flow, and enhancing 16.38% increased crop productivity. This emphasizes the lake's significance in replenishing nearby wells, establishing its crucial role in groundwater recharge. These insights are vital for informed water resource management, particularly in sustaining the region's water and agricultural needs. Understanding and harnessing the potential of extinct lakes emerge as imperative measures for ensuring long-term water security in rural India.

Keywords Groundwater recharge · Unconfined aquifers · Surface water storage · Runoff · SCS-CN · Hydraulic conductivity · Lake aquifer interaction

Introduction

Lakes and reservoirs cover less than 2% of the Earth's land surface. Despite this relatively small area, they signifi

✉ Saketh T. Shetty
sakethshetty@ajiet.edu.in

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Amba Shetty
 amba_shetty@yahoo.co.in

Sintayehu Yadete Tola
 sintayadete5@gmail.com

- ¹ Department of Civil Engineering, AJ Institute of Engineering and Technology, Mangalore 575006, India
- ² Department of Water Resources and Ocean Engineering, National Institute of Technology Karnataka, Surathkal 575 025, India
- ³ Faculty of Water Supply and Environmental Engineering, Arba Minch Water Technology Institute, 21 Arba Minch, Ethiopia

approximately 90% of the Earth's unfrozen surface fresh water. It also plays a crucial role in global hydrological and biogeochemical processes and is essential for maintaining a reliable source of fresh water for various ecological and human needs. Lakes and reservoirs are often biodiversity hotspots, hosting a wide range of species. The groundwater and surface water, such as lakes, are interconnected within the global water cycle [1, 2]. This means a dynamic water exchange exists between underground aquifers and surface water bodies. Understanding groundwater flow in and out of lakes is crucial for the sustainable management of surface water resources like lakes [3, 4]. This knowledge is essential

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for protecting, developing, and effectively managing water bodies. While it is relatively easy to characterize the inflow of surface water into lakes, understanding how interactions with aquifers affect the quantity and quality of lake water is challenging [5]. Quantitative approaches are necessary to understand the influence of changes in groundwater levels on the flow patterns and hydraulic relationships between lakes and aquifers. These approaches involve measuring and quantifying various parameters and variables [6].

The Indian government has considered lake restoration to solve the country's water scarcity issues. Prioritizing scientific research and lake restoration measures is necessary to address water resources [7, 8]. Arid regions have a more significant number of lakes, but semi-arid areas and humid regions have a greater need to improve their lakes in the Indian context [9, 10]. Water harvesting structure improvement has been practiced in Karnataka for a long time [11]. As per the archaeological and historical records, lake restoration was implemented during the Chandra Gupta Maurya [392–297 BC] period. Karnataka has only 5% of its water harvesting structures installed throughout the state. Despite the abundance of lakes, one-third of Karnataka's total irrigation depends on Lakes (6th Minor Irrigation Census). Due to reduced rainfall, the coastal Karnataka region has faced water scarcity for agricultural production, which has led to a few crop rotations in the past year. Heavy groundwater pumping in the region has significantly influenced the freshwater gradient toward the sea. This gradient has sometimes reversed, causing saltwater intrusion from the sea into the freshwater aquifers [12]. This intrusion can contaminate and damage the internal freshwater resources [13]. The damage caused by saltwater intrusion can have long-lasting implications for the affected aquifers. For instance, the paddy crop is typically rotated three times per year, but due to water scarcity, the yield has been reduced to one crop in recent years [14].

Previous studies have examined groundwater (GW) and surface water (SW) systems as interconnected components of a larger hydrological cycle [5, 15]. The amount of water generated from the catchment to the lake is the primary concern in hydrological studies. The amount of groundwater recharging an aquifer is determined by precipitation distribu-

to evaluate the total runoff generated in the catchment and lake storage and its overall benefit for unconfined aquifer to improve the groundwater table. The study assesses the general runoff generated from the catchment to the lake, quantify the total storage of the lake using the Korkmaz method and evaluate the lake benefits for unconfined aquifers. To achieve this objective, lake-level and open well data are used to understand the benefits of lakes near unconfined aquifers.

Materials

Study Area

Kavoor Lake, located in Mangalore taluk of Dakshin Kannada district and adjacent to the old Mahalingeshwara Temple in Kavoor, holds historical importance as the water from the lake has been traditionally used for temple rituals. The study area is located to the north of the city, between latitudes 12°54'00" N to 12°55'30" N and longitudes 74°51'00" E to 74°52'30". The lake, irregular in shape and extending to 300 m, covered an area of 0.0338 km² (8.37 Acres) in 2000, diminishing to 0.0142 km² (3.51 Acres) by 2022. With four inlets and an outlet channel directing water to the Kuloc River, the lake's hydrological connectivity is crucial to its ecosystem. However, rapid urbanization in the vicinity has led to siltation, encroachment by builders, and sewage disposal, resulting in the lake's deterioration. This degradation, attributed to escalating urbanization, has adversely affected the lake's health and significantly reduced its size. Due to its ecological and cultural significance, preserving and rejuvenating Kavoor Lake has become imperative to protect its environmental integrity, restore its historical and cultural value, and maintain its role as a valuable resource for the local community. Details of the study area are given in Fig. 1

Data Sets

This study employed various data sets obtained from situ-

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recharge challenging to examine in all water resource evaluations [16, 17]. Limited research has been conducted to investigate the status of the extinct lake and how it could impact nearby groundwater levels in the coastal Karnataka context. Selecting potential lakes in coastal Karnataka and conducting studies of unconfined aquifers are critical. The Kavour lake has deteriorated over the last decade due to sewage discharge, encroachment, siltation, and weed infestation. The restoration of these aquifers is a complex and time-consuming process that could take several years. The present study aims

soil. A 2.5-m resolution image from the Google Earth Pro satellite imagery database for 2004, 2014, and 2021 was used for land use land cover (LULC) classification. The years were chosen based on satellite images with less cloud cover availability and with a focus on photos taken during November and December in the years 2004, 2014, and 2021 to minimize the drying out of natural landscapes, such as lakes or vegetation, which can occur during the summer months. The LULC data provides a comprehensive perspective on the endogenous dynamics of land utilization. The study utilizes the FAO

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Fig. 1 Study area

world ESRI soil shapefile and the SWAT 2012 database to determine the hydrologic soil group (HSG) of the soil in the study area. Temporal daily rainfall data for one rain gauge station from 2019 to 2021 located in the study area was collected from the Coastal Karnataka Minor Irrigation Department. It serves as the primary source for obtaining accurate and reliable precipitation measurements for the study period.

Methodology

catchment area. The survey focused on community members living near the lake for 30 to 40 years and engaged numerous households, predominantly targeting respondents aged 40 to 60 who have resided in the region for an extended period. The summary of questions discussed during the questionnaire survey is listed in Table 1.

SCS-CN Method

The SCS-CN method was used to estimate runoff through the watershed. It is based on the Soil Conservation Service Curve Number approach, as documented in studies by

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age capacity using specific methods (SCS-CN approach and the Korkmaz method). Figure 2 illustrates the overall methodology employed in the study.

Questionnaire Survey

The questions are designed to gather information about crop productivity improvement after the bund construction in the

Service (SCS) in 1969. It is a widely used method for calculating the amount of direct surface runoff in hydrological studies. The CN, a critical parameter in the SCS-CN method, represents the runoff potential of a particular area. CN values range from 0 to 100. A CN value of 100 represents impervious conditions. Conversely, a value of 0 denotes indefinitely abstracting conditions, where the surface allows maximum infiltration, preventing runoff

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September 2023 · Sustainable Water Resources Management

● Saketh Shetty · Amba Shetty · ● Varadaraj Kasaragod

Lake restoration is one of the regional initiatives aimed at increasing natural resource-based livelihoods. Typically, data on lake inflows/outflows or benefits are not available. Under the circumstances, the best way to collect data is through a questionnaire survey and interviews with residents of the area. The study aims to determine the present condition of the lake and quantify the ... [\[Show full abstract\]](#)

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Poster

Modeling interactions between El Hamiz River and Mitidja Aquifer

June 2023

● Kastali Fatima · ● Mohamed Meddi · ● Abdelmadjid Boufekane

The interaction between surface water and groundwater systems has a significant impact on the hydrological cycle, which also has a significant impact on water resource management and ecosystems. Indeed, these interactions affect both the quantity and quality of the water supply. Moreover, climate change highlighted the weaknesses of water supply management around the world, especially in ... [\[Show full abstract\]](#)

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Land cover change and its implication to hydrological regimes and soil erosion in Awash River basin,...

December 2021 · Environmental Monitoring and Assessment

● Sintayehu Yadete Tola · Amba Shetty

The Awash River basin is one of the most developed basins in Ethiopia, and its water resources are crucial to development. The collective impact of land cover (LC) changes has driven a difference in the hydrological components, substantially impacting the availability of water resources and demand. This review aimed (i) to examine the extent of change quantitatively and its effects; (ii) to ... [\[Show full abstract\]](#)

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Flood hazard map of the Becho floodplain, Ethiopia, using nonstationary frequency model

April 2023 · Acta Geophysica

● Sintayehu Yadete Tola · Amba Shetty

Flood estimates based on stationary flood frequency models are commonly used as inputs to flood hazard mapping. However, changing flood characteristics caused by climate change necessitate more accurate assessments of the probabilities of rare flood events. This study aims to develop a flood hazard map based on the nonstationary flood frequency using a generalized extreme value distribution model ... [\[Show full abstract\]](#)

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