ISSN (Online):3048-5088
International Journal of Advancement and Innovation in Technology and Research (IJAITR)
Volume 3, Issue 1, (Jan-Jun) 2026

RainScope: Rooftop Rainwater Harvesting Assessment and Artificial Recharge App

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[1] ***Abstract-*** **In India, where water levels are steadily declining in about 78% of districts, groundwater depletion has become a significant environmental concern. There isn't a straightforward, user-friendly digital assessment tool for Rooftop Rainwater Harvesting (RTRWH) and Artificial Recharge, despite government initiatives and guidelines. By offering a web and mobile application for on-site evaluation of rooftop rainwater harvesting potential and artificial recharge feasibility, the suggested system RainScope fills this gap. The system uses GIS-based data, rainfall datasets, and algorithmic models to generate detailed outputs, including rainfall-runoff potential, aquifer characteristics, recharge structure recommendations, cost estimation, and feasibility rating, based on basic inputs such as location, roof area, number of residents, and open space. RainScope, which supports a number of regional languages, encourages sustainable and data-driven water management practices by raising public awareness and encouraging participation in groundwater conservation.**

Index Terms— **Groundwater Management, Rainwater Harvesting, Artificial Recharge, GIS Integration, Mobile Application, Sustainable Water Solutions.**

I. INTRODUCTION

Since 60% of irrigation and nearly 85% of drinking water in rural areas of India rely on groundwater, the country is facing a serious groundwater crisis. Water tables are declining in the majority of regions as a result of excessive extraction, urbanization, and decreased percolation. Despite the fact that organizations like the Central Ground Water Board (CGWB) have published technical manuals and guidelines for Rainwater Harvesting (RWH), there are currently no easily accessible digital tools that allow people to assess rooftop harvesting potential in real time. RainScope was developed in order to overcome this difficulty. It is an application that uses few input parameters to automatically evaluate the viability of artificial recharge (AR) and rooftop rainwater harvesting systems. RainScope democratizes groundwater management and enables citizens to participate in sustainable resource use by combining data from the Indian Meteorological Department (IMD) and CGWB.

II. LITERATURE REVIEW

Although they offer useful data, existing tools like hydrological models and CGWB calculators are frequently complicated and inaccessible to the general public. Prior research has emphasized how crucial it is to combine rainfall and geospatial data in order to assess harvesting potential. But there are still issues with real-time evaluation, data visualization, and public usability. Building on those foundations, this research develops a multilingual, intuitive application that supports GIS.

III. PROPOSED SOLUTION

In order to ascertain harvesting and recharge potential, the suggested system is made to gather user inputs such as location, roof area, open space, and occupancy and process them using rainfall-runoff algorithms. It offers cost estimates, suggested recharge pit or trench designs, and graphical outputs. The application supports multiple languages for inclusivity and is available on both web and mobile platforms.

IV. SYSTEM DESIGN

Three primary parts make up the system's modular architecture: (1) the Data Collection Layer, which manages user input and GIS data; (2) the Processing Layer, which uses hydrological algorithms; and (3) the Visualization Layer, which displays results in an interactive dashboard. HTML5, Flask/Django for backend processing, PostgreSQL with PostGIS for spatial data, and APIs for retrieving rainfall and groundwater data are among the technologies utilized.

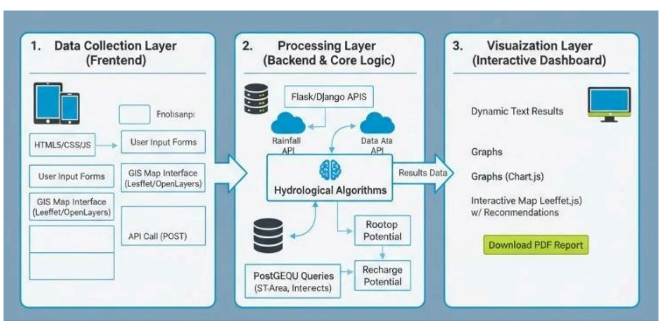

Fig. 1. Application Flow

V. Data Sources

Reputable government databases like the India Meteorological Department (IMD), CGWB, and NRSC are used to gather data on rainfall, groundwater levels, and aquifers. The type of roof material and slope are taken into consideration when choosing runoff coefficients. Implementation costs are estimated using regional cost data.

The Evaluation Process: From User Input to Useful Results

The main purpose of the application is to provide a smooth transition from little user input to an extensive, useful evaluation. The structure of the final output report and the user-facing data parameters are defined in this section.

A. User Interface (UI) and Input Data Parameters

The front-end of the application will be made to be easy to use and accessible on both web and mobile platforms. The following minimal information will be gathered from the user:

- **Name:** To customize the final report that is produced.
- **Location:** The most important piece of information is location, which serves as the main key for all ensuing GIS queries. This must be obtained by the app through:
  1. **Automatic (GPS):** Acquiring exact latitude and longitude on mobile devices.
  2. **Manual Map Input:** A Bhuvan satellite imagery base layer is used in a "Pin on Map" interface
  3. **Address/Pincode:**A backup technique that uses a geocoding service to translate an address into coordinates of latitude and longitude.
- **Number of Dwellers:** The demand-side computation that determines the ideal storage tank size based on household water requirements uses this input only.
- **Roof Area :** The main catchment area, expressed in square meters. The app will have a helper tool to help non-technical users by letting them trace the outline of their roof on the satellite map, which will then compute the area automatically.
- **Roof Type:** a straightforward drop-down menu with options like Metal Sheet, Tiled, Concrete/RCC, and Other. In order to choose the appropriate Runoff Coefficient and calculate harvesting efficiency, this input is necessary.
- **Available Open Space:** A user-estimated area of open, unpaved ground (such as a garden or lawn) is known as available open space. To ascertain whether there is physically sufficient room to erect an artificial recharge structure, this parameter is a crucial feasibility check.

B.The Output Report (User-Facing Dashboard)

A customized, dynamic report will be produced by the system after the inputs have been processed through the calculation engine (Section 2) and GIS queries (Section 3). The main output for the user will be this report, which is organized into the following modules:

1. **RTRWH Potential:** An obvious headline figure, such as "You can harvest X liters of water from your roof annually."

2. **Feasibility Check:** Using a RAG (Red-Amber-Green) status or checkmarks, provide a concise, high-level summary:
   Feasible Rooftop Harvesting (Storage)

Artificial Recharge (Recharge):

3. **Recommended Action:** A plain-language prescription.
   - *Example 1 (Storage): "To meet Z% of your family's non-potable water needs, we advise installing a Y-liter storage tank."*
   - Example 2 (Recharge): "We advise building a Recharge Pit to replenish local groundwater based on the hydrogeology of your area."

4. **Design & Dimensions:** A "View Details" button will expand to show:
   - Structure Type: Storage Tank, Shaft, Trench, or Recharge Pit.
   - Suggested Dimensions:Length: X m, Width: Y m, Depth: Z m.
   - Filter Media: A straightforward diagram that shows the necessary layers (e.g., Boulders, Gravel, Coarse Sand).
5. **Local Hydrogeology:** "Details about where you are:"
   - Principal Aquifer: [such as "Alluvium"].
   - Groundwater depth : [e.g., "Approx. 12 m below ground level"].
6. **Economic Analysis:**
   - Estimated Cost:"approximately ₹X to build."
   - Benefit (for Storage): "Potential to save ₹Y on your water bill annually"
   - Payback Period (for Storage): "Approx. **Z years**."

The value of the app comes from its capacity to link these straightforward user inputs to an intricate backend of engineering computations and geospatial data. The fundamental architectural model of the system is this data flow.

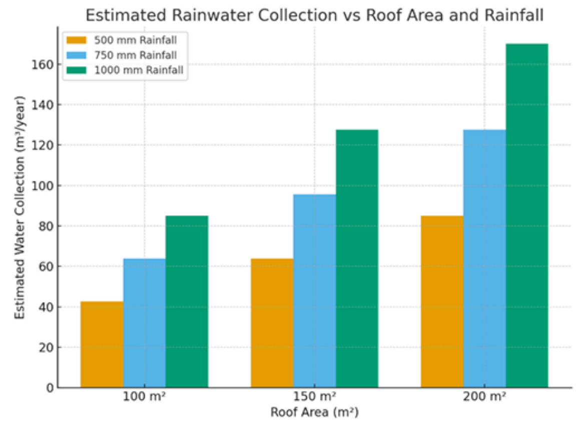

Fig. 2. Estimated Rainwater

VI. CONCLUSION

The development of this on-spot assessment application represents a critical fusion of public policy, environmental science, and digital technology. By going beyond theoretical advice and offering a useful, scalable tool for public action, it directly addresses the national imperative to augment groundwater resources.

Strong, scalable, and maintainable is the goal of the architecture described in this report, which consists of a lightweight, multilingual frontend backed by a potent intermediary API. The expert knowledge found in the CGWB's "Manual on Artificial Recharge of Ground Water" and "Master Plan for Artificial Recharge to Groundwater" is successfully digitized and made available to the general public.

This application will demystify rainwater harvesting by providing recommendations that are location-specific, economically-analyzed, and supported by science. It will directly support the framework of Village Level Water Security Plans and encourage the "Jan Andolan" (public movement) for water conservation by empowering people and communities to make informed decisions. In addition to providing citizens with information, this tool empowers them to take an active role in safeguarding India's water future.

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