Masters Thesis Information Showcase
Spring Semester-2026
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Department: Computer Science & Information Technology
Programme: Masters of Science
Specialization: GeoSpatial Data Science

1	**Title of the Thesis:** Identification of Potential Rainwater Harvesting Sites in Balochistan Using Remote Sensing and GIS-Based Multi-Influencing Factor (MIF) Model
2	**Abstract** (min 300 to 500 words) Water scarcity is one of the most pressing challenges faced by Balochistan, Pakistan's largest yet most arid province. The growing population, erratic rainfall patterns, and over-exploitation of groundwater resources have heightened the urgency to explore sustainable water management solutions. Rainwater harvesting (RWH) has emerged as a viable and eco-friendly approach to alleviate water stress, particularly in arid and semi-arid regions. This study aims to identify and map potential rainwater harvesting sites in Balochistan using an integrated geospatial framework combining Remote Sensing (RS), Geographic Information Systems (GIS), and the Multi-Influencing Factor (MIF) model. Seven thematic layers: slope, land use and land cover (LULC), soil texture, mean annual rainfall, normalized difference vegetation index (NDVI), drainage density, and lithology. The data were extracted, processed, and reclassified using ArcMap 10.8 and Google Earth Engine. (GEE), and Python-based geospatial libraries. The MIF model was used to give weights to each theme based on evidence, which means that the importance of each theme was determined by looking at the facts and data and a weighted overlay analysis was conducted to generate a comprehensive spatial suitability map classifying the study area into five RWH suitability zones. The results indicate that approximately 8.44 percent of Balochistan falls under high suitability and 0.04 percent in areas with extremely high suitability, a total of 324 potential sites for Rainwater Harvesting (RWH) have been identified, covering a wide range of areas, from small plots of 5 square kilometers to larger areas of 100 square kilometers. Spatial validation through overlay of digitized karez network, We were able to check the model's results in different locations, which confirmed that they made sense from a hydrological point of view. A web-based Decision Support System (DSS) was developed using Python Flask to identify potential RWH sites for any province or district in Pakistan, bringing the entire site identification process online for improved decision-making and greater accessibility.
3	**Impact on Sustainability of Urban Regions or SDG-11 "Sustainable Cities and Communities"** (min 500 words) This study covers the province Balochistan,Pakistan, which is mostly a dry and rural province. Even so, its results matter a great deal for urban areas, and they connect clearly with Sustainable Development Goal 11 "Sustainable Cities and Communities." The clearest link comes from where the suitable sites are located. Most of the high and very high suitability zones identified by the MIF model fall in the northeastern districts: Quetta, Pishin, Ziarat, Qilla Abdullah, Qilla Saifullah, Zhob, Loralai, and Mastung. These districts contain almost all of Balochistan's towns and cities, including the provincial capital. Quetta sits in a closed valley where groundwater is being pumped out faster than it is being

	replaced. Many of the 324 RWH sites identified in this study lie in the catchments that feed these urban areas. So the study does not only map rural water potential, it maps the recharge areas that urban Balochistan depends on.This supports **Target 11.a**, which asks for stronger links between rural, peri-urban, and urban areas in development planning. RWH structures such as check dams, percolation tanks, and recharge ponds built upstream of Quetta, Pishin, and Ziarat serve two groups at once. They give farmers more water in the rural catchment, and they recharge the same aquifers that city wells draw from. In Pakistan, rural watershed management and urban water supply are handled by separate departments, even though they share the same water. This suitability map gives both a common starting point. The results also relate to **Target 11.5**, which aims to reduce losses from water-related disasters. Rain in Balochistan falls in short, heavy bursts. This causes flash floods in and around towns, even though the province is dry overall. RWH structures placed in high drainage density areas do two jobs: they slow down and hold back flood water, and they store that water for later use. Many of the identified sites lie in exactly these high-runoff corridors that drain toward the Quetta and Pishin valleys. **Target 11.b** asks for more settlements to adopt integrated plans for resource efficiency and disaster risk management. The Python Flask-based Decision Support System is the main contribution here. Local planners can select their own province or district, set their own layer weights, and download results as GeoTIFF, shapefile, or map images. Offices without GIS staff or ArcGIS licences can still produce useful suitability assessments. This makes RWH planning a routine tool rather than a one-time academic exercise. Two limits should be stated honestly. The 90 m resolution is good for choosing priority areas, but not for final construction decisions, each site still needs field survey. Also, this model looks only at physical conditions. Land ownership, water rights, karez ownership, and community agreement decide whether a structure actually works, and these lie outside the scope of this study.
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	Graphical Abstract

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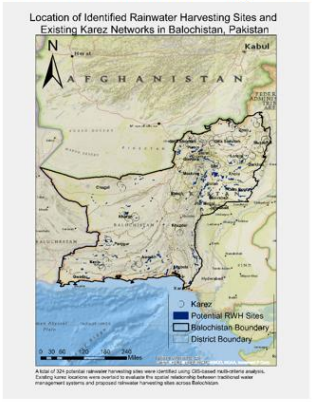
Identification of Potential Rainwater Harvesting Sites in Balochistan Using Remote Sensing and GIS-Based Multi-Influencing Factor (MIF) Model

Study area
Balochistan, 347,190 km²

Seven thematic layers
Rainfall, lithology, slope, soil, LULC, drainage, NDVI

MIF weight assignment
Rainfall 25%, lithology 20%, slope 18%

Weighted overlay
S = Σ (Wi × Ri), five suitability classes



324 potential RWH sites and existing karez networks, Balochistan
Model output overlaid on centuries-old karez locations, providing independent spatial validation

Web-based Decision Support System
Python Flask, GEE, PySheds, Rasterio

- Select any province or district of Pakistan
- Assign your own MIF layer weights
- Layers auto-sourced and clipped
- Export GeoTIFF, shapefile and PNG map

Live link: https://rwh-sites-of-pakistan.up.railway.app/

Why it matters
Most suitable zones lie in the catchments feeding Quetta, Pishin and Ziarat — recharging the aquifers those cities depend on, while attenuating flash floods downstream.

324	8.48%	7 layers	SDG 6 · 11 · 13
potential RWH sites, 5–100 km² each	of province suitable, 28,771 km²	reclassified into five suitability classes	water, sustainable cities, climate action