

Development of Dweep Agricultural Information System Using Web-Based GIS for the Andaman and Nicobar Islands

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Abstract

Web-based geoportal platforms have emerged as effective tool for improving the planning, management, monitoring, and execution of agricultural land-use systems. This research details the creation and utilization of the Dweep Geoportal, a comprehensive web-based GIS platform developed by ICAR–CIARI specifically for the Andaman and Nicobar Islands. The geoportal consolidates multi-thematic spatial datasets pertinent to agriculture and related sectors, disseminating them through standardized Web Map Services (WMS). This enables efficient visualization, access, querying, and distribution of geospatial information. The platform encompasses a diverse array of spatial layers, including road networks, inhabited islands, village boundaries, geomorphology, lithology, elevation, slope, forest cover, soil resources, water bodies, socio-economic characteristics, and land-use and land-cover data. Furthermore, the geoportal offers district-wise spatial distribution of key crops, floriculture activities, and livestock populations, including cattle, pigs, goats, sheep, and buffaloes. With a user-friendly interface, the Dweep Geoportal promotes seamless integration and visualization of cross-domain geospatial information for various stakeholders, such as planners, researchers, administrators, and extension personnel. The platform enhances evidence-based decision-making and spatial planning by providing real-time access to updated thematic data within a unified framework. The Dweep Geoportal showcases considerable potential for sustainable agricultural resource management, infrastructure planning, environmental monitoring, and policy development in vulnerable island ecosystems. This study emphasizes the significance of web-based geospatial technologies in bolstering digital agriculture initiatives and fostering data-driven governance in geographically isolated areas like the Andaman and Nicobar Islands.

Key words: *Dweep Geoportal; Web GIS; Web Map Services (WMS); Sustainable Resource Management; Andaman and Nicobar Islands; Digital Agriculture*

Introduction

The Andaman & Nicobar Islands (ANI), a Union Territory of India, are located approximately 1,200 km from the mainland in the southern Bay of Bengal and serve as a strategic gateway to ASEAN countries. The region is recognised as one of the 36 global biodiversity hotspots. ANI lies between 92°12'E and 93°57'E longitude and 6°45'N and 13°41'N latitude, covering an area of 8,249 km². The Ten Degree Channel separates the Andaman group of islands from the Nicobar group. The archipelago comprises 836 islands, islets and rocky outcrops and is extensively forested, containing biosphere reserves, national parks and tribal reserves. These areas are home to six notified tribes: the Andamanese, Onge,

Sentinelese and Jarawa in the Andaman group; and the Nicobarese and Shompen in the Nicobar group. Out of the 836 islands, 31 are inhabited, supporting an estimated population of 434,192 (2019). ANI is administered as a Union Territory of India. Its physical isolation from the mainland by 1,200 km of ocean waters provides a largely pollution-free environment and supports rich endemic germplasm resources. Within the Andaman group, North, Middle and South Andaman form the major islands, while Great Nicobar in the southern group has an area of about 1,000 km². Little Andaman, covering 731 km², is the next largest island. Among the remaining islands, 32 each exceed 10 km², while 96 individually cover less than 1 km². Of the inhabited islands, 12 have populations exceeding 1,000 persons.

Of the total geographical area of 8,249 Sq.km., approximately 46,287 ha are under agriculture. The main land-use pattern includes 10,303 ha under paddy and other field crops, 21,910 ha under coconut, 4,669 ha under arecanut, 1,198 ha under cashew, 1,593 ha under red oil palm, 3,745 ha under fruits, 1,369 ha under spices and 1,500 ha under rubber.

Livestock production also plays an important role in ANI. According to the livestock census, the islands support 36,438 cattle, 3,700 buffaloes, 64,761 goats and 40,488 pigs. Marine fisheries and related sectors constitute a major source of livelihood and employment for the island population. Sustainable utilisation of marine fishery resources is essential for long-term resource security. Effective resource management requires proper assessment of fishery stocks to determine optimal harvest levels. The management of scientific data in fisheries is therefore critical for planning, conservation and sustainable resource management.

There is a growing need to improve agricultural efficiency, and much of this depends on better information management and the use of modern tools. As Information and Communication Technologies (ICTs) continue to advance, it has become possible to generate, store, analyze and share data in ways that directly support farmers and farming communities. These developments help strengthen both agricultural productivity and long-term sustainability. Moving from traditional practices toward digital agriculture is expected to bring additional social and economic benefits. Within this shift, the effective dissemination of agricultural information remains essential. Farmers increasingly rely on timely access to knowledge, as it plays a central role in improving both their productivity and their income.

A Web-based Geographic Information System (WebGIS) provides a way for users to view and work with spatial data through the internet. It merges the analytical strengths of GIS with the accessibility of web technologies, allowing maps and geospatial tools to be used from any device with an internet connection. Using Internet-based GIS has become an effective approach for managing farming systems and conducting agricultural studies at various scales, as it makes GIS functions

available through a simple web browser. Over the last several decades, geoportals have developed into an important means of accessing and sharing spatial data. They make it easier for users to locate, view and handle large amounts of geoinformation online. In this context, a geoportal serves as the main point of interaction between users and digital systems, acting as a centralized gateway for spatial data and GIS resources. It supports information exchange and helps connect geospatial data providers with those who need the information.

Emerging applications of GIS have been observed in the agricultural sector. Accurate and timely information on natural resources is essential to improving decision-making for planners, resource managers, and other officials. Geoportals have become an important source of spatial information for a wide range of users. Planning any kind of developmental activity depends, first and foremost, on having reliable information about natural resources as well as socio economic conditions. Because of this, there is a strong need for systems that can organize and manage computer-based information effectively. In agriculture, the use of remote sensing and geographic information systems generally falls into two main areas, which are inventory or mapping work and management related activities. Inventory efforts often involve estimating crop area, assessing crop condition, forecasting yields and mapping soils. Management activities, on the other hand, such as irrigation planning, cropping system analysis and precision farming, require additional spatial and environmental information.

Materials and Methods

An open-source web GIS application was created using GeoServer, OpenLayers, and PostgreSQL. It includes basic tools such as pan, zoom, home, information window, measurement tools, legend button, geo location, search bar, layer selection, mini map, attribution and mouse position display. The primary focus during development was to build a user-friendly Graphical User Interface. The application is designed to support the mapping and visualisation of agricultural and related information, including administrative boundaries, natural resources, demographic features and agro-economic and socio-economic data. Through the Web Map Service, multiple

users can access and use the application simultaneously without affecting the stored datasets. The platform will act as a reporting system for standardised map products.

Installation of PostgreSQL

PostgreSQL with the PostGIS extension was installed and configured as the database server. During installation, the Spatial Extension option was selected through the stack builder, which enabled the system to support PostGIS. With this extension in place, the database can store and manage spatial maps along with other geographic information.

Installation and Configuration of Geoserver

The Java Development Kit was initially installed as it is essential for executing and developing Java-based applications on the system. Subsequently, the Apache XAMPP server was installed, followed by the addition of

the GeoServer package within the XAMPP environment. These procedures were crucial for establishing a functional GeoServer setup to serve spatial data.

Development of Front end GUI

The development of the user interface for the Dweep Geoportal played an important role in making the platform visually appealing and accessible to users. Standard web technologies such as HTML, CSS and JavaScript were used to create the front end. The portal was designed using a three tier architecture. Web Mapping Services were employed to provide spatial layers on island resources, and these services were delivered through the Geoserver platform hosted on the XAMPP server. All spatial layers were stored in a PostgreSQL database.

System architectural design

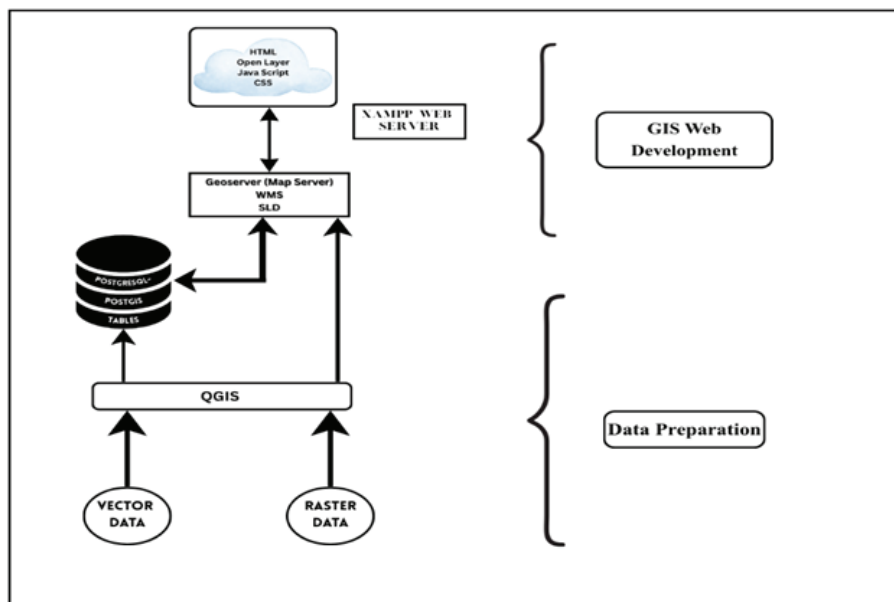


Fig. 1. System architecture used for developing the web GIS platform.

Results and Discussion

Base Map for the Andaman & Nicobar Islands.

The Dweep Geoportal contains a detailed base map of the Andaman and Nicobar Islands. This map presents road networks with road names, inhabited islands, village

boundaries and several thematic layers that illustrate geomorphology, lithology, elevation and slope. Using QGIS, maps were prepared to show the density and distribution of major crops and livestock populations, including cattle, pigs, goats, sheep and buffaloes, across the districts of the Andaman and Nicobar Islands. These maps were generated using information from the

livestock census conducted in the year 2019 and the Basic Statistics for 2021 to 2022 published by the Directorate of Economics and Statistics for the Andaman and Nicobar Administration.

A map showing the production areas of important crops, including cereals, oil seeds, pulses, sugar crops,

spices, plantation crops, root crops and fruits, has also been developed using secondary data. In addition, floriculture maps for the years 2019 to 2020, 2020 to 2021 and 2021 to 2022 are available on the Dweep Geoportal. These maps present the distribution of flowers such as marigold, rose, jasmine, hibiscus, ixora and muscanda.



Fig. 2. Base map of Inhibited Island

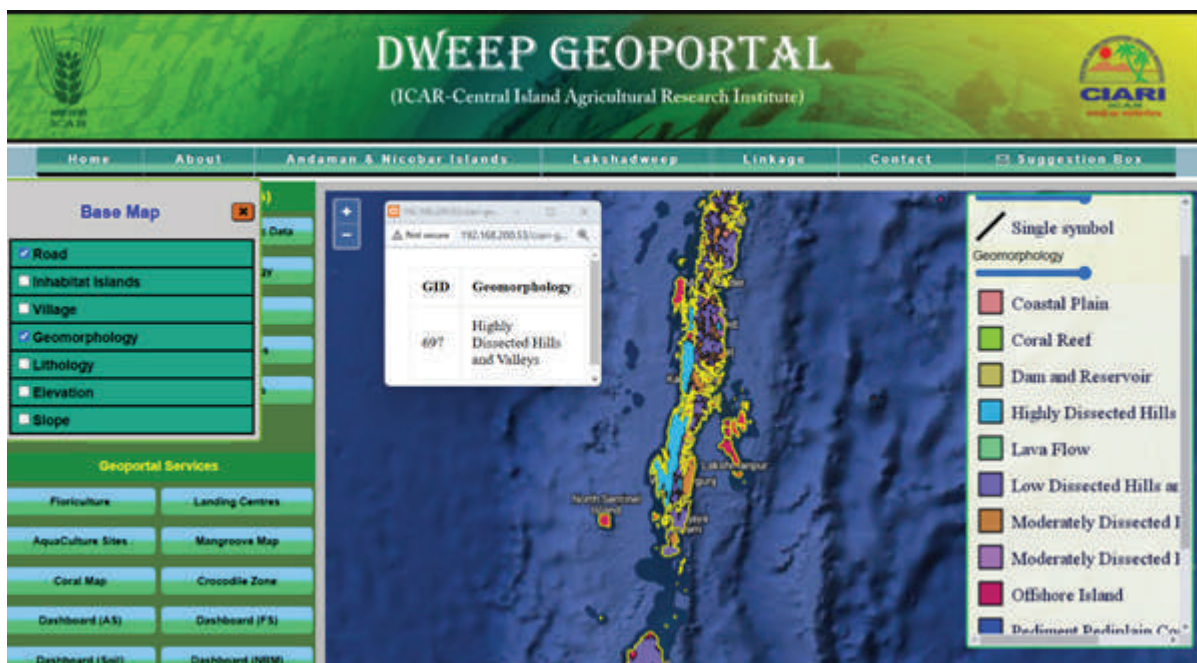


Fig. 3. Base map of Geomorphology Map

Water body information on Geoportal

Web GIS provides the ability to create maps and data sheets for water bodies. It includes thematic services that allow users to select, explore and query thematic datasets available on the portal. Geospatial mapping, which is a form of location-based analysis within a geographic information system, is a valuable tool for fisheries scientists, aquatic resource managers and policy planners as they design and implement strategies for fisheries resources. A total of one thousand five hundred and sixty ponds located in the South, North and Middle Andaman

and Nicobar Islands were delineated using Google Earth, and the KML files were then imported into the Dweep Geoportal. A Web Map Service was created using the Open Layer interface to display these images through Geoserver. The map presents information such as pond area, district, taluk, ownership and details on species stocking. This mapped information will help planners and stakeholders by providing easy access to district and tehsil level data on different aspects of fisheries in the Andaman and Nicobar Islands, which in turn will support better planning, management and development of the fisheries sector.



Fig. 4. Water body Map

Land Use Land Cover Map

A Land Use/Land Cover (LULC) map was prepared to show the spatial distribution of land use and land cover across the Andaman and Nicobar Islands. This map is an important reference for environmental management, urban planning, agriculture, forestry and overall resource management. It includes categories such as agricultural land, built up areas, forests, water bodies and wetlands. Users can examine the map to identify specific land types, and for agricultural land it provides details on the crops being cultivated along with their respective areas. This information is made accessible through a geo-server for VMS service.

Mangrove map of Andaman & Nicobar Islands

A detailed map of the forests and mangrove regions in the Andaman and Nicobar Islands has been prepared. The mapped distribution of mangrove species includes *Avicennia* species, *Bruguiera* species, degraded mangrove areas, *Heritiera*, littoral zones, *Lumnitzera*, mixed mangrove groups, *Phoenix*, *Rhizophora*, *Xylocarpa* and several *Rhizophora* species. Users can explore the map to obtain information on the area measured in square meters, the perimeter measured in meters and descriptive details on the mangrove species present at specific locations. The portal also provides a forest cover map that classifies

forest types such as deciduous, degraded, mangrove, evergreen, forest plantations and gregarious forests. This thematic service allows users to select and examine a range of thematic datasets available on the portal.



Fig. 5. Land Use Land Cover(LULC) map of A&N Islands



Fig. 6. Distribution of Mangrove species in A&N Islands

Soil map of Andaman and Nicobar Islands

Soil maps for Car Nicobar, Cambel Bay, Hudbay Little Andaman, Havlack and Niel Islands, Camorta, Nancowry, Trinkat Island, Tarasa Dwip, Tillongchang Dwip, Bompoka and Little Nicobar were prepared using the Soil Atlas of NBSS and LUP together with QGIS

software. Additional soil maps were created for the South Andaman region, which includes Port Blair, Diglipur, Mayabandar and Ranget. A thematic map with a legend was produced through PHP to show different soil types and their characteristics. These maps were then uploaded to the Postgres database and to Geoserver in order to support the VMS service.

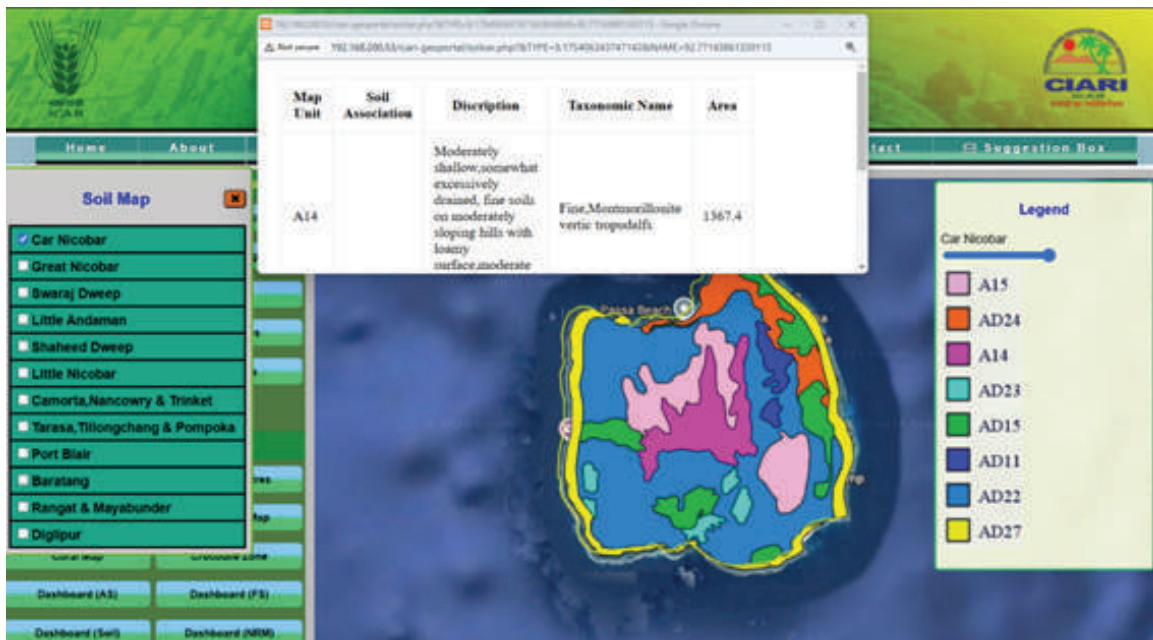


Fig. 7. Soil Map of Car-Nicobar Islands

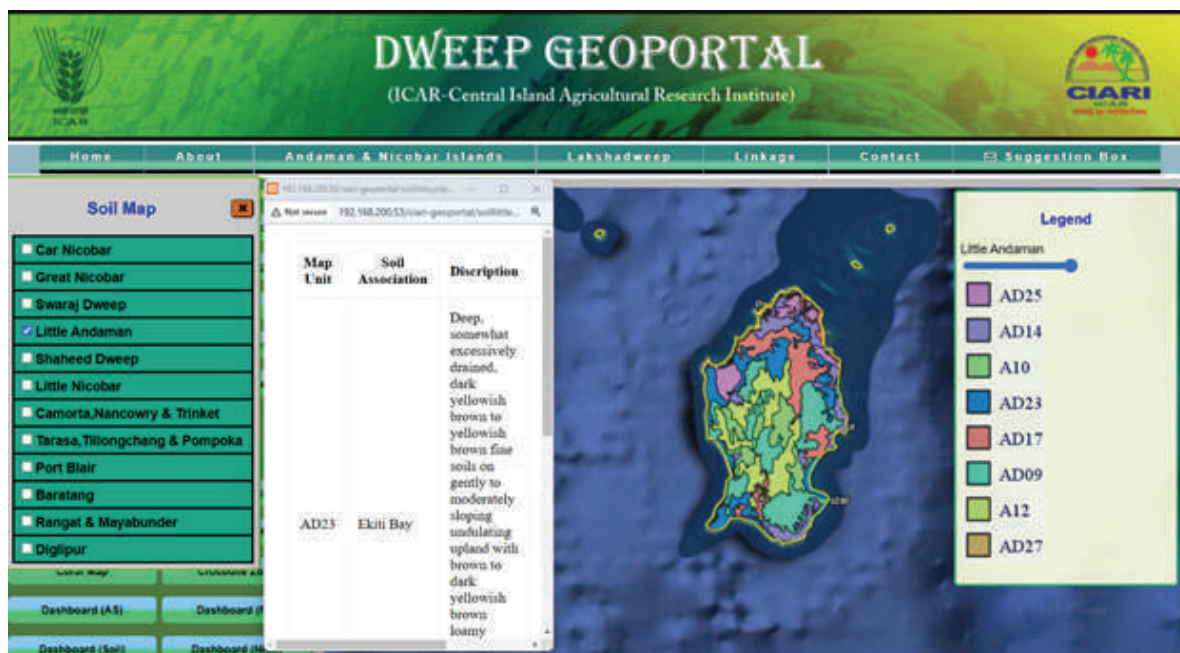


Fig. 8. Soil Map of Little Andaman

Conclusion

The creation of the Dweep Geoportal signifies a major leap forward in utilizing web-based geospatial technologies for the planning of agricultural and related sectors in the Andaman and Nicobar Islands. By amalgamating various thematic datasets and providing them through standardized Web Map Services (WMS), the portal facilitates effective visualization, access, and distribution of spatial information within a cohesive digital framework. The provision of multi-layered data concerning land use and land cover, soil resources, geomorphology, elevation, slope, forest cover, water bodies, socio-economic characteristics, crop distribution, and livestock populations significantly boosts the ability for informed, evidence-based decision-making. The intuitive interface of the Dweep Geoportal promotes seamless cross-domain analysis, thus aiding in sustainable agricultural resource management, infrastructure development, environmental monitoring, and policy formulation within the delicate island ecosystem. Additionally, the platform enhances digital governance by increasing data accessibility for researchers, planners, administrators, and extension agencies. In summary, the Dweep Geoportal illustrates the transformative capabilities of web-based GIS in fostering sustainable development and data-driven agricultural planning in geographically isolated areas. Prospective improvements may concentrate on real-time data integration, mobile access, and sophisticated spatial analytics to further enhance operational efficiency and stakeholder involvement.

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