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Integrated Geospatial Database and Web Based Tools for Land Management and Administrative Planning (ILMAP) for Imphal East and Thoubal Districts, Manipur State, India

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Abstract

Manipur, as most of the north eastern area, come under hilly and difficult area, economically and infrastructurally underdeveloped area category. Manipur is facing the unenviable situation of being a resource starved State coupled with decades old insurgency widespread across the State, desperately crying out for a major thrust in inclusive development. As part of the initiative by the Govt. of India for the development of the north-eastern India, an Integrated Land Management and Administrative Planning (ILMAP) was taken up in Manipur State with the state-of-the-art technology. In the present work Imphal East and Thoubal Districts are selected. The objective of the study is to generate GIS database on drainage, water bodies, administrative boundaries, and other utility maps. The methodology involves geo-referencing of Quick Bird (QB) data with the help of DGPS survey. Drainage and surface water bodies, base map and land use/land cover maps are generated with the help of QB data. Point of Interest is mapped in all urban areas covering important landmarks such as Govt. offices, post offices, banks, religious places, and places of tourist interest etc., along with photographs and geographical coordinates. Using the soil maps generated by AISLUS and NBSS and LUP as a base, soil maps are prepared. All these maps are geo-referenced to QB satellite data. Using this database, a customized GIS application is developed for e-governance which can be accessed by authorized beneficiaries through State Wide Area Network (SWAN). The application was deployed in the State Data Centre (SDC) and training was provided to all the department officials for effective use in all developmental projects.

Keywords: Land use/Land cover; Manipur; Point of interest; E-governance; High resolution satellite data

Introduction

The north-eastern India known as the land of rising Sun is uniquely endowed with nature's bounty. This is a region of mega-biodiversity but steeped in poverty. In the midst of bounty of nature and lack of economic plan of development, it has built up strains and intense conflicts in the region. It needs a paradigm shift in our policies to rid the region of the bane of poverty as well as economic isolation. Manipur is one of the States in that region reeling under poverty. Manipur is a State in north-eastern India, with the city of Imphal as its capital. The capital lies in an oval-shaped valley of approximately 2,000 km^2 surrounded by blue mountains and is at an elevation of 790 metres above sea level. The State lies at latitude of 23°80'N – 25°68'N and longitude of 93°03'E – 94°78'E. It is bounded by Nagaland to the north, Mizoram to the south, and Assam to the west and Burma lies to its east. The State covers an area of 22,327 square kilometres.

Manipur has a population of 2,721,756, of which 58.9% live in the valley and the remaining 41.1% in the hilly regions. Its people include the Meetei, Kuki, Naga, and Pangal tribes who speak Sino-Tibetan languages. The Meetei ethnic group, represents 53% of the population of Manipur State. The official languages are Manipuri (Meeteilon) and English. According to 2011 census, Hinduism is the major religion in the state closely followed by Christianity. Other religions include Islam, Sanamahism, Buddhism etc. Imphal airport is the second largest airport in India's northeast. The road network of Manipur, with a length of 7,170 km connects all the important towns and distant villages.

The mountain ranges create a moderate climate, preventing the cold winds from the north from reaching the valley and barring cyclonic storms originating from the Bay of Bengal. Manipur may be characterised as two distinct physical regions: An outlying area of rugged hills and narrow valleys, and the inner area of flat plain, with all associated landforms. These two areas are distinct in physical features and are conspicuous in flora and fauna. The climate of Manipur is largely influenced by the topography of this hilly region. Lying 790 meters above sea level, Manipur is wedged among hills on all sides. Manipur enjoys a generally amiable climate, though the winters can be chilly. The maximum temperature in the summer months is 32°C. In winter the temperature often falls below 0°C, bringing frost. The State is drenched in rains from May until mid-October. It receives an average annual rainfall of 967 mm. The soil cover can be divided into two broad types, *viz.* the red ferruginous soil in the hill area and the alluvium in the valley. The valley soils generally contain loam, small rock fragments, sand and sandy clay. The top soil on the steep slopes is very thin. Soil on the steep hill slopes is subject to high erosion, resulting in gullies and barren rock slopes.

Natural vegetation occupies an area of about 14,365 square kilometres nearly 64% of the total geographical area of the State. Broadly, there are four types of forests: Tropical Semi-evergreen, Dry Temperate Forest, Sub-Tropical Pine, and Tropical Moist Deciduous. There are forests of teak, pine, oak, uningthou, leihao, bamboo, and cane. The State is covered with over 3,000 square kilometres of bamboo forests,

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making it one of India's largest contributors to its bamboo industry. Manipur has primarily an agrarian economy, with significant hydroelectric power generation potential. Manipur's climate and soil conditions make it ideally suited for horticultural crops. Rubber, tea, coffee, orange, and cardamom are grown in hill areas. Rice, a staple food for Manipuris, and other cash crops make up the main vegetation cover in the valley. Some cash crops suited for Manipur include litchi, cashew nuts, walnuts, orange, lemon, pineapple, papaya, passion fruit, peach, pear and plum. The objective of the study is to generate GIS database on drainage, water bodies, administrative boundaries, natural resources, and other utility maps using very high resolution satellite data. With the help of this geospatial database a customized GIS based web application is developed for e-governance.

Study Area

Manipur has currently nine administrative districts. In the present study, Imphal East and Thoubal Districts are selected (Figure 1). Imphal East District has an area of 709 Sq.km with headquarters at Porompat. Imphal East District has a total population of 456113 persons of which 272906 reside in rural and 183207 are in urban areas. The percentage decadal variation recorded at the district level during the decade of 2001-2011 is 15.5%. The decadal variation for rural population is -4.8% whereas of urban population it is 69.2% [1].

Thoubal District has an area of 514 sq.km with its headquarters at Thoubal. The population of Thoubal District is 4, 22,168. In Thoubal District the percentage decadal variation recorded during the decade of 2001-2011 for total population is 15.9% comprising of 16.3% for rural and 15.3% for urban areas of the District. The percentage of urban population to total population of the District in 2001 was 36.0% which registered a slightest declining trend and stood at 35.8% in 2011 census [2].

Geology of the study area

Manipur is part of Assam-Burma geological Unit. It is the eastern part of the Himalayan orogenic formation. The detail information of its tectonic and geological history is inadequate. However, an attempt is made to describe the geology of the study area in brief. The Imphal East district is mostly occupied by semi consolidated formations which covers almost the entire area comprises shale, siltstone, sandstone and conglomerate. These formations belong to Disang, Barail, Surma and Tipam group of rocks. In the western part of the District unconsolidated alluvium of Quaternary age occurs in the valleys and topographical lows [3].

Thoubal District is generally occupied by hills and alluvial sediments. The hillocks inside the valley are basically composed of Disang shale of Eocene age. The Disangs are dark grey to black splintery shales, Sandstone, minor buff coloured shale, grit, conglomerate and Limestone, Sandstone buff coloured shale and limestone, siliceous, grey shale with minor mudstone, siltstone, siltstone and sandstone. They are usually thinly laminated, intercalation of siltstone and fine-grained sandstone in the form of lensoids and bands. Based on the nature and litho-character, the Disangs are found to be flysch sediments [4]. Alluvium of fluvio-lacustrine origin covers major areal extent in the Thoubal District. These are mainly sand, gravel, pebble, silt and clay, dark grey to black in colour. This unconsolidated alluvium is of Recent to Sub-Recent age.

Geospatial technology based studies in Manipur

In recent times, advancement of remote sensing and GIS technology has helped many workers to generate spatial database on natural resources, disaster management and infrastructural facilities to monitor the changes of late, remote sensing techniques have been developed, which have proved to be of immense value for preparing accurate land use/land cover maps and monitoring changes at regular intervals of time. However, the north-eastern India has received less attention in many scientific studies. An attempt is made to review the existing literature on studies using geospatial technology in Manipur State.

Roy et al. [5] generated baseline information for all eight north eastern States on vegetation types, floristic composition of forest types and various other parameters like their value, uniqueness, land cover and land use, fragmentation, disturbance and bio-rich areas as part of Biodiversity Information System for better planning and management and decision making. SAC [6] developed a methodology for forest encroachment mapping using remote sensing and GIS at 1:50,000 scale and standardized for the State of Manipur. In this study they mapped encroachment status map (area and type of encroachment) showing encroachment separately in National Parks (NP), Protected Forests (PF), and Reserve Forests (RF) areas. It is observed that the type of encroachment in the State is mainly due to shifting cultivation (Jhum). The methodology can be adopted in other forested regions for delineating encroachment.

With the help of Landsat ETM+ data and SRTM DEM data geological, structural and geomorphological features were delineated in the intermontane Imphal Valley in Manipur State [7]. Further, DEM derived drainage network and relative drainage density in the basin were used in interpreting the location of fault plane in the valley and slope and lineament maps were prepared using SRTM DEM. They state that entire valley is covered by very low slope (0°-9°) and Lineaments are oriented N-S, 180° while in south-east of valley the direction is largely NW-SE and conclude that the change in lineament direction suggests that the eastern side of the valley is controlled by Indonesian Island arc strike direction.

State Government has initiated a New Land Use Policy (NLUP) for Manipur with the objective of inclusive development through effective land resource development and livelihood of the people to assess Land Resources (soil, water and vegetation) of the State and coordinate activities of line Departments, plan and coordinate on issues connected with health and scientific management of land resources, collect, compile and make available statistical and other data/map etc. on land use and status of natural resources [8]. This policy also provides support in preparing perspective plan, studies, investigation, etc. for conservation, development and management of the natural resources and, continuously review implementation of schemes/programme of govt. department and other agencies which affect land resources.

The study carried out by Abujam Manglem Singh and Koijam Renubala Devi [9] reveal that rapid growth of Imphal is encroaching into fertile lands in fringe areas largely because of unregulated constructions of built ups use for multiple purposes and the changes have not occur uniformly in all areas of the Imphal fringe, as arterial roads have usually attracted more settlements than other areas. They further state that if the current rates of spread of urban structures continue unabated into the surrounding lands, Imphal city may stand to lose its spatial form and may perhaps morphed into large urban sprawl with city core and urge the State government to formulate a coherent land use policy which takes into considerations various competing interests.

Methodology

The methodology involves collection of ground control points through DGPS survey. Further, Quick Bird (QB) satellite images are geo-referenced and ortho-rectified with the help of DGPS data.

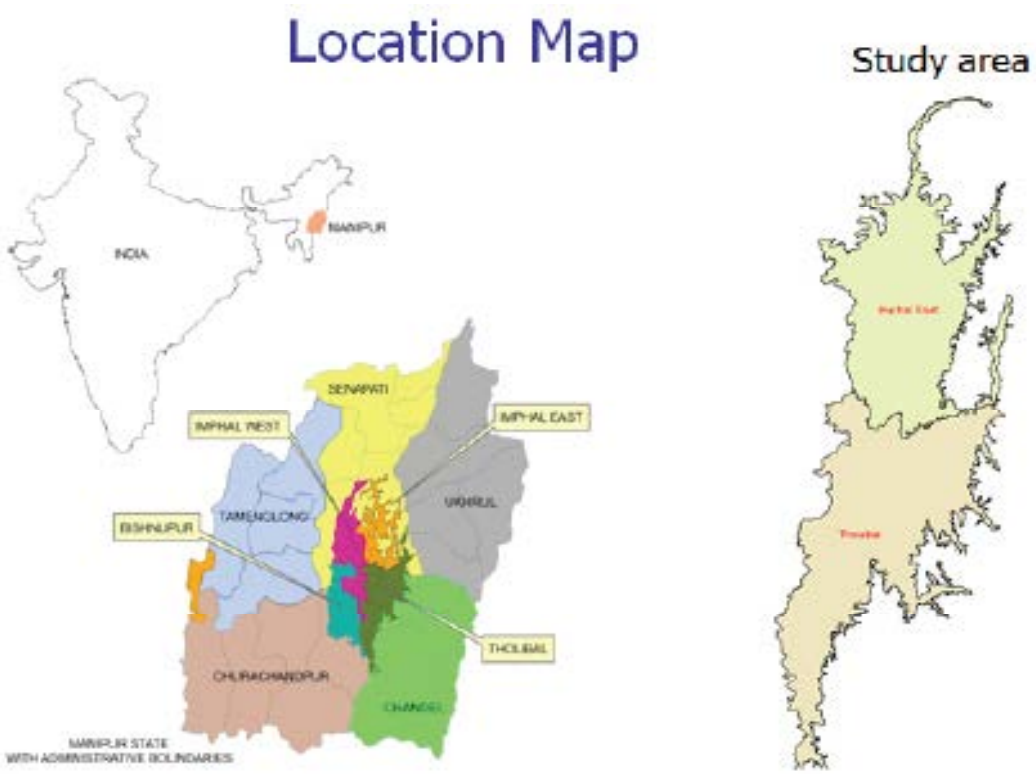

Figure 1: Location map of the study area.

Drainage and surface water bodies, base map and land use/land cover maps are generated by onscreen interpretation with the help of QB data on 1:10,000 scale with proper ground truth. Maps on Point of Interest (POI) are generated along with their geographical coordinates in all urban areas covering important landmarks such as Govt. offices, post offices, banks, religious places, and places of tourist interest etc. along with photographs. Using the existing soil maps generated by AISLUS and NBSS and LUP as a base, soil maps are prepared. Administrative boundary maps namely District, sub-divisions, village and cadastral maps of these two Districts are collected scanned and digitized. Attribute information is added to all these thematic maps. All these maps are geo-referenced to QB satellite data. All these thematic maps were also geo-referenced to the Survey of India topo grid. With the help of this geospatial database a customized GIS application is developed for e-governance which can be accessed by authorized beneficiaries through State Wide Area Network (SWAN). The application was deployed, and training was provided to all the department officials. A similar study was also carried out for two Districts of Sikkim which is being widely used by all government departments for all developmental programmes [10].

Results and Discussion

Using very high resolution satellite data, land use/land cover map was generated on 1:10,000 scale. As per the guidelines of National Remote Sensing Agency [11] Level 4 classification was followed and accordingly all land use/land cover categories were mapped. Different categories of road network (highway, metal road, un-metalled road, other roads, cart track etc.) maps were collected, scanned, digitized, geo-referenced to QB satellite data and attribute information was incorporated. Drainage and surface water bodies were mapped with the help of QB data. Point of Interest (POI) such as government organizations, educational institutes, medical centres, commercial complexes, hotels, hostels, cell towers, transformers, petrol pumps, places of worship, tourist places etc. were collected in all urban clusters with feature type, description, geographical coordinates, photographs and plotted on the image. Administrative boundaries like District, sub-division, village and cadastral maps were collected scanned, digitized, geo-referenced with the help of DGPS data and superimposed on to the high-resolution satellite data.

With the help of this geospatial database a web-based application is developed. The web application shows all feature and functions presented on the page and it is used to view and analyze the data. There are different functional tools to view the maps, select the features based on attribute queries, and edit selected feature information. The web application is deployed in the State data Centre (SDC) and training is provided to all government officials. Based on this application the user departments have sound reference for analysis of future planning.

Conclusion

The customized web application is helpful for e-governance which can be accessed by approved user departments with the help of State Wide Area Network (SWAN). Spatial and non-spatial information is readily available on a single platform in an easily retrievable and updatable form. The entire database is in a comprehensive manner in such a way that it can be readily useful for the requirement of user departments. This integrated geospatial database and web based tools provide necessary information for planners, decision makers and field level officers not only for land management and administrative planning but also in all developmental programmes of the two Districts. It is a first step towards embracing modern GIS tools for analysis and planning.

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