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Empowering the Electoral Planning and Monitoring System (EPMS) using GeoWeb tools and services – a case study on the Meghalaya legislative assembly election, 2018

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Abstract: This paper showcases the effective utilization of Information and Communication Technology (ICT) and Geospatial Technology based tools and services to empower the electoral planning and monitoring activities in the State of Meghalaya. The aim of the Electoral Planning and Monitoring System (EPMS) is to provide actionable inputs during pre-election preparation and also during the day polls. Live Geo-visualization of polling updates and turnout at the control room on the day of election is the vital component of system. It also generates the live heat map based on the live feed of polling updates from the various polling stations. EPMS is one of the unique initiatives of North Eastern Space Applications Centre (NESAC), Umiam, Meghalaya executed for the Office of the Chief Electoral Officer (CEO) of Meghalaya. The application was effectively utilized for the first time in the country during the last Meghalaya Legislative Assembly Election, 2018.

Keywords: ICT, geospatial technologies, GeoWeb Tools and Services, Electoral System

1. Introduction

India is the largest democracy of the world with the second largest population. In such a democratic system, time bound free and fair elections are compulsory phenomena. Elections decide the composition of the government, the membership of the two houses of the parliament, the state and the union territory legislative assemblies, the Presidency and the vice-presidency (ECI portal). Elections for the Lok Sabha and every State Legislative Assembly are required to take place every five years, unless called earlier by the Election Commission of India (ECI) due to extra- ordinary circumstances. Conducting elections for either the Lok Sabha or Vidhan Sabha in a country as populous as India with tremendous diversity in social, cultural and topographical levels is a hectic exercise. It demands involvement of large human resources with government machinery and technical endeavours. Currently, advanced technological tools are being employed in the election planning, monitoring and result dissemination. The ECI has been exploring the modern Information and Communication Technology (ICT) tools to improve the fidelity of the electoral rolls (Chutia 2011). A number of web applications and including Mobile Apps are already developed for ECI for planning electoral activities. For example, Returning Officer (RO) Net of ECI was tuned by the Chief Electoral Officer (CEO), Punjab for assisting Returning Officers in the arc of their duties right from the nomination process till the counting of votes. Some other instance is the ECI 360 degree mobile app used in the general elections 2016 as a prototype to share necessary information (e.g. Advancement of the nomination process), facilitate interactions among the electoral officials, including political parties and media during the election. Suraksha is another important App of ECI to provide details security related aspects during the election. The ECI Apps Suite is another step of ECI during 2018 towards empowering the electoral process in a democratic manner. In addition, few studies in the applications of geospatial technologies have been reported towards planning and management of election in India. A list of some applications that have been created to aid the election planning and monitoring process are presented in table 1. The Election Commission portal is made available via Bhuvan geoportal of Indian Space Research Organization (ISRO) to provide critical information on the polling stations in terms of 17 important parameters as function of pre-poll requirements. It eases the tool for vehicle tracking and incident reporting. Users can upload the information on basic minimum facility. Heat map algorithm (Susewind 2014) was proposed for demarcation of constituency boundaries using polling booth datasets published by ECI. Election Management System (Chutia 2011) developed for the state of Meghalaya as per the suggestion of CEO, Meghalaya is a spatial decision support system (SDSS) on electoral process. It provides the optimal locations of polling stations in the spatial domain as per the guidelines of ECI.

Nevertheless, none of the applications were synergized together with ICT and geospatial technology for real time planning and monitoring of the electoral scheme. Hence, considering the updated database of EMS (Chutia 2011) as a foundation, we conceived a novel EPMS as per the suggestions of CEO, Meghalaya to plan the last Meghalaya Legislative Assembly Election, 2018 more effectively.

2. Methodology

Proposed Electoral Planning and Monitoring System (EPMS) has three major modules; 1) e-Atlas Manager, 2) Live Dashboard and 3) Updation module. The e-Atlas module of EPMS is the core of the application with different capabilities and functionalities and internetworked with the other modules. Availability of geospatial information and the services of the modules are synoptically illustrated in figure 1. The capabilities and functionalities of each module are as listed in table-2. The landing page of e-Atlas Manager of EPMS hosted at election.nedrp.gov.in (NEDRP portal) is shown in figure

2. It provides an interactive and responsive user interface (UI) for visualization of geospatial layers, on the fly-statistics with proximity and multi-dimensional querying capability. Live Dashboard and Updation modules are hyperlinked from the e-Atlas Manager. Live Dashboard is one of the powerful and unique modules of the entire application to offer live visualization of polling updates and turn out at the time of the Election Day. It also provides the heat map representing the occurrences polls based on the live feed of polling updates from the various polling stations. Updating module is another important tool for updating the details of polling stations or the addition of any new polling station in spatial domain without interacting with any GIS software or Application Programming Interface (API). The result of a multidimensional query is depicted in figure 3 as an example

Table 1: List of few ICT and geospatial based applications developed for electoral planning

Previous applications	Domain	Service features	Goals
RO Net	ICT	Web, MobileApp & SMS	DSS on electoral planning
ECI 360	ICT	MobileApp	Overall knowledge base on electoral process
Suraksha App	ICT	MobileApp	DSS on security related issues
EMS	ICT & Geospatial Tech.	WebGIS	SDSS on electoral planning & optimization of polling station locations
Bhuvan	ICT & Geospatial Tech.	WebGIS and MobileApp	SDSS on Important pre-poll requirements
Susewind R. (2014)	Geospatial Tech.	GIS	Demarcation of boundary for constituencies
ECI Apps Suite 2018	ICT	MobileApp	Single window platform of all ECI web and MobileApps

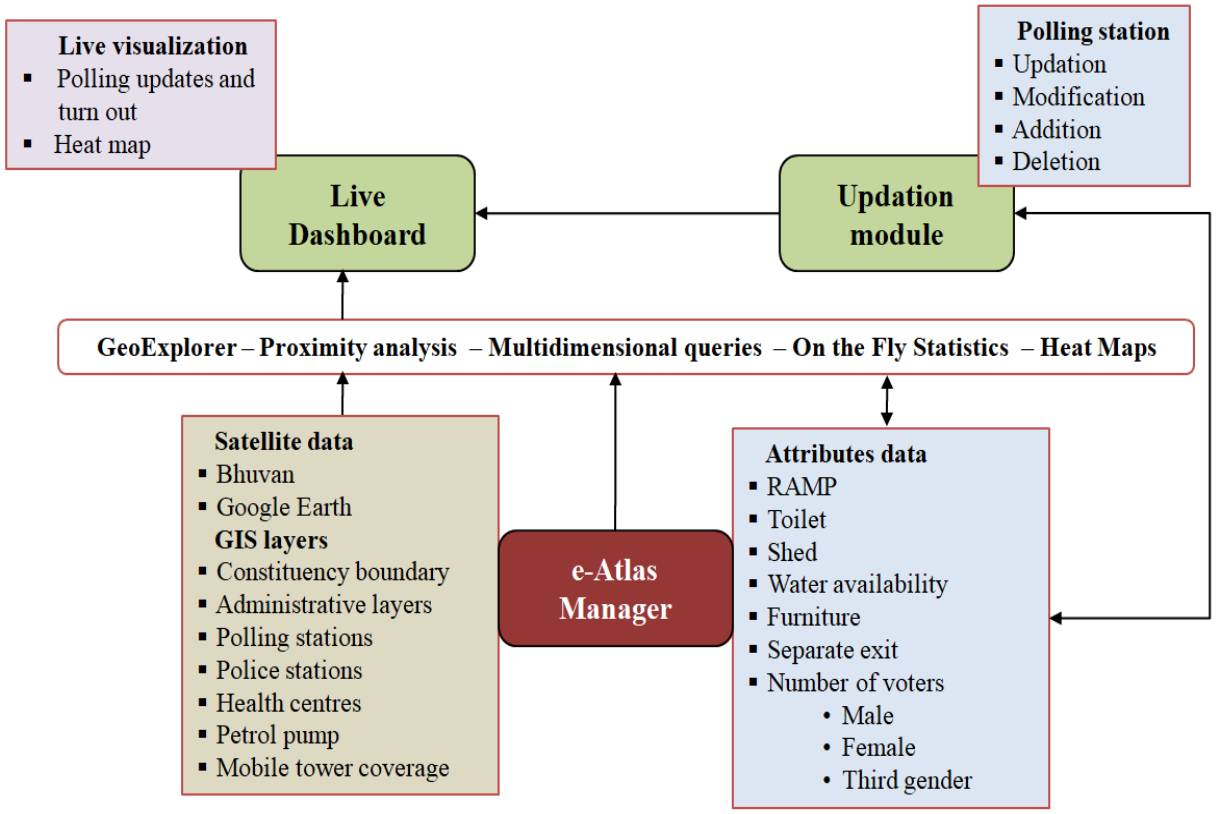

Figure 1: Availability of geospatial information and the services of respective modules are illustrated synoptically.

Table 2: Capabilities and functionalities of different modules of the developed EPMS

Modules	Capabilities and functionalities
e-Atlas Manager	• GeoExplorer: roads, settlements, police and polling stations, health centres, mobile networks, Assembly and Parliamentary Constituencies boundary and satellite base map (Bhuvan/Google) • Proximity to: roads, police and polling stations, assured minimum facility (AMF), health centres, State and International boundary • Multi-dimensional query: between proximity, AMF and voter counts • Heat map based on spatial frequency of polling stations
Live Dashboard	• Live visualization of polling updates and turn out • Heat map generation based on live polling updates • Categorized view of polling statistics
Updation module	• Updation of existing polling stations details • Addition of new polling stations • Live updation of polls for Live Dashboard

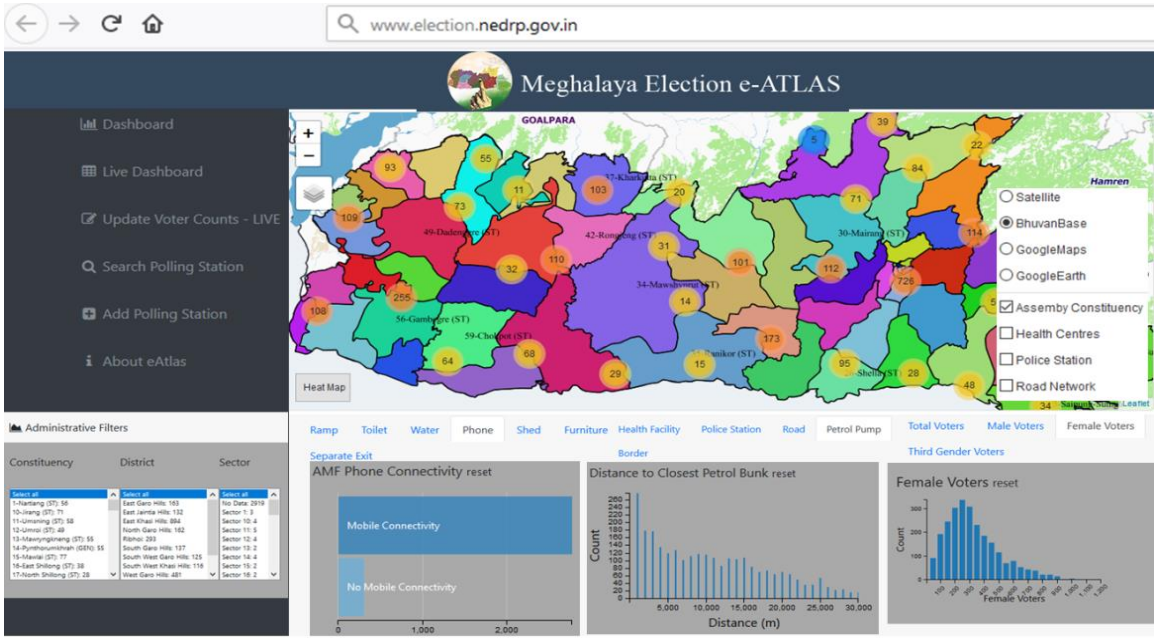

Figure 2: The landing page of EPMS hosted at election.nedrp.gov.in

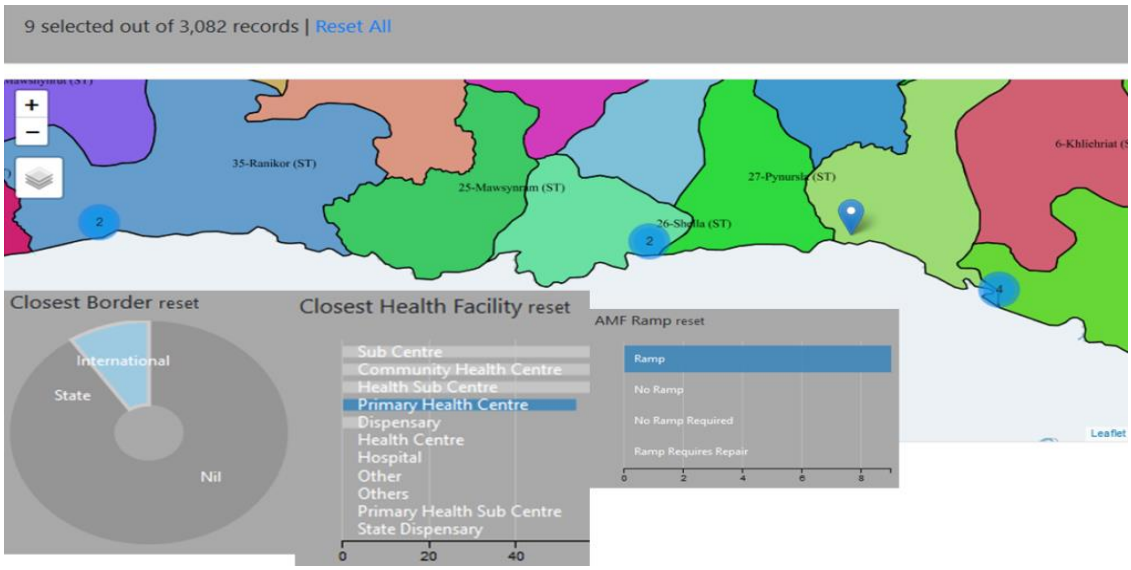

Figure 3: An example of multidimensional query fired to find out the list polling stations nearer to the International boundary having primary health centre and assured minimum facility (AMF)

2.1 Architecture of EPMS

The application comprises of a 3-tier architecture; 1) Database, 2) GIS server and the 3) Web/client mapping tier. The database used for the application is PostgreSQL 9.6. PostgreSQL was chosen as it offers a rich library of spatial querying methods when used with the PostGIS extension. PostgreSQL is enriched with flexible permissions system, with the ability to bundle out specific privileges to specific roles, and provide users with the powers of one or more of those roles. In addition, it uses multiple different systems to authenticate users. The geometry of the vector layers has been stashed away in the database in the Well Known Text (WKT) format. The access to the data is improved by the presence of indexes which were created keeping two factors in mind: numerical queries and spatial questions. The Generic Index Structure (GiST, Douglas 1979) was preferred for spatial queries as it was more effective in spatial indexing as compared by to B-Tree (Hellerstein et al. 1995) Geospatial data is served to the client end via Open Geospatial Consortium (OGC) services. These services are generated with the help of GIS servers and in this case Geoserver is used to serve the information as web mapping services (WMS) as well as web feature services (WFS). The architectural design follows the service oriented architecture (SOA). The services are being provided to the other modules by application interface, through a communication protocol over a network. Geoserver acts as a platform to host these services as well as to attach additional data onto the layers such as styling and layer projection. GeoServer allows access to be determined on a per-layer basis. Providing access to layers is routed via roles. Layers and roles are linked in a file located in the security directory. It contains the rules that control access to workspaces and layers. The client side application is a browser based application. Services generated by Geoserver need to be hosted in a WWW browser – this is accomplished using JavaScript based leaflet APIs. Leaflet acts as a platform for visualizing the geospatial data that are hosted via Geoserver. Map data are passed to the user browser as JavaScript Object Notation (JSON) objects.

The application offers the functionality to query between live polling mode as well as poll station information management mode. User can also query based on the parameters which are attached to the spatial layer as attributes (the query is carried out on the client side with the help of the JavaScript based API, Cross Filter which is a platform for carrying out multi-attribute queries utilizing clients' resources, allowing server to be extensible for data hosting) as well as perform a search upon multiple numeric and non-numeric parameters like distance from nearest petrol bank and police station or nearest hospital. The search results can be used to navigate to the appropriate polling station entry. Further queries can be fired dynamically based on its major attributes. Access to the application needs to pass through the central authentication system (CAS). The architectural flowchart is illustrated in figure 4.

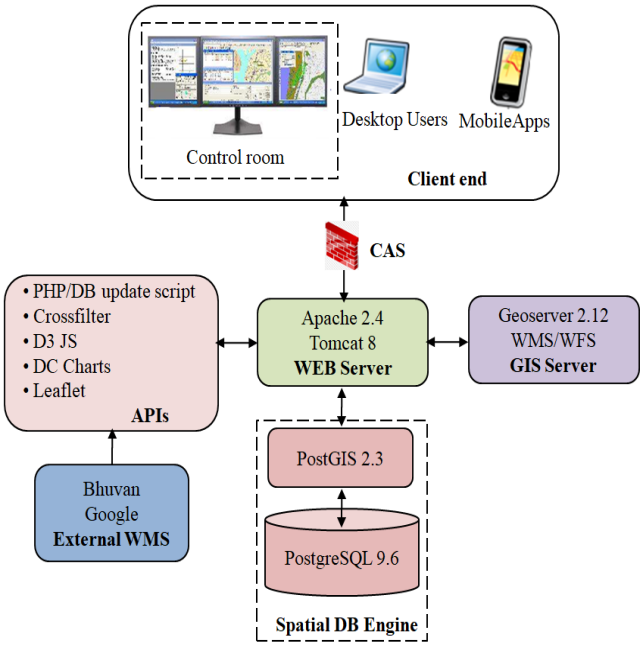

Figure 4: Architectural flowchart of the EPMS

3. Discussion

EPMS was developed in a phase manner to meet the requirements of CEO, Meghalaya. New tools and functionalities have been incorporated into each phase of development as per the suggestions. The application was made functional for testing and updating of polling details much before the last Meghalaya Legislative Assembly Election, 2018 held on February 27, 2018. CEO, Meghalaya also launched the election e-Atlas on September 27, 2017 during a State level function. The greatest challenge was to deal with the live feeding of polls of more than 3082 polling stations of Meghalaya during the day of election. Two control rooms were set-up; one at the Office of Deputy Commissioner (DC), RiBhoi district and another one at North Eastern Space Applications Centre (NESAC), Umiam, Meghalaya. The key aim was to capture the live feeds of the polls and to display into the display panel of the DC Office (Figure 5) via GeoExplorer.

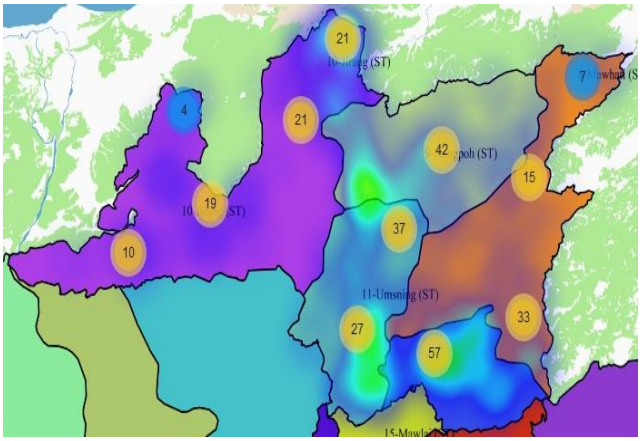

Figure 5: Live visualization of the density of polls demonstrated via a heat map in RiBhoi district

Subsequently, the portal was effectively utilized during the 43-Williamnagar (ST) by-election held on April, 2018. Before that the application was further amended with the enhanced functionalities as per the suggestion of DC, Williamnagar. A team of NESAC staff was deployed at the district Hq. to support the live feeding of polls. Live visualization of polling updates and turnout in 43-Williamnagar (ST) Assembly Constituency is depicted in the figure 6.

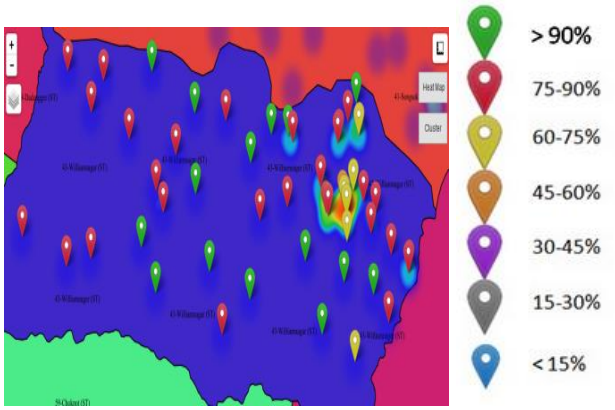

Figure 6: Geo-visualization of live polling turn out or polling percentage in 43-Williamnagar (ST) Assembly Constituency

The percentages given in the right side of the figure 6 with different colours reports the percentage of polls of different polling stations at any moment of time. At the end of the polling, the turnout report may be generated for inspection.

4. Conclusion

The study described here presents the utmost usage of ICT and geospatial technology and services for empowering the electoral process in the State of Meghalaya. It ensures the increased accountability, transparency and efficiency of the electoral system. This is one of the unique initiatives of CEO, Meghalaya towards strengthening the democratic process and this may be replicated to the country level operational activity. Recently, the application is also made available at apps.nesdr.gov.in/election.

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