Web-based GIS ancestral domain management using pull technology

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Abstract. The changes made by emerging technologies brought a significant effect on how people deal with everyday living even the least and reserved individuals in the community. In the Philippines, especially the National Commission on Indigenous Peoples (NCIP) a commission empowered to take the necessary protection and preservation of welfare, rights, and culture among IP's has been affected by this rapid changes, particularly the Ancestral Domains. It has twenty (20) Certified Ancestral Domain Title (CADT’s), two (2) ongoing and CADTiables comprising areas of the Caraga region. Gathering and producing of information has always been a challenge but over the years it was eventually resolved into manually storing and keeping of data into the computer. Time, being an essential factor in the delivery of service to the IP clients and vital in coordination with other agencies, as much as possible the office responds immediately to the needs of the clients by providing them with reliable and accurate data. However, with the current status quo, retrieving files will take time, thus delaying coordination and delaying delivery of service to the clients. A “Web-based GIS Ancestral Domain Management Using Pull Technology” is a response to the pressing needs of the commission to the delivery of service to their clients, a digitized spatial data banking. The system is packed with a variety of technologies such as Mobile, Web, GIS, and other mapping tools and frameworks; scripting languages and database software integrating therein that made it functional. Thus, providing a convenient and efficient way of information generation.

1. Introduction

In today's era, incipient and emerging technologies have helped a lot the way people do, move, work and even play throughout the hemisphere[1]; the use of new technology change the views for any corporation, business enthusiasts, individuals, and government institutions. Web-based GIS has flourished in providing visually appealing data presentation on the map, and other spatial information[2], a direct way of informing the community about specific phenomenon can be done through interactive maps[3]. In the Philippines, particularly Butuan City, the center of commerce and trade in the Caraga region has roughly changed the living of the Butuanons due to the shaping of needs and lifestyle. NCIP is a commission under the Office of the President goal to shift their community services from the tedious manual processes to automation to keep updated of the current trends and provide fresh information to their clientele [4], especially in the service of the IP’s and mandated by Philippine Law[5]. NCIP Region 13, have 20 Certificates of Ancestral Domain Title (CADT's), two ongoing CADT's and Cadtiables, which composed of 4 Provinces to name; Agusan del Norte, Agusan del Sur, Surigao del Norte, and Surigao del Sur, in Caraga Region. Gathering of data has always been a challenge, but over the years it was eventually resolved into manually storing of data into the computer and handwritten by the NCIP personnel.
With an influx of validation activities, documentation process on the various implementation of programs for the welfare of the IP/ICC’s. There has been an information overload on the retrieval of the information whenever needed and necessary for either public consumption, used for researches or used by other regional line agencies who are NCIP's partners as advocates of promoting and preserving the rights of our IP clients [6]. Time, being an essential factor in the delivery of service to the IP clients and vital in coordination with other agencies, as much as possible the office responds immediately to the needs of the clients by providing them with reliable and accurate data. However, with the current status quo, retrieving files will take time, thus delaying coordination and delaying delivery of service to their clients. A “Web-Based GIS Ancestral Domain Management Using Pull Technology” is a response to the pressing needs of the commission to deliver the quality services to their clients. The system is composed of a variety of technologies such as Mobile, Web, Cloud computing, GIS and other mapping tools and frameworks, scripting languages and database software integrating therein that made it functional.

2. Literature Review
There are abundant studies and literature on geographic information systems in diverse applications[7]. Some intended it for mapping and visualization[8], a good way is through web application incorporating GIS tools to provide more detailed information. In the study of Vaitis, et al., they used GIS in order to present and data about climate change in Greece[2], it allows a spatial GIS that enhances management, visualization and even decision making[9]. In likewise manner, Kulawiak, et al., also uses GIS to project and present the sea level of Baltic [10], explicitly monitoring the depth of the shallow sea. Bhatia et al. developed web-based GIS using an open source Leaflet and GeoServer toolkit [11] that helps to create mobile-friendly interactive maps[3]. The combination of GIS and Internet offers excellent possibilities, such as interactive access to geospatial data, data integration and transmission[12], in which is the paper of Potter emphasized that web applications will compelling visual information are much more needed in any development.

Helali et al. believed that disseminating meaningful spatial information on the web significantly improves the decision-making process of any organization[13], and based on their work, it increases performance and efficiency. While the work of Singh, on web GIS-based framework for citizen reporting on the collection of solid waste and mapping has exuded convenient way of mapping [14][15], [16]and tracking of the solid waste facility[17]. With end-user reporting and lodging, complaints that makes municipal officers respond directly to any complaints.

With extensive information on the application of GIS with integration also of the Global positioning system(GPS) [11], [18], this makes this study more applied to the current situation of NCIP Caraga with regards to management of ancestral domains among the indigenous people. Because they need to be taking care of their domain lands and the possible way to resolve land disputes especially on boundary and acquisition, and preservation of the inherit lands[19].

3. Methodology
The development of the project uses Iterative Model which involves build phase, design and development phase, and testing phase.

3.1 Build Phase
According to NCIP Region 13 CADT’s are issued to the IP’s in order to protect the ancestral domain from illegal entry. This CADT’s are classified generally as approved, on-going and cadtiables. As of today NCIP Region 13 already have a copy of paper-based and individual shapefiles of 20 CADT’s and 2 CADT application. Cadtiables are on process. Geodetic Engineers of the commission are responsible for gathering the data in order to make the shapefiles. The actual size and location of the CADT’s are surveyed individually to plot the map accurately. Shapefile are made digitally but are issued in the paper base.
3.2 Design and Development Phase

The design of the system uses web-applications and plugins that allows users to upload map data in geojson form which can be viewed as a web-map application[20]. Geojson is a format designed to simple geographic features based on JavaScript Object Notation (JSON) and are made from shapefiles using third party software, and the researcher preferably uses Quantum GIS (QGIS).

Figure 1. Depicts the entire map of Caraga region that the agency has approved to be ancestral domain land.

Figure 2. GeoJSON Shape File. This is how a shapefile be converted into GeoJSON file, hence uploading shapefile in the map requires only GeoJSON-ready file[21].
Also, a system architecture is designed to reflect the user level and access on the entire application as presented in the following figure.

![System Architecture Diagram]

**Figure 3.** System Architecture. The figure depicts how public users and NCIP officials can access the system. Different users have different user roles and levels, and all data from the rendering interface are coming from a web server with databases on it.

### 3.3 Testing Phase
During this phase, alpha and beta tests have been conducted to ensure that the application fully complies with the user's needs and requirements. Before the implementation of the system, the hardware specifications and server configuration are appropriately managed and planned. Random testing was also conducted to the future users of the system inside the NCIP agency.

### 4. Results and Discussion
The following are the results of the development of "Web-Based GIS Ancestral Domain Management Using Pull Technology." Based on the data acquired, map management and visualization among other users are of importance in the entire application.
Figure 4. Manage Map. A module for managing or updating shapefiles and maps.

This represents the manage map page which enables the user with an admin account to add shape to map, update shape and other information, add location to map and remove location to map. Updating shapefile and maps are done in this module.

Figure 5. Caraga CADT Map. The Caraga region map with overlaying CADT maps within.

Figure 5 illustrates the CADT map of Caraga region. Showing all shapes with the corresponding color on the legend to identify the name of the CADT. With the aid of Google Map API, the shapefile is overlain in the Google map.
Figure 6. Agusan del Norte map. Selection of province map covered within the region of Caraga pushes said map to be editable.

The figure depicts the map of Agusan del Norte with its respective CADT's. Every CADT has a marker on it, and it is clickable. Whenever the user hits the marker, a modal will be produced showing the details of the CADT and two (2) links for the printable map and full profile of the CADT in pdf or document form.

Figure 7. Printable map of CADT 022. A printable-ready map is available from the system.

The figure shows the printable map of CADT 022 which is in pdf form and can be downloaded from the link provided by the system. The map shows the location map of the CADT and the barangays where the CADT belongs.
5. Conclusion

In this study, upon viewing and testing by the respondents and the NCIP Caraga employees, the developed system for ancestral domain and land management system using JSON has been achieved, and data for web mapping and twitter bootstrap with apache server for the web application is integrated[22]. The system helps the NCIP Caraga offices store their data (shapefile) on a database with the centralized data server. This further enables them to transact online which is more efficient than the manual method of processes. With the use of the map, they can quickly figure out the location and information of the CADTs.

Further, indicates that the respondents find that the software is useful and provide a friendly user interface and reliable information is accomplished. With this recent development of mapping CADTs, Indigenous People in Caraga has now an efficient and convenient way[23] of locating their ancestral lands and domains. As a result of this study, the agency has a more natural way of visualizing data maps rather than on hard print out materials. This further concludes that the project significantly improved in the processing and verification of domain lands amongst IPs[19].

6. Future Works

The researcher recommends the following that will help in the improvement of the system.

1. Enables the system to adequately manage the data of Indigenous peoples by providing more modules and functionalities;
2. The GPS capability should be maximized as an integrative tool to locate exact coordinates and points in the map;
3. Add chart for the number of Indigenous People (IP’s) for decision making and other visual information on the land title;
4. Further, enhance as a more dynamic mapping and visually-aiding maps.
5. There should be security measure when the application is deployed and used, especially in the web infrastructure where data transmission of volatile of breached[24].

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