Sustainable Planning Information Sharing System and Evolution of Digital Geo-Spatial Data Dissemination Platform in Web-GIS Environment

Urban Development Directorate
Ministry of Housing and Public Works
Government of the People's Republic of Bangladesh
June, 2018

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ACKNOWLEDGEMENT

It is our great pleasure to express the heartiest satisfaction that Urban Development Directorate (UDD) has successfully completed a Research work entitled "Sustainable Planning Information Sharing System and Evolution of Digital Geo-Spatial Data Disseminating Platform in Web-GIS Environment". This Research work is done in pursuit of dissemination of digital geo-spatial data through Web-GIS based planning information sharing system.

The research team is highly grateful to Engineer Mosharraf Hossain, MP, Honorable Minister for Ministry of Housing and Public Works for inaugurating the Web GIS in the Ninth Session of the World Urban Forum (WUF 9) held in Kuala Lumpur, Malaysia in April, 2018.

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Last but not list, the research team express their indebtness to the assistance provided by the officers and staffs of UDD for providing other necessary assistance for successful completion of the research work.

Research Team Composition

UDD Team

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1. Introduction

Rapid urbanization in developing countries has been observed to be relatively high in the last two decades, especially in the Asian and African regions. Although many researchers have made efforts to improve the understanding of the urbanization trends of various cities in Asia and Africa, the absence of platforms where local stakeholders can visualize and obtain processed urbanization data for their specific needs or analysis, still remains a gap. In this research paper, we present feasibility of an Internet-based GIS platform called Development of Web based Geographic Information System (Web-GIS). The Platform will be developed in view of the urban planning and management challenges in Bangladesh, due to the limited availability of data resources, effective tools, and proficiency in data analysis. It will provide online access, visualization and data sharing services within an interactive framework of the Web-GIS, with the third-party map services using HTML5/JavaScript techniques. Through the integration of GIS, remote sensing and Internet GIS, several indicators for analyzing urbanization are provided in Web-GIS to give diverse perspectives on the urbanization of not only the physical land surface condition, but also the relationships of population, energy use, and the environment. The design, architecture, system functions and uses of this platform are discussed in the paper. It is aimed at contributing to sustainable urban development in Bangladesh a developing country of Asia.

2. Background

Although urbanization has generally been an issue of Bangladesh, the technology advances, globalization, transport systems evolution, and rapid population growth have transformed urbanization into a worldwide issue. Notwithstanding the benefits of urbanization (e.g., economic growth), it poses a potential threat to urban development without sustainable planning, and can damage the stability of the existing social system and bring chaos in some extreme situations. The challenges of urbanization are even more problematic in developing countries like Bangladesh due to limited funds, the absence of appropriate technologies, and a limited number of specialists, which make sustainable future urban development difficult.

Primate cities in developing countries of the Asian and African regions like Dhaka the capital of Bangladesh have arguably been the most rapidly urbanized in the last two decades. It is for this reason many researchers have focused on urbanization patterns in the developing countries. Although these researchers have made efforts to improve the understanding of the urbanization trends of cities in Bangladesh, the absence of platforms where local stakeholders (e.g., planners and policy makers) can visualize and obtain already processed data for their specific needs or analysis, still remains a gap.

On the other hand, Internet-based GIS has been widely recognized in both public and private organizations as a fundamental tool for storage and distribution of data to targeted audiences. Internet GIS refers to a network-centric GIS tool that uses the Internet as a primary means of providing access to distributed data and other information, disseminating spatial information, and conducting GIS analysis. The development of platforms integrating Internet-based GIS has since increased over the last two decades. Many projects have attempted to use Internet-based GIS platforms to assist their targeted audiences (e.g., general users, decision makers, local communities, governments, and researchers) overcome the challenges of limited availability of

data resources and effective analysis tools. For instance, various platforms have been developed in the fields of natural resources management and conservation, such as in enhancing public participation in wind farm planning, Iceland conservation, fauna, flora and plant landscape data management, and civil protection and emergency management. Other platforms are focused on decision support. Examples include environmental sustainability and natural hazards and risk management. However, there are few Internet-based GIS platforms (e.g., urban observatory, http://www.urbanobservatory.org/) that are focused on urbanization in the developing countries within Asia and Africa. Moreover, most of the platforms are not open, and their databases are not freely available to the public.

Therefore, in this paper, we present feasibility of an open Internet-based GIS platform for data sharing, visualization, and spatial analysis of urbanization in context of Bangladesh. The Platform is aimed at contributing to sustainable urban development in the developing country like Bangladesh. The platform provides a geo-spatial database of indicators for analyzing urbanization through the physical land surface conditions and their relationships with population, energy use, and the environment. The targeted audience is, but not limited to, urban planners, decision makers, local communities, governments, and researchers. To present the platform, the paper is organized as follows. First, we discuss the development of Internet-based GIS technology i.e., the progress

from mainframe Geographic Information Systems contributed Data base. Secondly, we present the system design, including the architecture, creation of the geodatabase, and the system implementation. We then (third) present the system functions and usage for potential users to understand how they can use the platform. We also discuss (fourth) the scientific contribution and limitations of the platform. We conclude the paper with a discussion on potential future works.

3. GIS Technology: Mainframe GIS ystems to Distributed GIS Services

With the development of computational capability, mobile devices and Internet technology, the method, and carrier for GIS computing have advanced from the traditional mainframe and desktop (stand-alone) GIS systems to the Internet-based (distributed) GIS services in the past half-century. The historical development of GIS technology along with the evolution of the Internet has not only improved the methods of data acquisition, but also the carriers for geoprocessing. One of the recent advancements in Internet-based GIS services technology is the use of Interactive Web-GIS platforms. Interactive Web-GIS platforms provide geoprocessing functions that can bring scalable, on-demand, and cost-effective geoprocessing services to geospatial users. Notwithstanding the undoubted power and expandability of spatial analysis in mainframe and desktop GIS systems, many traditional GIS software are still largely platform-dependent as they are usually written in programming languages that have to be recompiled between different operating systems. Due to the cost reduction of data storage and transmission on the Internet, plus increased computing ability in Interactive Web-GIS Services, more people have started to utilize Interactive Web-GIS based geoprocessing instead of the traditional desktop analysis.

In the inception stage, due to limited computing resources and technology, both data collection and geoprocessing could only be done by a local client. With the emergence of Internet, people could access more types of the dataset from the network storage to enrich their approaches, although

geoprocessing was still limited to local clients. The first stages represent the typical mainframe and desktop (stand-alone) GIS systems. Next stage which represents the present-day distributed GIS services has benefited from the current Internet web and mobile services, as well as accessibility to big data and the power of internet geoprocessing. With the distributed GIServices everyone can access the immense cloud geographic data as they want, and the massive cloud computing lets the user do the heavy geoprocessing faster than any local client. Furthermore, in the next generation, all the geoprocessing has been moved to cloud-based processing. A good example of a internet-computing platform that applies the next generation pattern is the Google Earth Engine (https://earthengine.google.com/), which is used for processing huge raster satellite imagery by Google Inc (Mountain View, CA, USA). The platform presented in this paper uses applying both local and internet geoprocessing to establish the GIS services.

4. System Design

To develop architecture of two tire Web GIS that involves a server and more clients, where the server is a Web application server and the client is on a Web browser. The server will have a URL so that client can find it on the Web. The client will rely on HTTP specifications to send request to the server. The server will perform the requested GIS operation and will send a response to the client via HTTP. The format of the response may be an HTML which will be used by the Web browser client or may be XML or JavaScript. In summary it can be said assignment will a GIS application that uses Web technology to communicate between computers.

4.1 Basic System Architecture:

In performing the GIS analysis tasks, WebGIS is similar to the client/server typical two-ties architecture. The geo processing is breaking down in the server side and client-side tasks. A client typically is a Web browser. The server side consists of a Web server, WebGIS software and database.

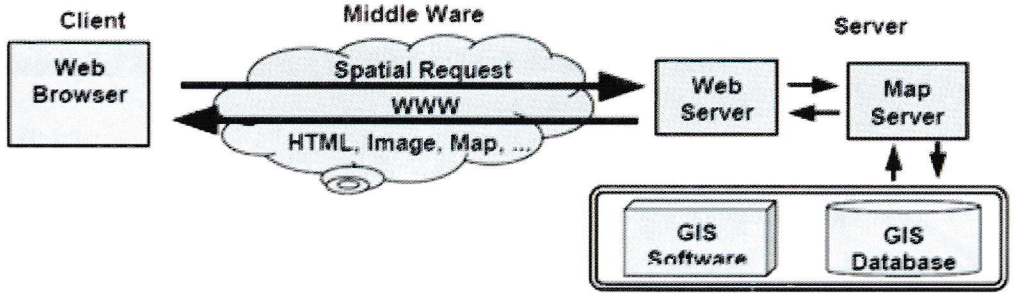


Figure: How a WebGIS model works

4.2 Design Pattern:

Web GIS Application = Base map (Administrative layer, land use layer, feature layer.)
+ Operational Layers
+ Tools

1.3 Objectives of the Assignment:

The objective of this assignment is, to develop a WebGIS based interactive land use information system to support its stakeholders with easy visualization & dissemination of proposed GIS based land use with user friendly environment which will facilitate user with authenticate Geo-information from anywhere any time.

4.4 Functions of Web GIS:

Mapping (visualization) and query: web mapping, as the face of Web GIS, is the most commonly used function. GIS data and analysis results are usually presented as map. Every location on the map, attributes to support operation like spatial identification.

Dissemination of geospatial information: Web GIS is the ideal platform for the wide distribution of information. This application allows users to view operational results and download map and information. For example government's agencies like RAJUK using Web GIS to inform proposed land use of its jurisdictional area. These geo-portals encourage collaboration and cooperation among and across departments and organizations. These help organization to leverage existing geospatial resources rather than duplication efforts re-creating them, leading to reduced costs and increased efficiency.

Geospatial analysis: Web GIS has gone beyond mere mapping. It also provides analytical functions like those closely related to daily life, such as measuring distances and areas, finding suitable space for business, construction and others.

Besides this, one of the interesting and new functions of the map is its role in a search engine. This is especially relevant in the environment of a geospatial data infrastructure (GSDI). Maps can also be used as a metaphor, and as such function as an index to other information. The hyper-linked nature of the Web allows this information to be of geographical or non-geographical nature. Particular map elements can be linked to other, more detailed maps, geospatial data sets, drawings, photographs, text, and videos or animations.

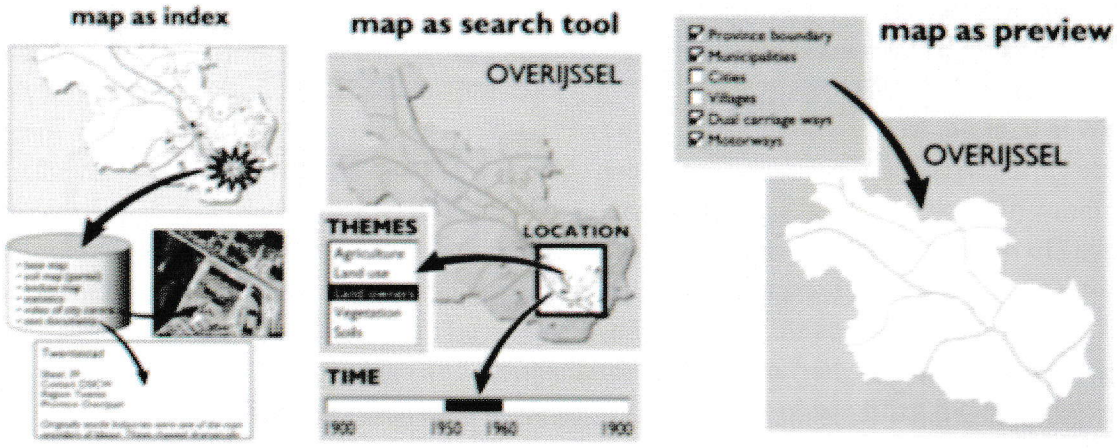


Figure: Functions of the map on the Web. From left to right, the map as an index to other geographic and/or non-geographic data, as part of a search engine in a local geodata infrastructure, and as preview of data to be downloaded.

5. UDD's benefits of this assignment:

The internet and web removed the constrain of distance from cyberspace, allowing instant access to information over the web without regards to how far apart the user and the server might be from each other.

5.1 A step forward as a developed country:

As a government agency to maximize the serving ability with transparency and efficiently, Web base access to information is the only way. To being on the way to developing country introducing Web base information system is like stepping forward to development.

5.2 A global reach:

A developer can present Web GIS application to the world, and the world can see them. A user can access Web application from their home computer or cell phone.

5.3 A large number of users:

In general, a traditional desktop GIS is used by only one user at a time, while a WebGIS can be used by hundreds of user simultaneously.

5.4 Better cross-platform capability:

The majority of clients of Web GIS are Web browsers such as Internet Explorer, Mozilla Firefox, Apple Safari and Google Chrome for diverse operating systems including Microsoft Windows, Linux, and Apple Mac OS. These Web browsers largely comply with HTML and JavaScript standards. Web GIS than relies on HTML clients typically supports with different operating system. Web GIS that relies on Java, NET and Flex clients can run on multiple platforms where the required run-time environment in installed.

5.5 Low cost as averaged by the number of users:

In the spirit of the Internet, the vast majority of the Internet contents are free of cost to end user. Like that, to use Web GIS no need to buy software or pay to end user.

5.6 Easy to use for end users:

Desktop GIS is intended for professional users with years of training and experience in GIS. Web GIS is intended for a broad audience, including public user who may know nothing about GIS.

5.7 Unified update:

For desktop GIS to be updated to a new version, the update needs to be installed on every computer. For Web GIS, one update works for all clients, making updating a lot easier.

6. Target User:

As a government institutes UDD has a wide range of stakeholder in professional and academic sector from national and international platform. But prime target user is general people of project area. Policy makers and administrative personnel are also vital target.

7. Work Plan and Approach

Tasks	Output
Preparing Server system for web GIS Establish JAVA platform Include service and servlet engine Construct server environment	Server system for Web GIS
Preparing Geo-database for Author Reconstruction of topography of administrative feature database. Conversion of feature database from provided form to appropriate form. Preparing several layer of data. Such as query database, symbology layer, output layer. Minimizing overshoot and undershoot problem of feature. Rewriting each layer's attribute in software format (or making SQL).	Base file for WebGIS. (.axl file)
Development of architecture in Designer Path declaration for resource data and output data. Declaration of service location. Declaration of service name. Declaration of automatic output management. Nomination of web layer and declaration of hierarchy. Declaration of layer visibility and scale dependency.	Service for WebGIS
Administrative function declaration Defining service control Defining Auto start up system Defining automatic clean up system	Web GIS Function

8. Discussion

The Web-GIS project is focused on discrimination of urbanization data sharing to contribute to participatory approach for sustainable urban development. From a scientific standpoint, the contribution of this project is twofold.

Firstly, to provide a diverse perspective of urban development, Web-GIS provides a geodatabase of important urbanization indicator (i.e., present Land Use/Cover, Infrastructure and Network, Important Planning input and future Land Use/Cover), processed by using scientifically proven methodologies applied in Cartography and GIS. Understanding the spatiotemporal patterns of Land Use/Cover is necessary for making rational economic, social, and environmental policies that can mitigate the negative effects of urbanization on the environment, and maintain optimal ecosystem functioning. Also, examining the spatiotemporal patterns of Land Use/Cover together with an opportunity to understand the urbanization effect phenomenon. In fact, in the context of Bangladesh, very few studies exist on the urbanization effect. The urbanization effect are

responsible for some negative impacts, such as increased energy consumption, increased emissions of air pollutants and greenhouse gasses, compromised human health and comfort, and impaired water quality. Thus, Web GIS platform also provides processed data human population. Therefore, the project has the potential to contribute not only to sustainable urban development, but also to social and economic development in Bangladesh. There are no projects that have processed such huge datasets of these specific urbanization indicators in Asia and Africa, and made them available to the public freely. Access to the above data in one platform gives the opportunity to urban planners and policy makers as well as general people to understand the urbanization trends locally, as well as learn from regional trends.

Secondly, it is focused on the use of Internet-GIS techniques to study and share the knowledge of urbanization in Bangladesh to the public. Compared with traditional desktop GIS systems and software, it provides a non-platform dependent and widely accessible system for urbanization studies, which remarkably reduces the threshold for physical, technique, and funds requirements. From the technical perspective, the developed architecture and functionality has some unique features that can be easily used to develop new extensions and functions. For instance, the use of HTML5/JavaScript techniques provides high flexibility and expandability in the system developing, which could be a reference for readers to develop similar applications. Additionally, based on a number of lessons learned and feedback from general users, the analysis modules in the platform are provided in a progressive without too complex functions.

9. Dissemination of the Developed Web GIS Platform

The developed Web GIs was presented the Ninth Session of the World Urban Forum (WUF 9), which was held in Kuala Lumpur, Malaysia in April, 2018. Engineer Mosharraf Hossain MP, Honorable Minister for Ministry of Housing and Public Works opened the Web GIS in the Side Event of WUF 9. MR. Md. Akhter Hossain, Additional Secretary, Ministry of Housing and Public Works, Architect Kazi Nasir, Chief Architect, Department of Architecture, Ministry of Housing and Public Works, other officials of Ministry of Housing and Public Works and delegates of various countries attended the Side Event of WUF9. All the audience praised highly about the developed Web GIS.

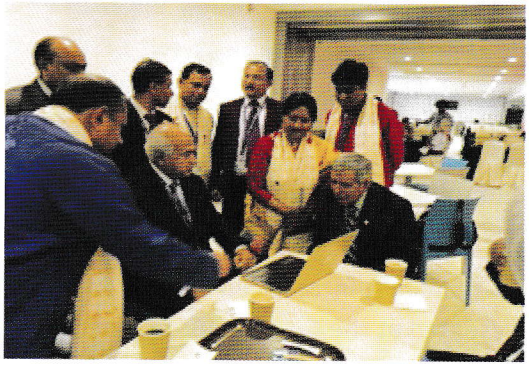


Photo 1: Engr. Mosharraf Hossain, MP, Honorable Minister for MoHPW Inaugurating the Web GIS in WUF9, Kuala Lumpur, Malaysia

Photo 2: The Web GIS presenting in the Unnayan Mela, 2018 held at Mymensingh

Then the developed Web GIS was also presented in the Unnayan Mela, 2018 held at Mymensingh. All the visitors' of the Unnayan Mela appreciated the developed the Web GIS.

Later, the Web GIS was presented before the government officials of Mymensingh district in a Coordination Meeting chaired by the Deputy Commissioner, Mymensingh held at the Conference Room of the Deputy Commissioner, Mymensingh. All the government officials appreciated the Web based GIS.

All the viewers' of the Web based GIS system appreciated the Web-GIS based planning information sharing system.

Photo 3: The Web GIS presenting in the Monthly Coordination Meeting held at DC, Office, Mymensingh

10. WebGIS Platform User View:

Dissemination is one of the most important part of the research. The team decided to verity the user acceptance of the platform. The platform were presented lively at a program of Mymensingh District.

Main objective of the exercise was to assess whatever the people can access the platform and whether the server equipment can support the users.

The team first introduced it to the Paurashava officials and received warm appreciation. I was also presented at the Co-ordination meeting of District Commissioners (DC) office where personals from various government Authority participated. Firefighting and public work related personals appreciated it very much. It was difficult to adjust the issue of generation gap for the common people. Young people were very much interested about the online system but they have very little knowledge about land parcel identification system like RS plot number or Mouza name. At the same time the elderly people they knew all information regarding to plot identification system but they were uncomfortable to use computer or online platform. For the team it is the real challenge to design a people friendly interface. Further reaches can be conducted on this phenomenon. But it was highly appreciated by them once they understand the system. Another objective was to piloting the capacity of the hardware at the server end. The result identified by the team that it needs some up gradation. Existing server system trends to slow over after 24 hours continuers servicing and need to reboot the whole system.

At the end the team evaluated that the system achieved the expected attractions among the stock

holder. Further reaches and awareness can help the system very much.

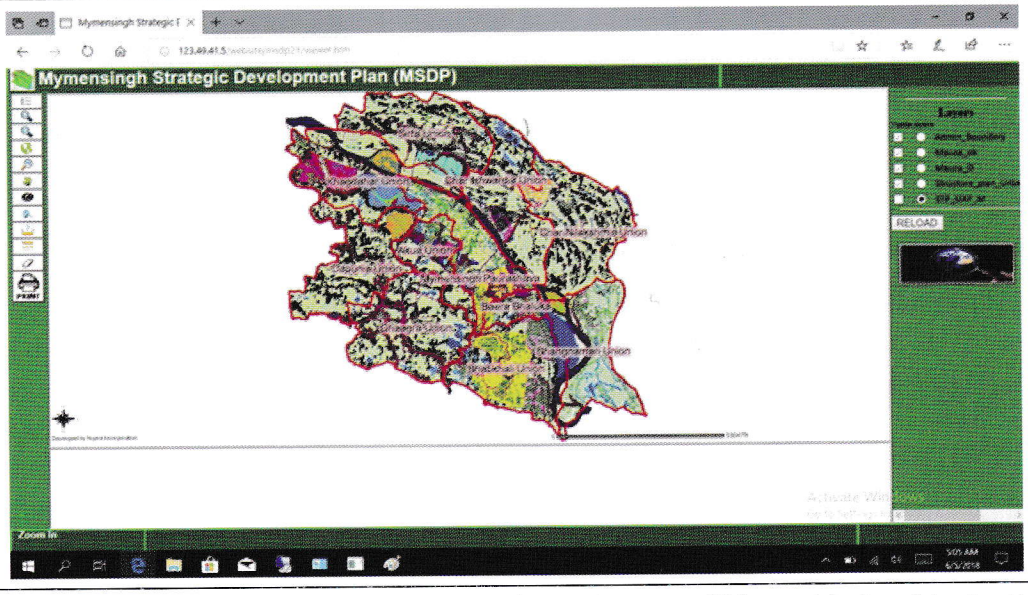
11. Conclusions and Future Works

In this report, we presented the feasibility of an Internet-based GIS platform for data sharing, visualization, and spatial analysis of urbanization in a city of Bangladesh. The platform will be developed to assist in overcoming a major challenge of the urban planning and management like limited availability of data resources, effective tools, and proficiency in data analysis in developing countries like Bangladesh. The targeted audience is, but not limited to, urban planners, decision makers, local communities, governments, and researchers.

The platform was designed and developed following a prototyping methodology GeoWeb Services (GWS) with third-party map services, to make geo-processed data on urbanization available online for visualization, analysis, and downloading. With the integration of GIS, remote sensing, land cover change geo-modelling, and Internet GIS, we used specialist-based semi-auto geoprocessing and automatic batch geoprocessing procedures to create geodatabase for the city. The geodatabase comprises of processed data from scientifically proven indicators of urbanization trends in the literature. The main feature of this platform is its visualization, spatial analysis interfaces, and data sharing system. To empower the targeted audience, this Web GIS platform also provides a download service for users to download the data provided and use it for further analysis in .jpg format. Worth noting is that Web GIS platform is always open to future improvements, including data provision or updating, as well as the development of new system functions and extensions. Some of the future plans to improve Web GIS platform include: (1) improving the geoprocessed products through the use of other additional dataset (e.g., high-resolution imagery and social network data); (2) increasing the numbers of the target cities across the country; (3) providing more Internet-based spatial analysis functions; (4) providing support functions for users to upload their work and interact with others; and, (5) inviting key stakeholders in the targeted cities' to provide feedback on the usefulness of Web GIS platform and suggest more future improvements.

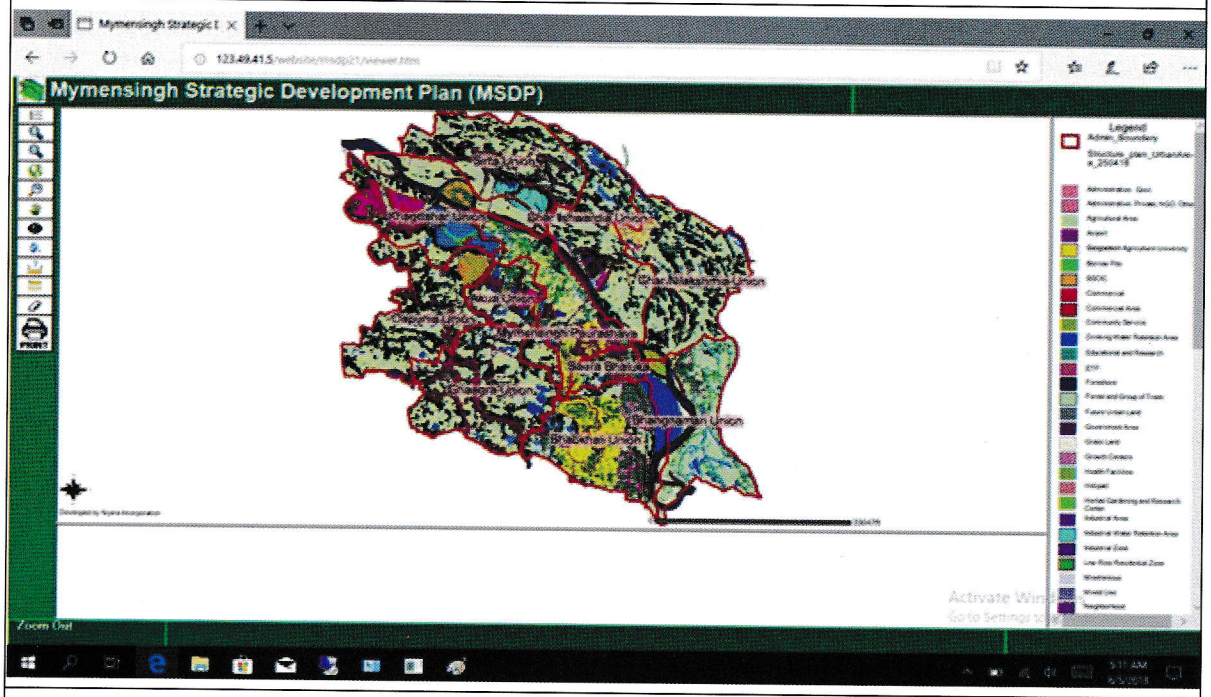
12. WebGIS Platform User View

Figure 1: Home Page



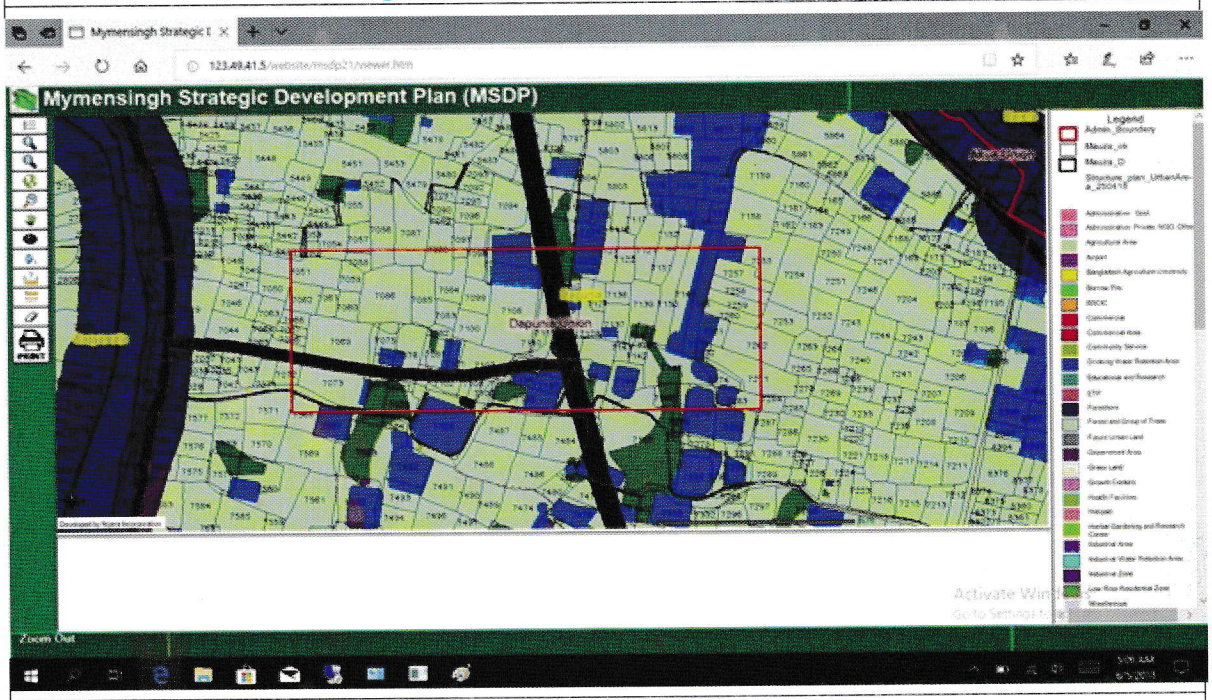
Home Page is the first active face of the platform. A user will be guided to his destination information. It is a set of 5 interactive html page. Center is the map viewer.it is the main frame of this page. It shows all the map and data associated with it. Left is the toolbar html.it contains all the tools that facilitates user to inter act with the geo-database. Top is the title html contains the heading and logo of the platform. At the right there is the table of contain html. It contains the list of layers, Legend and most importantly the Search button.

Figure 2: Legend and Global View



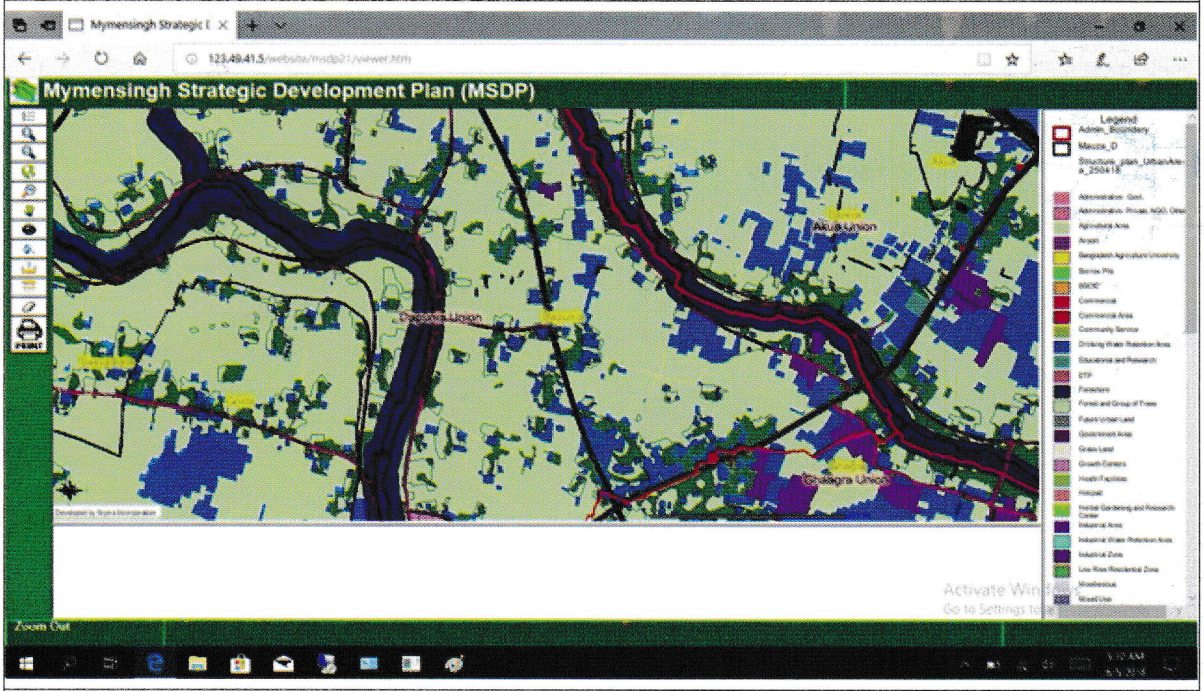
Home Page contain the global view of the map. But there is also a tool global which enable user to return at the global view. Generally the table of content include the layer list and search button. The first tool of the toolbar is legend. It enable user to toggle between Legend list and Table of content.

Figure 3: Zoom in & Zoom Out View 1



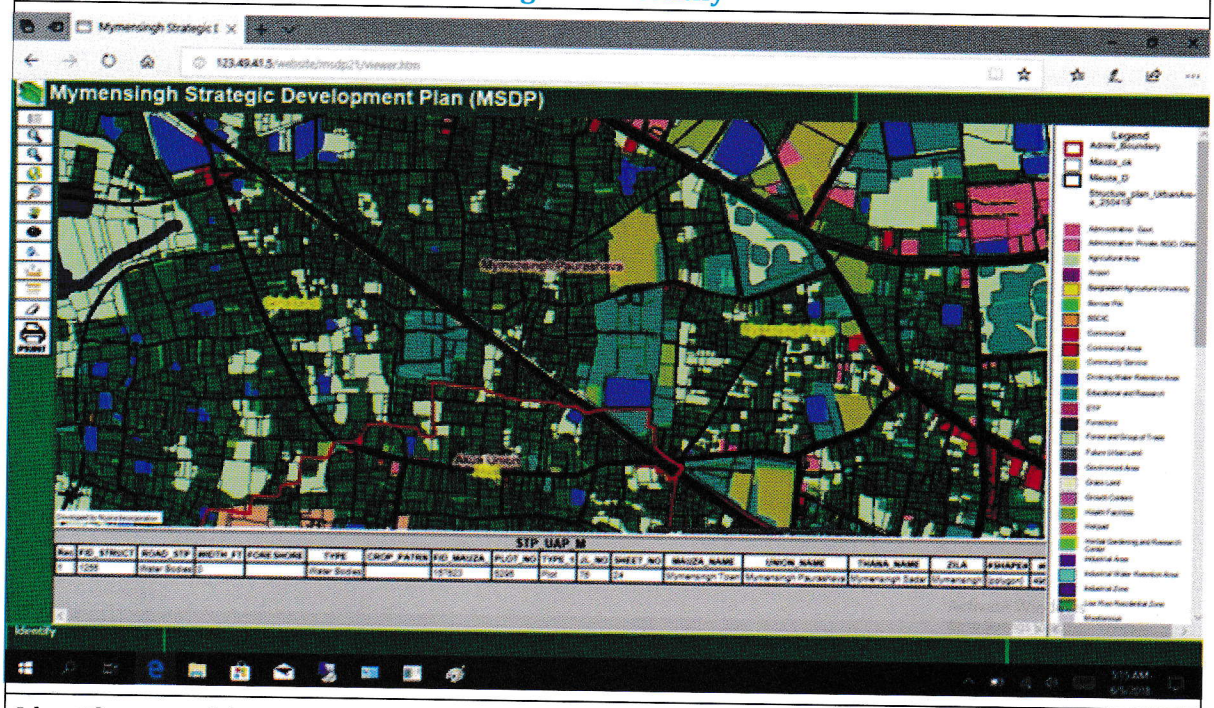
There are Zoom in and zoom out tool which enable user to zoom in or zoom out the map view. Select the tool and drag the portion intend to Zoom in or Zoom out. Different level of data is visible at different zoom level.

Figure 4: Zoom in & Zoom Out View 2



There are Zoom in and zoom out tool which enable user to zoom in or zoom out the map view. Select the tool and drag the portion intend to Zoom in or Zoom out. Different level of data is visible at different zoom level.

Figure 5: Identify

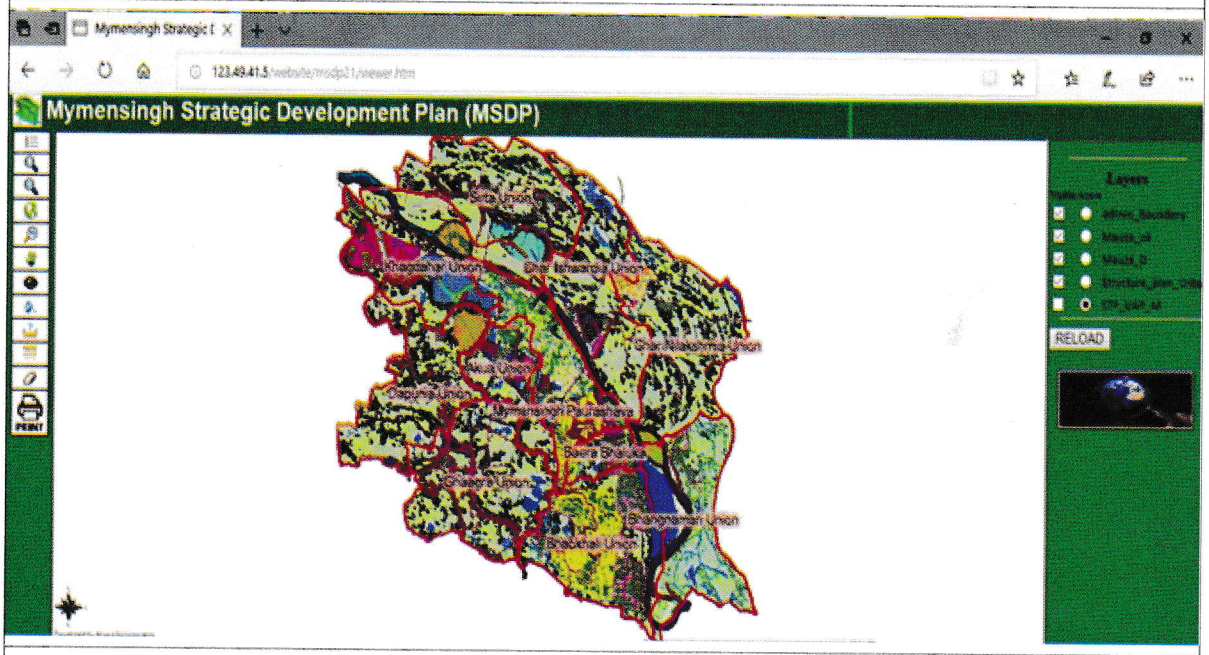


Identify too enable user to visualize the information/attribute of the map. Main function of this platform is access the user with these database. Generally these data is stored in GIS format. But this platform convert it in to html form and visualize to user.

Figure 6: Measure and Pan

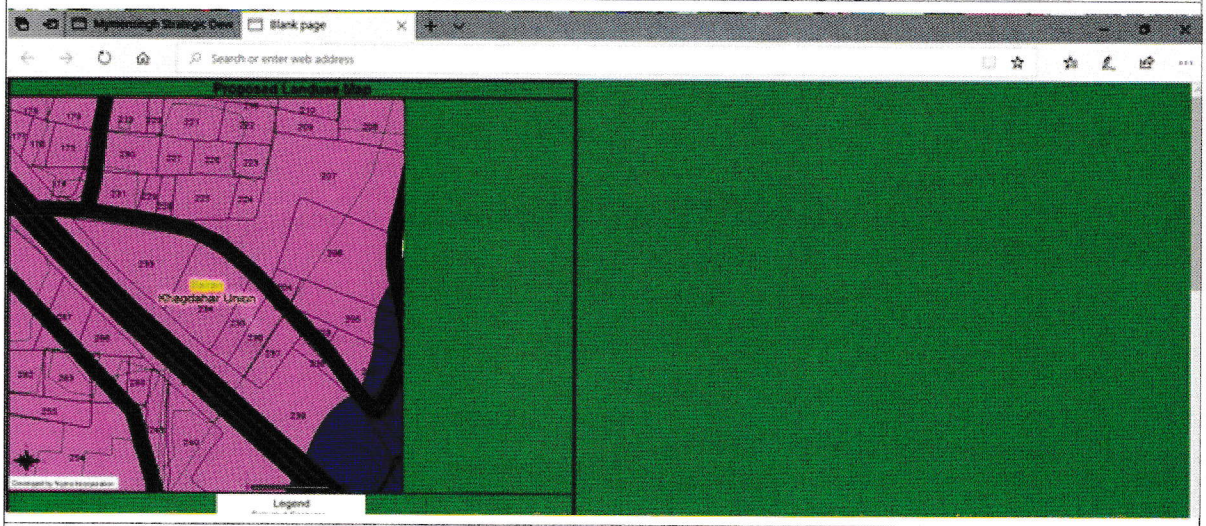
Pan tool enable user to move the view from one view to another view. Measure enable user to calculate the distance from one point to other point.

Figure 7: Search by plot



Search button at the right is the prime function of all the tools in this platform. This button opens the search option for user. User have to select the mauza name and type the plot name.

Figure 8: Print



Print option enable the user to print the output map. This page is the final output of the platform.

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