

Web-based Public Participation GIS application - A case study on Alwar city

Exploring a city in a GIS way

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Abstract

Web is considered to be an ideal platform when it comes to demonstrate GIS potential to the masses. Alwar is chosen to be the study area because of rapid industrial growth by RIICO (Rajasthan State Industrial Development and Investment) in recent years which have caused irreversible damage to the environment and Groundwater resources in the district. This Silverlight based Application allows the user to utilize basic and advanced GIS tools and services such as – buffer creation, performing spatial query or attribute query, routing tasks, printing tasks, adding graphics, import and export tasks. A Public Participation Portal is designed to showcase how effectively Indian Municipal Corporations can leverage GIS capabilities. It allows citizens to report neighbourhood related issues such as illegal mining, waste disposal, traffic, construction and others. Problems can be reported by entering an address or clicking on the map, along with a photograph and a brief description about the problem. Administrative staff can use the Administrative interface to generate heat maps, analyze issues, update problem status and send updates/feedbacks. The beauty of GIS lies in the fact that it integrates with other platforms very easily. A multi-criteria evaluation method called Analytical Hierarchy Process (AHP) is utilized in GIS environment to evaluate the suitability of potential landfill sites in Alwar which examines the area to determine the following factors: distance from waste generation centres; distance from roads; slope; distance from surface waters; distance from environmentally sensitive areas; soil productivity; soil permeability; distance from settlements; distance from cultural sites. Based on the values of the above factors weightages are estimated. User is required to provide their order of preference for the above factors based on their understanding of the place so that weightages can be decided more efficiently. This algorithm assists in site suitability analysis for industrial waste disposal and stimulates the decision making process by giving a numerical value to human judgement.

Keywords: Analytic Hierarchy Process (AHP), ArcMap, Landfill suitability analysis, Routing, Solid waste, Silverlight, Web application

About the Author



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1. Introduction

Alwar is in the state of Rajasthan about 150 km north of Jaipur, the capital of Rajasthan. It is located at 27.57°N 76.6°E. It has an average elevation of 271 meters (889 feet). The area is a booming industrial hub of India. The Rajasthan government, through Rajasthan Industrial Cooperation (RIICO), has developed industrial zones in various stages. Companies from India and abroad have set up their units in these industrial areas and many more new industries are arriving which is not only adding a new dimension to the industrial progress of Rajasthan but also creating new employment opportunities. Japanese industrial zone developed by RIICO is an extension of previously existing industrial zone. Alwar also consists of some of India's environmentally sensitive zones like Sariska Wildlife Reserve, Neemrana Fort among others. Neemrana which is an ancient historical town in Alwar district of Rajasthan and situated at about 122 km from Delhi on the Delhi-Jaipur highway is chosen to be the main center of attention for the research project due to its easy accessibility for surveying purposes.

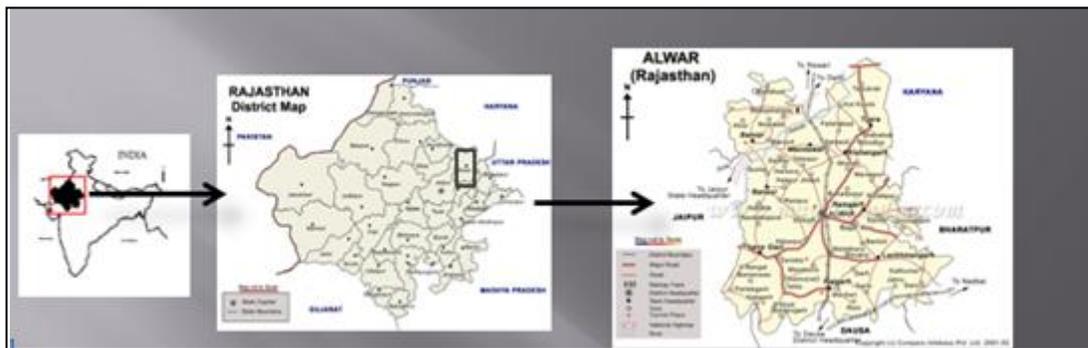


Fig: 1 – Study Area

2. Aims & Objectives

The main objective of this web application is to map entire Neemrana (Commercial, Residential, Agricultural, Road networks) with attribute information, and deploy the web application with rich user experience so that it can become a service for general cause. The web application will consist of some basic and advanced tools and services which can be used by clients for multiple purposes. A public participation portal has also been designed where people can report issues & administrators can review and send their feedback. Analytic Hierarchy Process (AHP) which is a structured technique for organizing and analyzing complex decisions is also combined with GIS which assists in site suitability analysis for industrial waste disposal and stimulates the decision making process by giving a numerical value to human judgement. It tells the decision maker whether a site chosen is suitable for waste disposal or not.

3. Software Used

- i. **ArcGIS for Desktop version 10.1**-used for digitizing, topology, joining spatial and non-spatial data and publishing of services.
- ii. **ArcGIS for Server version 10.1**-used to publish maps and other geographic data on the server with several capabilities
- iii. **ArcGIS API for Silverlight version 3.0**-used to utilize the mapping, geocoding and geoprocessing capabilities provided by ArcGIS server and Bing services in the web application.
- iv. **Arc objects SDK for .NET framework**-to make addins on ArcMap for testing purposes
- v. **ArcGIS viewer for Silverlight version 3.1**-used to deploy rich web applications with a GUI configuration user experience.
- vi. **ESRI maps for Office (trial version)**-used for making dynamic map for the data present in excel format and adding geographic data enrichment services.
- vii. **Image Processing Software** - it is used to apply image processing techniques on satellite imagery.

- viii. **Silverlight 4 and its tool for visual studio 2010**-it is a plugin which allows us to deploy a rich web application in .NET framework using Silverlight technology.
- ix. **Microsoft Visual Web Developer 2010 express edition**-it provides an integrated development environment (IDE) for code development, testing, debugging and code deployment.
- x. **IBM's SPSS Statistics**-used to perform statistical operations on large amount of data
- xi. **Google Earth**-It is used to visualize satellite data.
- xii. **Easy Google Map Downloader**- used to download Google earth imagery at specified zoom level.

4. Methodology:

**Table 1:
Sequence of operations**

DESCRIPTION	DATA NEEDED	FUNCTION NEEDED
Step1: Acquiring satellite imagery of the study area.	Google Earth Imagery of Alwar	<ul style="list-style-type: none"> • Google Earth for viewing the imagery • Easy Google Map's Downloader which is software capable of downloading Google maps at a specified zoom level.
Step2: Surveying Step3: Applying DIP techniques on the imagery for image improvement	Boundary of study area Satellite Imagery of Alwar	GPS & Camera Image Processing Software used for applying digital image processing techniques
Step4: Bringing the processed image into the GIS environment	Processed Satellite Imagery	ArcGIS 10.1 for Desktop with ArcInfo license for mapping
Step5: Georeferencing & digitizing Step6: Adding attribute information to the spatial data Step7: Adding GPS points for critical locations i.e industries, residential zones, schools, colleges, public services etc.	Processed Satellite Imagery Road Network Image Digitized and processed satellite imagery & digitized road map <ul style="list-style-type: none"> • Data collected during surveying • Digitized & processed satellite imagery & digitized road map 	ArcGIS 10.1 for Desktop with ArcInfo license for mapping <ul style="list-style-type: none"> • ArcGIS 10.1 for Desktop with ArcInfo license • MS Excel • ArcGIS 10.1 for Desktop with ArcInfo license • MS Excel
Step8: Creation of network dataset	Digitized parcel map and road network of study area.	<ul style="list-style-type: none"> • ArcGIS 10.1 for Desktop with network analyst extension.
Step9: Importing & publishing the maps and network dataset to ArcGIS server Step10: Adding various tools & Services creating a buffer, performing spatial query or attribute query, routing tasks, printing tasks, adding graphics, import and export tasks(Web development)	Integrated maps & Network Dataset. Published maps with proper capabilities in ArcGIS Server	ArcGIS 10.1 for Desktop and server. <ul style="list-style-type: none"> • Microsoft Visual Web Developer 2010 • Silverlight 4 & tools for Visual Studio • ArcGIS API for Silverlight3.1
Step11: Development of Public Participation Portal(Web Development)	Published maps with proper capabilities in ArcGIS Server	<ul style="list-style-type: none"> • Microsoft Visual Web Developer 2010 • Silverlight 4 & tools for Visual Studio • ArcGIS API for Silverlight3.1
Step12: Testing and Debugging	Integrated maps & Network	<ul style="list-style-type: none"> • Microsoft Visual Web Developer 2010

the code	Dataset	<ul style="list-style-type: none"> • Silverlight 4 & tools for Visual Studio • ArcGIS API for Silverlight3.1 • ArcGIS 10.1 for Desktop • Arc Objects SDK for .NET framework • Microsoft Visual Web Developer 2010 • Silverlight 4 & tools for Visual Studio • ArcGIS API for Silverlight3.1
Step13: Integrating AHP Process with GIS		
Step14: Studying Groundwater potential of Study area	<ul style="list-style-type: none"> • Groundwater data of Alwar for past decade • District level map of Alwar 	<ul style="list-style-type: none"> • IBM's SPSS statistic • ArcGIS 10.1 for Desktop
Step15: Publishing of the final web service to the public domain		

5. Demonstration

This web application is a search engine which helps to explore the city in all respects. It has various features that help web client to make a search regarding property, institutional land, buffer all the nearest land parcels for a given point, find route from one location to another and various other tasks. This fact being known that Alwar is rapidly developing, so suppose an entrepreneur wants to buy a parcel of land and set up a factory, he can use this city explorer to perform various analysis like he can know the information of the parcels of land not occupied, by using identify feature tool. There are various other tools and services available in this web application which would be explained in detail:

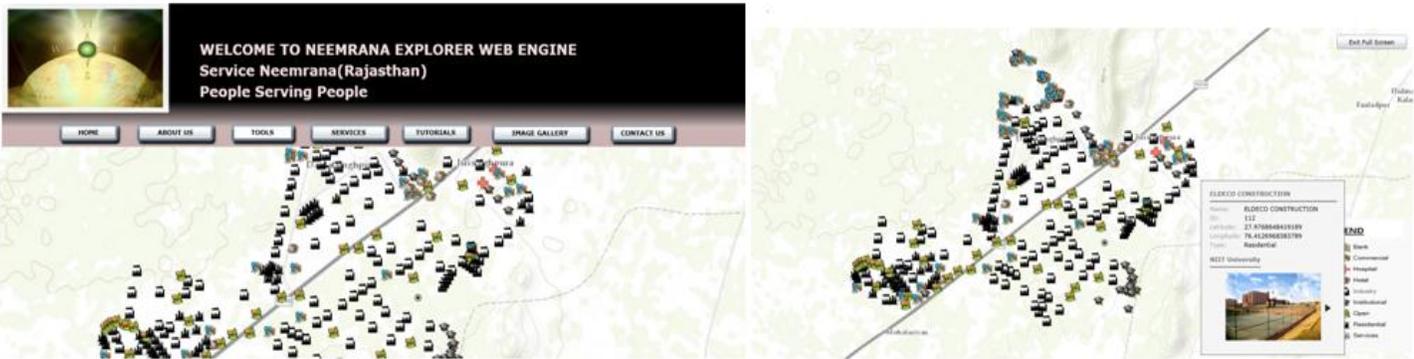


Fig: 2 – Home Page of Web Application

5.1 Tools

i. Query with buffer

This tool buffers the land parcels according to the user specified radius. In the top corner a box giving the details about the tool is shown. In the image a radius is being specified in the textbox by the web client and a buffer is generated along that radius and all the parcels in the buffer area are being highlighted. This tool can be used if a web client wants to know the unoccupied land parcels within a certain specified buffer area. See figure 3(a).

ii. Find feature

This tool helps to find a feature in the map. There is a textbox where the user can search for the specific feature. A table showing the specific search results appears in the right corner and the feature is highlighted on the map. If there is a

new admission in NIIT University parents of the concerned student can search for the NIIT University on map. See figure 3(b).

iii. Identify feature

This tool help to know about the feature selected on the map. A table describing various details of the land parcel which includes Object ID, Shape, Shape Area, Shape Length, Name, Latitude, Longitude and Type is being displayed. If a person wants to know that the land given to the specified industry like HERO HONDA has occupied how much land can be known by this tool. See figure 3(c).

iv. Add feature

This tool helps to add multiple feature layers to the ESRI’s base layer which as a result helps the user to analyze the map and other associated features. It also helps the user to print the base map along with other feature layers. Map can be printed in various formats defined like PDF, JPG, GIF, SVG and others. The map can have various layout formats as well like A3 Landscape, A4 portrait, MAP_ONLY and others. See figure 3(d).



Fig: 3 – Various tools in Application & their result

5.2. Services

i. Routing services

This service provides the route from one location to another on the map along with the directions. This can be used by someone who is new to Neemrana and would like to know the routes of specified locations. See figure 4(a).

ii. Printing services

These services can be used to print the map in the various formats present. The add graphic services is provided along with this service. Any area selected as a point, line or polygon on the map can be printed by the web client for later references. See figure 4(b).

iii. Querying services

This service helps to query any land parcel selected on map. A table displays the various attributes associated with that land feature. The table specifies the type of land parcel which may be industrial, residential or institutional along with the latitude and longitude fields. See figure 4(c).

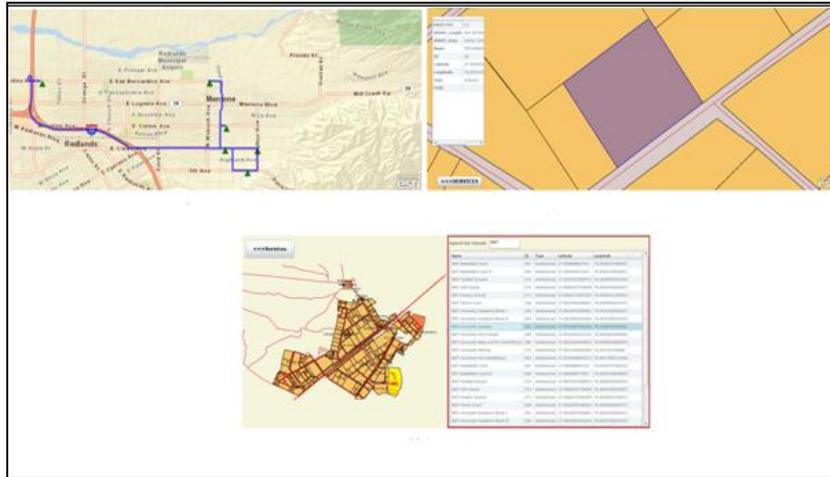


Fig: 4 – Various services in Application & their result

6. Extending the application to a Public Participation Portal (PPP)

This Portal can be used to showcase how effectively Indian Municipal Corporations can leverage GIS capabilities. This interactive web interface allows citizens to report neighborhood related issues such as illegal mining, waste disposal, pothole, posters & hoardings, trash, traffic, construction and others. Problems can be reported by entering an address or clicking on the map at desired location. While reporting a problem, citizens can attach photograph and add a brief description to describe the problem. Citizens can view all the reported problems in their neighborhood and add comments. Administrative staffs at Municipalities can use the Administrative interface to generate heat maps, analyze issues, update problem status and send updates/feedback via e-mail. Facility to use the drawing tools to identify the buffer area with different shape/color/transparency helps to identify various critical locations. Facility to display the results in pie-chart, bar graph, and table add to better interpretation of results.

Microsoft Visual Studio is used along with Silverlight4 Tools for visual studio and **ArcGIS API for Silverlight3.1**. See figure-5.



Fig: 5 – Reporting Problems in Public Participation Portal

7. Integrating Analytic Hierarchy Process with GIS for Decision making process in Solid Waste Disposal

This paper presents an algorithm for solid waste management. The present study utilized a multi-criteria evaluation (MCE) method in a geographical information systems (GIS) environment to evaluate the suitability of potential landfill sites in Alwar. To determine the most suitable landfill site, one of the MCE techniques, called analytical hierarchy process (AHP), was combined with a GIS to examine nine factors namely: distance from waste generation centers; distance from roads; slope; distance from surface waters; distance from environmentally sensitive areas; distance from settlements; distance from cultural sites. An algorithm is developed which will calculate each of these factors for a given area based on which weightages are decided. Those weightages are then put together in the reciprocal matrix for performing AHP analysis. User is also required to enter order of preferences of the chosen criteria so that weightages can be decided more efficiently. AHP helps us to derive ratio scales from paired comparisons. The ratio scales are derived from the principal Eigen vectors and the consistency index is derived from the principal Eigen value. From the AHP analysis we can come to know whether or not the site chosen is suitable for disposal of industrial waste or not. It also allows us to quantify our decision by giving a number which corresponds to confidence level. This algorithm assists in site suitability analysis for industrial waste disposal and stimulates the decision making process by giving a numerical value to human judgment.

This algorithm is developed as an 'Add-In' under Visual Studio utilizing **Arc objects SDK for .NET** framework which can further be converted as a web tool using Silverlight technology.

8. Conclusions

This application as a whole would not only help general public for their normal requirements but would also help administrative staff to perform extensive analysis and decision making. It would also help industries to know suitable sites for waste disposal and public can also participate in the Public Participation Portal (PPP) for their grievances. So this web application is an ideal platform when it comes to demonstrate GIS potential to the masses.

9. References

- [1] <http://help.arcgis.com/en/webapi/silverlight/samples/start.htm>
- [2] <http://www.esri.com/software/arcgis/arcgisserver>
- [3] <http://www.microsoft.com/silverlight/what-is-silverlight/>
- [4] Yoav TAL and Yaakov BAR-LAVI, " Innovative Cartography Standards for Web-GIS Portals"
- [5] Srebro, H., Bar-Lavi, J., and Weiss, B. (2006). A National Geographic Web Portal.