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A Framework of Participatory Geo-Spatial Information System for Micro Level Planning – A Case Study in Aquaculture

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I

INTRODUCTION

Computer based information systems proved to be very efficient and effective tools for managing data and information to aid in decision making. FAO (2000) proposed agricultural knowledge and information system for rural development (AKIS/RD) to link rural people and institutions to promote mutual learning and generate, share and utilise agricultural technology, knowledge and information. This serves as a vehicle for sharing ideas and principles with various stakeholders addressing the problems and seeking solutions to rural development. Although the rural development planning is top-down prescriptive approach, in reality the decisions are made by the stakeholders based on their perspectives, knowledge and priorities. The problems particularly related to environmental impacts are location-specific and contextual. Geo-spatial technologies may serve as a better vehicle to store and share all kinds of location-specific data and information. The state of mapping and management of geospatial data changed during the recent years with the diffusion of modern geospatial information technologies such as GIS (Geographic information system), GPS (Global positioning system) and image analytical system for remote sensing (RS) data. Adinarayana *et al.,* (2008) proposed a geographical information and communication technology (Geo-ICT) based information system called Grama Vikas (rural development) to assist the user in analysing the rural information for rural development/planning. During the recent years there is a paradigm shift in GIS applications for rural development particularly in developing countries, by way of integrating top-down approach with bottom-up approach by the stake holders who stand to be affected by the decisions based on these technologies. The emerging concepts include "community - integrated GIS", "GIS in participatory research" and 'participatory GIS" (Abbot *et al.,* 1998; Reddy and Rao, 2009).

There is an increasing interest in using GIS in a participatory context for environmental impact assessment (Algon, 2007) during the recent years. Aquaculture in recent years is one of the thrust areas in the Indian economy. The growing demand for aqaculture products, the fast depletion and degradation of natural resources, and

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rising costs of inputs, implicitly states that the judicial use of resources is inevitable for sustainable development of aquaculture. In the wake of commercialisation and globalisation, agriculture lands and nearby forests of the aquaculture location are swiftly changing their shape into culture ponds. The need for food security and commercial benefits drive potential environmental displacement and degradation in coastal ecosystem besides, affecting the sustainability by over-exploitation for short-term benefits. With the development of aquaculture sector, environmental issues became of increasing concern. The potential effects of aquaculture activities include impacts on water and sediment quality, and negative impacts on natural populations, landscape, and other pre-existing economical activities. To a great extent, these effects depend upon factors such as type of facilities, adopted technologies, geographical location and scaping, and produced species etc. As the environmental impacts are location-specific, the main goal of this study is to develop an independent software product on "Managing Geo-Spatial Information Management System for Managing Aquaculture". The broad objectives are: (a) to share and disseminate and update spatial and non-spatial data and information including stake holders perspective on aquaculture technologies and their impacts and (b) to make useful spatial database queries and generate required thematic maps along with tables and graphs for effective decision making on sustainable development of aquaculture.

II

GEOSPATIAL INFORMATION SYSTEM

This geospatial information system is developed as a deployable windows application using Map Objects GIS software, an object model for developing deployable GIS applications in Visual basic programming language and back end data base as Microsoft Access. The architecture of the geospatial information system is shown in Figure 1. Developers can use MapObjects to create applications that include dynamic live maps and GIS capabilities. Map Objects offers direct support for a wide variety of data sources such as Standard GIS formats we can add mapping components to enhance the existing applications. Besides they can build lightweight data viewing applications, Create customised mapping and GIS programmes that fulfill the specific tasks and requirements and develop simple query-based applications that easily enable access to data generated by sophisticated GIS solutions. MapObjects provides powerful spatial and attribute filters to optimise performance. MapObjects contains a collection of common utilities used in ArcExplorer, as well as sample applications demonstrating these components, that provide a framework for further development. MapObjects supports dynamic tracking for points, lines, polygons, rectangles, and ellipses, making it easy to manage GPS activities.

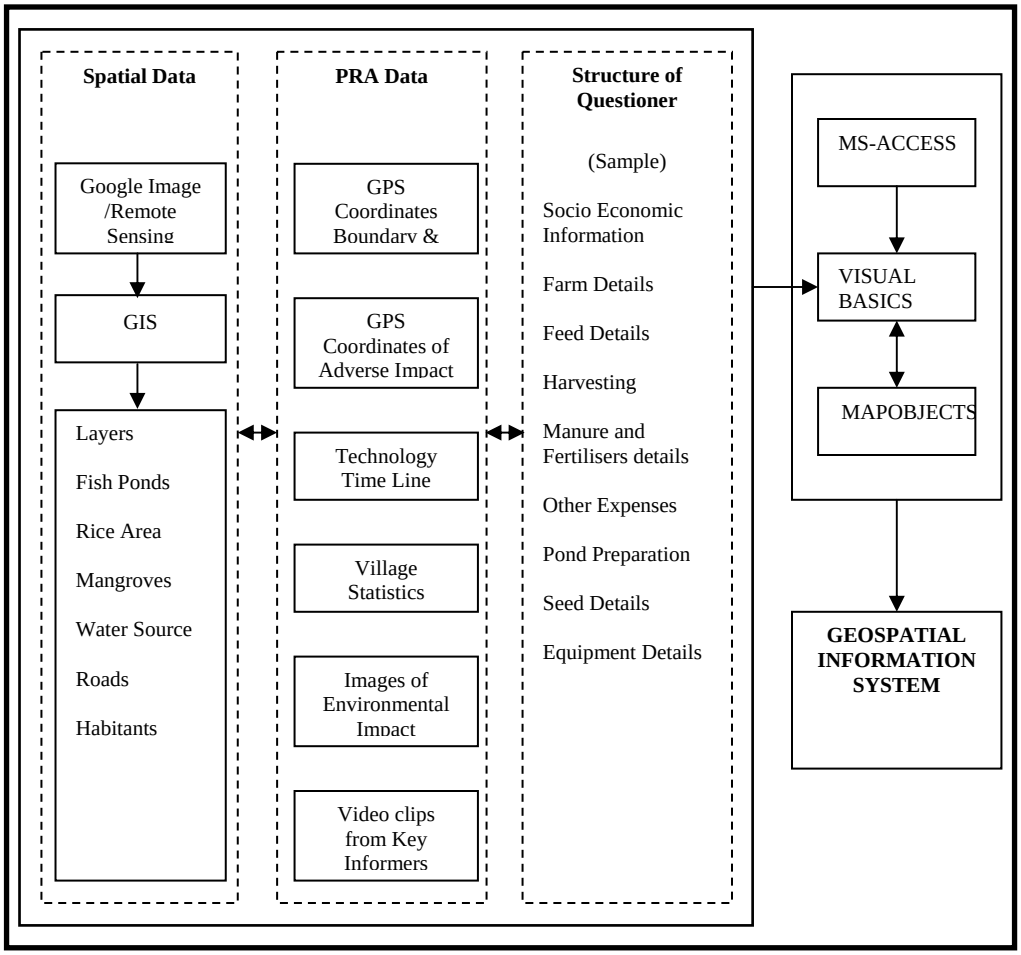

Figure 1. Agriculture of the Geospatial Information System for Managing Aquaculture

III

ACQUISITION OF SPATIAL AND ATTRIBUTE DATA

Selection of Study Area

The study area is identified of villages based on the intensity of spatial distribution of aquaculture ponds. For this the spatial distribution of ponds from Google Earth database is studied in GIS environment. The various steps involved are as follows:-

1. Produce identified village maps showing the spatial distribution of aquaculture ponds in GIS environment (Geo-referencing).
2. Collect data and information.

Data and Information: Details on technology adopted in terms of inputs such as seed, fertiliser, pesticides etc., and management factors.

Using PRA (participatory rural appraisal) tools and techniques:

a) Semi-structured interviews with key informants
b) Time line and change analysis
c) Village resource map
d) Agro-ecological map
e) Map showing soil pollution
f) Map showing water pollution

3. Validating all the spatial data and maps using GPS (Global Positioning System).
4. Geo-referencing and correcting village maps derived from PRA tools.

The image derived from google earth represents the actual spatial distribution of various features on the ground in the study area. The google earth image data is imported to GIS software, ArcGIS and different themes such as aquaculture ponds, vegetation, roads, settlements, canals were vectorised based on the information on village boundary collected through participatory approach as different layers. Vector map of different layers is shown in Figure 2.

Figure 2. Map of the Study Area of Korangi Panchayat Derived Through Participatory Approach.

The map clearly shows the spatial distribution of aqua ponds along with the other land use categories. This map produced by participating GIS method (PGIS) is more accurate than the maps being produced by traditional PRA methods. These maps in GIS are the basic input to model environmental impacts and its dynamics over time and space. These separate layers are required for implementation of spatial sampling with respect to aquaculture ponds. There are 449 aquaculture ponds in the study village and this layer is the sampling frame for implementing spatial sampling algorithms to collect spatially representative data on pond details. Different layers include spatial data on area under crops, irrigation canals, roads, village administrative buildings, hospitals, schools and other important elements which can be helpful in the process of identification, geodatabase creation, documentation and digitisation. After completing the above tasks, the important facet of the study is to validate the information obtained through field survey with the help of local villagers, and again checking the digitised map in the field for authentication. The villagers and the farmers were gathered in a place and they were shown the Geo-referenced Google earth map and were asked to locate their ponds, and validated the previously collected data. Some of the interesting facts revealed in the observation were that some of the agricultural fields were converted into aqua ponds and vice versa. Also some of the mangrove forests surrounding the aquaculture habitat lost their ground in the expansion of culture ponds.

IV

GEOSPATIAL INFORMATION SYSTEM

The main page (Figure 3) appears and a set of selection boxes for district, village, layer and attributes which allow selection of a district, village within the selected district, layer within the selected village, attribute within the selected village.

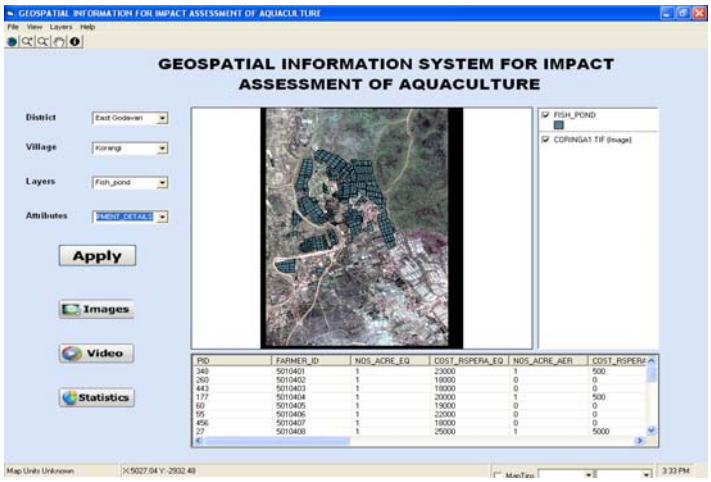

Figure 3. Main Screen of Geo-spatial Information System

It contains the buttons to images, video, and statistics when you click on the button it will go to the corresponding form. The user can come back to the first screen by clicking on the button Home.

The main page contains a menu bar of four Menu Items File, View, Layers and Help.

The **File** menu contains Exit option. The **View** contains Full Extent, Zoom in, Zoom out, Pan and Identify. The **Layer** menu contains Add Layer, Remove Active Layer and Legend Editor as menu Items. The **Help** menu contains About as menu item.

Clicking on Apply after selecting the district, village, layer and attributes it shows google earth image and the corresponding spatial layer is displayed in the map window. The X, Y Coordinate of the locations are displayed in the bottom of the window. These changes happen as mouse pointer moves over the map window. The user can select a particular attribute of his interest, after selecting attribute and click on apply then it displays the map, corresponding tabular data. We can Zoom in and Zoom out particular area of on the map by selecting the Zoom In and Zoom Out buttons in the Tool bar. Pan tool lets you pan a view by dragging the display in any direction with the mouse. To pan, move the cursor anywhere over the view, hold down the mouse button, and drag in any direction. Release the mouse button to leave the display in your desired position. As a view can contain themes with different spatial extents, Zoom to Full Extent enables you to set an extent that covers all the themes in the view. Use this option when you want to be able to see everything in a view. Full extent control zooms to the extent of all the themes in the view, whether or not they are currently visible or active. The Identify tool displays its results in a dialog box.

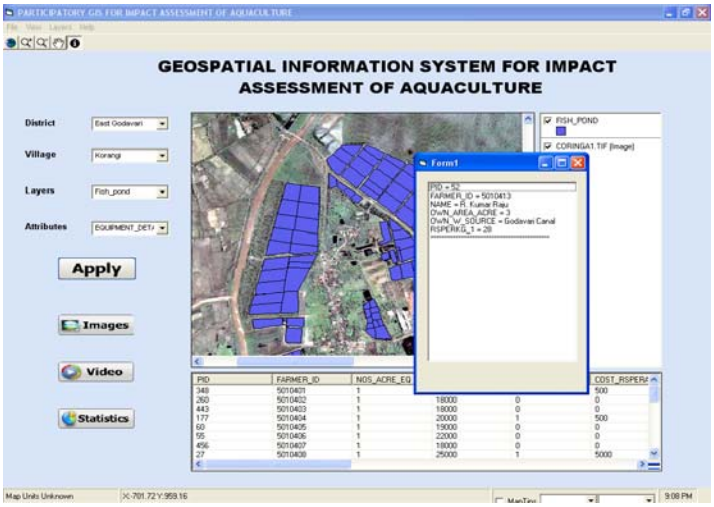

Figure 4. Identify Button

(i) Click on the Identify button and
(ii) Click on the Fish Pond polygon to know the details of individual polygons.

To display the thematic map of Fishpond area:

(i) Select the layer in legend, double click on the selected **Layer**, then a pop window displayed as showed in Figure 5.

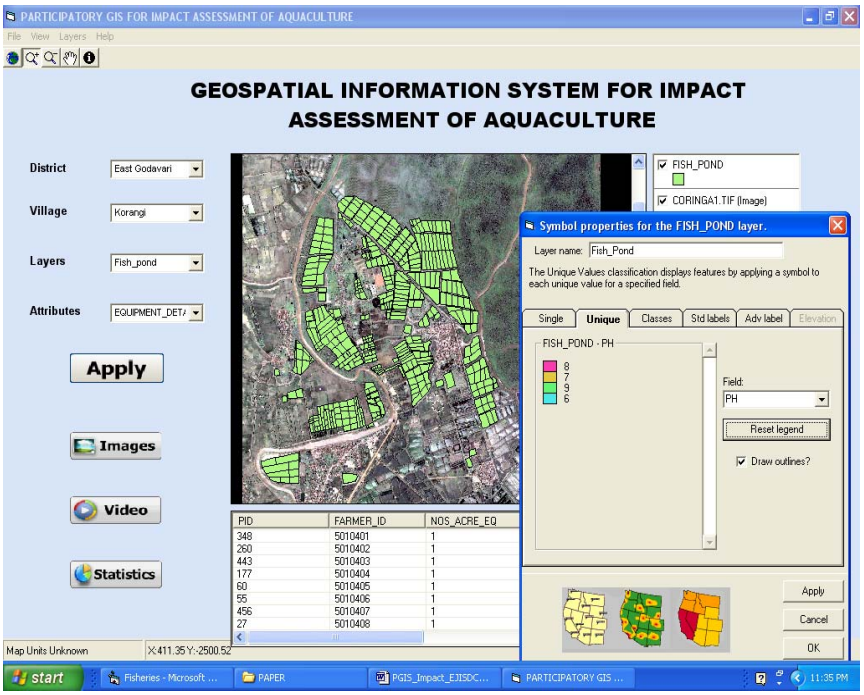

Figure 5. Thematic Mapping using Symbol Properties

(ii) Select **Unique** in the SSTab control
(iii) Click on the **Field** to obtain a drop down list of Fishpond Attributes, which can be mapped.
(iv) Select **PH** in the dropdownlist box
(v) Click on **Reset Legend**
(vi) Click on **Apply** and **OK.**

Thematic map showing the spatial distribution 0g PH will appear as shown in Figure 6.

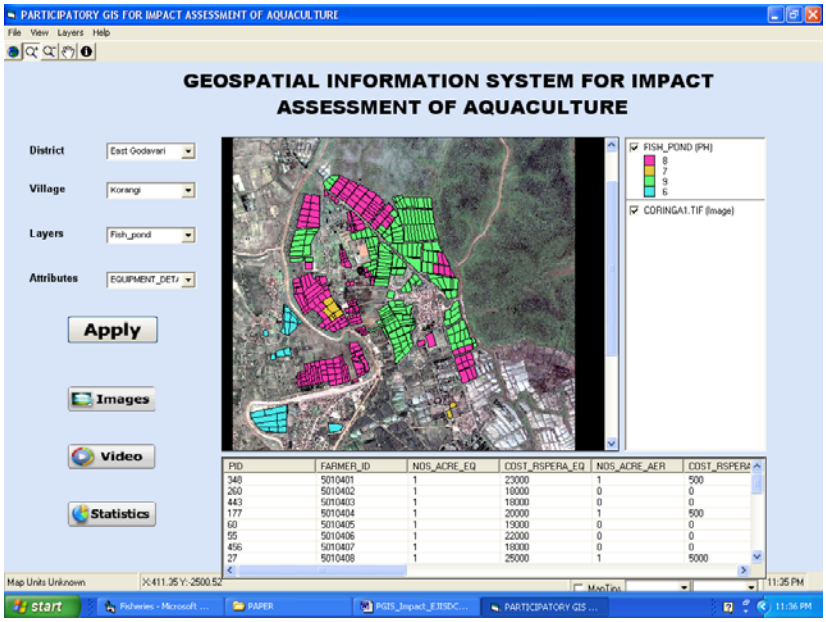

Figure 6. Thematic Mapping of PH

V

CONCLUSION

Information technology is identified as the key factor in economic growth. Hence, Government of India is implementing the village knowledge centres (VKC) programme (http://capart.nic.in/scheme/vrc.pdf) to bring access to range of services, content and information to people living in villages. GIS is a platform for sharing the learnings from local communities by creating a pool of knowledge/information by others for further learning and effective decision making, sharing knowledge and information including spatial data, information and knowledge results in innovations. Today, participatory rural development (PRA) is being widely used methodology for an interactive process for planning social development. PRA has been described as a growing family of approaches and methods to enable local people to express, enhance, share and analyse their knowledge of their livelihoods to plan and act (Chambers, 1994). Communication is a two way process. Involving stakeholder in the research and planning process has its own implications. The revolutionary changes and applicability of the Geo-spatial Information Technology has many facets, and one such component is in using it to investigate and document the data of natural resources at micro level. The more the public participation the more complex the planning will become, but the proposed geo-spatial information system will help

to address the complex spatial problems and in taking effective decisions for local level planning by sharing the spatial data and information by all stakeholders.

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