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THEME: Geo-Budget: Enabling Sustainable Growth

Web Based Karnataka State Watershed Information System

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ABSTRACT

Watershed Information System for Karnataka State assists users in their planning, decision-making and monitoring of watershed at various levels, the **IWMP**(Integrated Watershed Mission Program) project plan at various stages can also be visualized. It has been developed with the latest mapping server technology provided by Environmental Science Research Institute's ARC GIS 10 [desktop, server, catalogue, SDE] & Visual Studio .Net 2010.

This is the first Web based information developed for all watersheds in Karnataka State with details up to the micro watershed level. The module comprises of database system and a graphical user interface, which has all basic function and tools like search, query, identity, measurement, page layout which empowers the users further. In addition, large number of potential users who have the leverage to enhance the existing GIS capabilities can access geographic data anywhere and anytime using internet. The application requires very little training, and can be tailored for non-GIS users who need to visualize data quickly to make better decisions.

To build a foundation for sound decision-making and reduce electronic data transfer time, it is important to build an information management system concurrent with the development of a watershed management framework. Web based Karnataka State Watershed Information System is a computerized system that delivers Watershed information or tools to a manager or decision maker using a "thin-client" Web browser like Firefox or Internet Explorer. The Web based Watershed information system is made user friendly by adding geographic data query/display/process and is comprised of Hypertext Markup Language (HTML) user interfaces, internet interface programs, computational models and geographic databases. Expansion of the computer systems and advances in internet related technologies extend GIS in a new horizon. Developing a Web based information system, collecting data, delivering materials (maps), manipulating and updating data becomes easier and faster. Web based system utilizes internet to full extent and gives mass accessibility to geographic data. It also makes quick accessible to larger audience, more importantly worldwide.

Web based Watershed Information System for Karnataka State watersheds is developed by using Visual Studio.Net 3.5 and Arc GIS 10 [desktop, server, catalog,SDE]. It is a useful tool to access spatial and non spatial data and gives information of Watershed (rivers and water bodies, drainage) over the Web.

Use of Web enabled application comes largely from the ability to simultaneously access and process both map and attribute data faster. Web Based Watershed information system will be useful, to assist the respective departments in their day to day decisions depicting sub, mini and micro watersheds, which are essential for planners, decision makers and implementing agencies. The Web Application developed has a full-fledged combination of tools for both spatial and non spatial data. Using Arc Catalog the coverage's were converted to shape file. These shape files are transferred to DBO format with the help of Arc SDE. Data updating is done in Arc Map for this DBO files and saved as .mxd document file. Later, services are created for this .mxd files using Arc Catalog (GIS server). Microsoft Visual Studio .Net 2010 is used to design a user interface and coding in C# .Net. An interactive map is displayed in Internet explorer which has all basic functions. Important modules are developed like search, query, identity, measurement, page layout. Identity displays the information of the selected feature in the result panel. The Search function helps user to select a set of fields, provided by resources, in which to search for the occurrence of a user provided value. Query tool provides a drop down list of preset choices or a textbox for general text entry.

Web based Karnatak State Watershed Information System developed is first of its kind for the entire state of Karnataka. This is a technology from which it gets data from sources simultaneously in exact time intervals which will give clear edge to user especially Watershed Development Department, GOK.

Key words: KSWIS, Desktop GIS, Visual Studio .Net 2010, C# .Net, ArcGIS 10, ArcSDE.

Introduction

To build a foundation for sound decision-making and reduce electronic data transfer time, it is important to build an information management system concurrent with the development of a watershed management frame work. Web based Watershed information system is a computerized system that delivers Watershed information or tools to a manager or decision maker using a "thin-client" Web browser like Firefox or internet explorer. The computer server that hosts the application is linked to the user's computer by a network with the Transmissions Control Protocol/ Internet Protocol (TCP/IP). The Web based Watershed information system can be made user friendly by adding geographic data query/display/process and is comprised of Hypertext

Markup Language (HTML) user interfaces, internet interface programs, computational

Advantages of having Web based Watershed information system is:

- i. It is very useful database for planners, decision makers and implementation agencies. There is a tremendous scope for updating the database e.g. Watershed treated, ongoing and completed Watershed area in spatial database.
- ii. Ability to access everywhere over the internet.
- iii. Reducing time and minimizing effort to reach data.
- iv. Ability to produce reports based on user specified parameters.
- v. Analysis for building various structures for watershed improvement as well as water bodies is enhanced further by visualization that the application creates as it integrates watershed boundaries with that of administrative boundaries up to the village level.

Scope of the Study

- i. Watershed information system which provides complete data of Karnataka watersheds, where user can get required information via Internet.
- ii. Provide both spatial and non-spatial information. Generate live updated prospective plan Status Reports of the Integrated Watershed Management Programme(IWMP)
- iii. To generate IWMP project status information for Karnataka State in Excel format .

- iv. Geospatial web application incorporation of IWMP project prospective plan which includes different five year plans information.

Study Area: The state of Karnataka is part of two well-defined regions of India, namely the Deccan Plateau and the Coastal Plains and Islands. It can be further divided into four physiographic regions-the Northern Karnataka Plateau, Central Karnataka Plateau, Southern Karnataka Plateau and the Coastal Karnataka Region.

Location : Set on the meeting point of Western and Eastern Ghats, the state has a positional coordinate of 11.5° to 18.5 ° Northern latitude and 74° to 78.5 ° Eastern longitude.

Extent : Karnataka extends to about 750 km from north to south and about 400 km from east to west. The Coastal belt with an average width of 50 to 80 km covers a distance of about 267 km. from north to south.

Data Used: Data generated under Project Sate Natural Resources Information System has been collected from KRSAC which consists of point, line & polygon themes including attribute data on 1:50,000 scale and using LISS IV satellite image of 2000-2001.

Feature Class Details are as follows:

- i. Administration Boundaries :State Boundary, District , Taluk,Hobli,Village ,Settlements
- ii. Transportation: Roads, Railway line.
- iii. Drainage Info: Canals, Drainage(Line),Water bodies, River \Streams.
- iv. Watershed Info: Watershed (8 Levels), IWMP project Status(prospective plan viz treated, ongoing& to be treated).

Materials and Methodology

All the data that has been procured from KRSAC is in the Polyconic Everest Bangladesh projection system which is a local Datum, for standardized acceptance of data following OGC Standards the entire data has been reprojected to UTM (Zone 43 North) WGS84 and the web page is developed on the same lines. Thereby taking care of data Interoperability and Standards into consideration .UTM coordinates are not unique across the globe. They are certainly unique within the zone, but the same address can exist in each UTM zone,most popular shapefile appendage is the optional .prj file. It tells you what projection the data is in.

Further, this data is refined and prepared according the components used for web application development . The .dbf of the files is linked to the SQL server using the import data wizard ,

queries are custom written generate the searches such as drop down for District ,Taluk, Watershed. The service is generated using the Arc Server and published this is the service that is used to display using the Java script API. The steps involved in generation of this web application (Figure 1). Spatial data requirements of Water Resources Information System, is recommended as the spatial information of whole Karnataka either have to be prepared from SOI topographic map or to be procured from concerned departments who are custodians of various map data that is available in digital form.

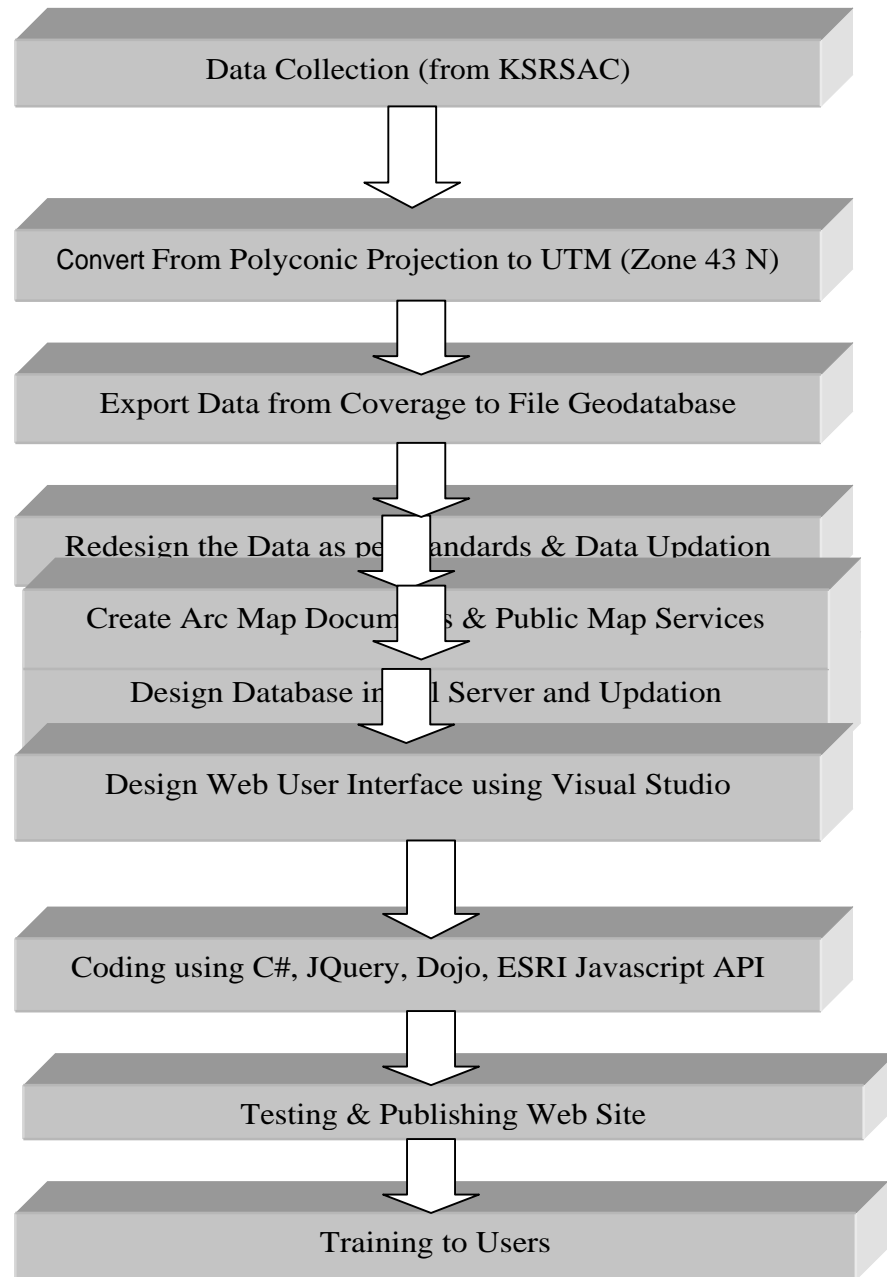


Fig 1 : Project flow diagram

Database Structure: The database structures of the various attributes used are as mentioned in the tables below

Exporting feature datasets, classes, and tables: Exporting data allows you to share data across multiple geodatabase and optionally change the format of the data. There are several ways to export data using ArcMap and ArcCatalog. Using the context-sensitive menu in ArcCatalog, Using geoprocessing tools, Using the Extract Data Wizard in ArcMap, Using the Export Data command in ArcMap etc.

The project uses File Geodatabase to create database connections. A File Geodatabase stores datasets in a folder of files on your computer. Each dataset is held as a file and can be up to 1 TB in size (and you can optionally configure a file geodatabase to store much larger datasets). File geodatabases can be used across platforms and can be compressed and encrypted for read-only, secure use.

Web service URLs

For clients to access Web services, they will need to know the URL. When we make an Internet connection to the server, we will use a URL in this format:

i. `http://<server name>/<instance name>/services`

To connect to a specific service, the URL takes a longer format:

ii. `http://<server name>/<instance name>/services/<folder name (if the service resides in a folder)>/<service name>/<service type (required for some services)>/<capability type (required for some services)>`

Further instructions on the URL formats to use with our services, see the documentation topic specific to the type of service we are creating. To change the format of the URL, we can use URL mapping.

Capabilities that require Web access:

Some capabilities require that clients access the service through the Internet; therefore, there is no option to disable Web access for these capabilities. The capabilities that require Web access are KML, WMS, and Mobile Data Access.

User Interface Designing (GUI) Using Asp.Net

ASP.Net became a “grown up” version of its ASP technology, using its mature programming languages C#. ASP.Net 3.5 fundamentally reduces the barriers for development of complex Web sites. HTML is sent to the browser, there is no requirement for special capability on the browser beyond display of HTML and the execution of a single simple Java script. Any browser that can display HTML can display ASP.Net 3.5 pages.

Master and Content pages

A site benefits from a consistent look and feel, and we rarely find sites on the Internet that deviate from having a generic site layout, which generally includes the following

- i. A common header and menu system for the entire site.
- ii. A bar on the left side of the page offering some page navigation options
- iii. A footer providing copyright information and a secondary menu for contacting the Webmaster.

The master page contains some of the content available to each page on the site, so standard copyright footer text can be defined here, along with positioning the main site logo at the top of the page .

It is decided to develop a master page & a content page for this project. A master page defines the layout to be used by all pages based on the master. It's the overall parent that controls layout, specifying how big the header will be on every page, where the navigation features will be placed, and the text to display in the footer on every page, a bit like a cookie cutter for each page.

A content page is a page based on a master, and is where we add the content for each page on a site that varies from page to page. The content page contains text, HTML , JQuery, JavaScriptAPI and controls within <asp content> tags. When the content page is requested, its content is combined with a copy of the master page, with the specific content defined in the conten page placed within the specified placeholder on the master page.

Preparation of Maps: Maps are prepared by storing in .mxd files using Arc Map. Following are the maps prepared in the present study.

The findings of the study and discussion are included in this Chapter. Results of the study are explained in detail below. It includes following functionalities.

Toolbar Collection: This toolbar contains a series of tools(Figure-5) that can be used interactively in the map display. First click the tool icon to select it (pan tool is selected) and then click in the map display to use it.

Zoom out: Used to Zoom-out the map. There are two ways in which this tool can be used. One is by single left clicking and the map will Zoom-out and re-center where it is clicked. The second is to draw a rectangle around the area we want to display and the map will Zoom-out to the area of the rectangle. This is accomplished by left clicking and dragging to draw the rectangle and then releasing the mouse button to cause the map to Zoom-out. The

smaller the rectangle we draw, the more the map will Zoom-out.

Zoom in: Used to Zoom-in the map. There are two ways in which this tool can be used. One is by single left clicking and the map will Zoom-in and re-center where it is clicked. The second is to draw a rectangle around the area which we want to display and the map will Zoom-in to the area of the rectangle. This is accomplished by left clicking and dragging to draw the rectangle and then releasing the mouse button to cause the map to Zoom-in. When we Zoom-in selecting a particular taluk it highlights particular Watershed falling within the respective taluk .

Pan:This tool is used to move around the map without changing the scale. With this tool selected left-click and drag the map to move it around.

Full Extent: Clicking this tool in the toolbar will zoom the map all the way out to the full Extent (the entire state).

Identity: Select the tool and click on the feature to identify (get information). An identify icon will be placed on the map at the location clicked. Feature information should then display in the results panel. It displays the following results if we click on taluk .

- a) Watershed code & names of Micro & Mini Watershed
- b) Rivers and water bodies information
- c) Taluk boundary with its respective area and perimeter

Zoom Back To Previous Extent: Clicking this tool in the toolbar will zoom the map back to the previously viewed extent.

Search Option: The Search control enables a developer to select a set of fields, provided by resources, in which it searches for the occurrence of a user provided value. At runtime, each field is queried for the occurrence of a value provided by the user. Partial values are permitted. Only feature layers in resources provided by a MapResourceManager can be used.

Search by District: This is the customized Search that is designed as illustrated below, the task and results are shown as drop down widgets, the auto zoom to selected search is shown as result filtering is done for District ,Taluk and Watershed wise.

Export Search results to Excel format: The required details District wise and Taluk wise can be generated and exported to excel. Printout of the same can also be taken.

Result and Discussion

The findings of the present study with previous works are discussed here. From Science planners to public, recent advances in technology are more broadly accepted and adopted. User now a days is interested in embracing online forms of Geographic Information Systems (GIS) without the need for technical understanding and all of this is happening very rapidly. Associated with these opportunities for information sharing are increased expectations which are user friendly. Web based Watershed information presents data to the user in many ways. Tabulated data from Water Resource Region to Microwatershed, online status update features, visualization of Admin boundaries etc. Will be useful to users in overlaying along with spatial data. The developmental measures undertaken at micro-watersheds level include soil and moisture conservation, land shaping, bunding, construction of water harvesting structures, ground water recharge structures and drainage line treatment structures. micro-watershed wise implementation is ideal as it helps in concentrating on the smaller area with low financial burden and also to take care of all the villages coming under the area In the present study this is taken care of as data visualized is up to the microwatershed level.

The system design encompasses the database and the server. Web based Watershed information system provides the user with easy access to timely data in various forms. The end user need not have all the high end GIS software.

Watershed Programs Monitoring Information System (WPMIS) developed by Department of Land Resources, Ministry of Rural Development, Govt. of India (<http://Watershed.nic.in>) gives list of all the projects and their fund-releases, sanctioned for the concerned district will be presented to the authenticated DRDA/ZP users of WPMIS. This application displays non spatial data, whereas present study includes both spatial and non spatial data. The spatial database is very important for planners, decision makers and monitoring. This feature is much more enhanced as the IWMP data and plan progress can also be visualized.

^[1]Sudhirendar Sharma, 2001 reported that few successful Watershed projects are outnumbered by many unsuccessful ones because of lack of proper database both spatial and non spatial. This kind of problems can be overcome by developing Web enabled applications, which is emphasized in the present study.

Centre for Spatial technologies Arkansas, U.S have also developed Watershed information system. It is a comprehensive statewide Watershed Atlas consisting of series of practical maps and reports for 308 Watershed units. Land use changes, soil, slope maps and reports were utilized in this system. But it is having a limited tool option. In the present study, query and search option tools are developed which is very important for planning and monitoring of Watersheds as well as for prioritizing and follow up of various plan progress made the analysis capabilities are also enhanced. Further, in the present study all the thematic layers (^[2]Lakshmikantha et al., 2006) were utilized in development of Web based Watershed information system.

The Geospatial database created for IWMP prospective plan containing treated, ongoing, yet to be treated categories has been utilized in the present study for web application development. This is very useful for the planning ,decision making, assessment and understanding the watershed at various levels viz, Taluk, District, State (^[2]Dr.Lakshmikantha B.P et.al.2011)

Missouri Watershed Based Information on the Web using ArcView Internet Map Server the Center for Agricultural, Resource and Environmental Systems (CARES) (www.gis.esri.com) is serving Watershed based information for the State of Missouri through the World Wide Web. This has been developed using ArcIMS but has limited option of tools. The present Web based Watershed information system for Karnataka state Watershed provides both spatial and non spatial data along with Watershed code. It has many functions like query, identity, measurement and search. The development of Web based Karnataka State Watershed information system is first of its kind in the State.

Web based Watershed Information System for Karnataka State watersheds is developed by using Visual Studio.Net 3.5 and Arc GIS 10 [desktop, server, catalog, SDE]. It is a useful tool to access spatial and non spatial data and gives information of Watershed (rivers and water bodies, land use/land cover, drainage) over the Web.

Advantages of having Web based Watershed information system is:

- i. It is very useful database for planners, decision makers and implementation agencies. There is a tremendous scope for updating the database eg. Watershed treated, ongoing and completed Watershed area in spatial database.
- ii. Ability to access everywhere over the internet.
- iii. Reducing time and minimizing effort to reach data.
- iv. Ability to produce reports based on user specified parameters.
- v. Authenticated user

- vi. Analysis for building various structures for watershed improvement as well as water bodies is enhanced further by visualization that the application creates as it integrates watershed boundaries with that of administrative boundaries up to the village level.

Conclusions:

Web based KSWIS is a GIS application developed for more comprehensive management of watersheds and help authorities in planning and implementing the effective strategies in tackling the implementation projects through spatial and non-spatial analysis of the data. Watershed department can make use of the tools provided to find area of concern and get the information using identifier module and on the hand they can edit the data using update status option. The user can use the road network layer in predicting the proximity of conveyance to the project area. Other information like IWMP project status summary can be exported district and taluk wise, updates can be made for the same as well. This study envisions a future where GIS is recognized, as an integral and indispensable information system, serving the integrated information needs of the general public. It can act as a guide mainly for watershed department to have a clear visibility on maintaining and improving watershed regions for locals, and various civic/government authorities. It acts as a base for the future applications (GIS) development. It primarily provides information about the administrative regions that a particular watershed falls under and presents free, up-to-date, interactive information in a visual format. The database is useful for planning, implementing and monitoring of Karnataka state watersheds up to micro level. The KSWIS is a GIS based web application developed for the state could provide useful information in further developments. There are many other functions that can be incorporated into the application. However, the following are the suggestions that can be taken up

- i. Integration of Cadastral maps on a Sub, Mini, Micro watershed.
- ii. Timely Updation of treated and untreated areas of Watershed under IWMP, which is not happening spatially throughout the state.
- iii. Developing Arc hydro Utility Watershed information system.

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<http://www.gis.esri.co>

<http://www.gisdevelopment.com>

Taluk Boundary
Table 4 :Taluk Boundary Attributes

S.No	Filed Name	Data Type	Units	Description
1	Area	Float	Acers/Ha	Area of the Taluk
2	Perimeter	Float	Meters/KM	Perimeter of the Taluk
3	Dist_Name	String		Name of the District
4	Taluk_Code	Interger		Code of Taluk
5	Taluk_Name	String		Name of the Taluk
6	State_Name	String		Name of the State

District Boundary
Table3 District Boundary Attributes

S.No	Filed Name	Data Type	Units	Description
1	Area	Float	Acers/Ha	Area of the District
2	Perimeter	Float	Meters/KM	Perimeter of the District
3	Dist_Code	Interger		District Code
4	Dist_Name	String		Name of the District
5	State_Name	String		Name of the State

Table 8:Drainage Attributes

ID	Filed Name	Data Type	Units	Description
1	Length	Float	Meters/KM	Length of the Stream
2	Stream_Code	Interger		Stream Code
3	Order_No	Interger		Stream Order

Village Boundary Table 6 :Village Boundary Attributes

ID	Filed Name	Data Type	Units	Description
1	Area	Float	Acers/Ha	Area of the Village
2	Perimeter	Float	Meters/KM	Perimeter of the Village
3	State_Name	String		Name of the State
4	Dist_Name	String		Name of the District
5	Taluk_Name	String		Name of the Taluk
6	Hobli_Name	String		Name of the Hobli
8	V_Code	Integer		Village Code

Watershed Boundary
Table 9 Watershed Boundary Attribute

ID	Filed Name	Data Type	Units	Description
1	Area	Float	Acers/Ha	-
2	Perimeter	Float	Meters/KM	-
3	Region_Name	String	-	-
4	Basin_name	String	-	-
5	Catechment_Name	String	-	-
6	Subcatchment_Name	String	-	-
7	Watershed_Name	String	-	-
8	Subwatershed_Name	String	-	-
9	Miniwatershedcode	Integer	-	Alphanumeric

Fig 10:Export to excel sheet

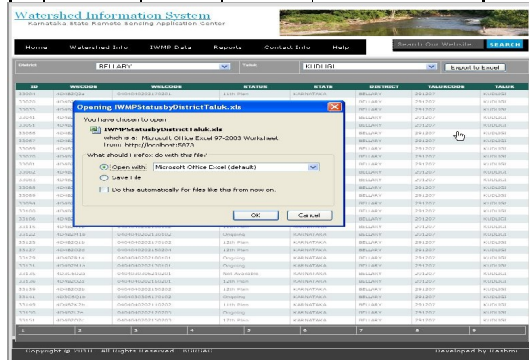




Fig 3 :Results of search by Taluk



Fig 1:Master Page developed for Web based KSWIS

Fig 4 :Search by District Result

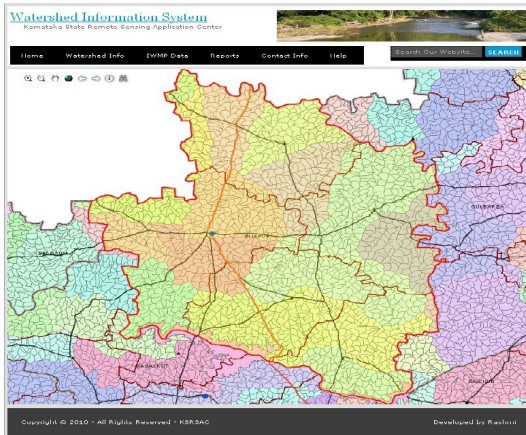


Fig 6: Search by Watershed microwatershed



Fig 7 Search by MicroWatershed Task Results

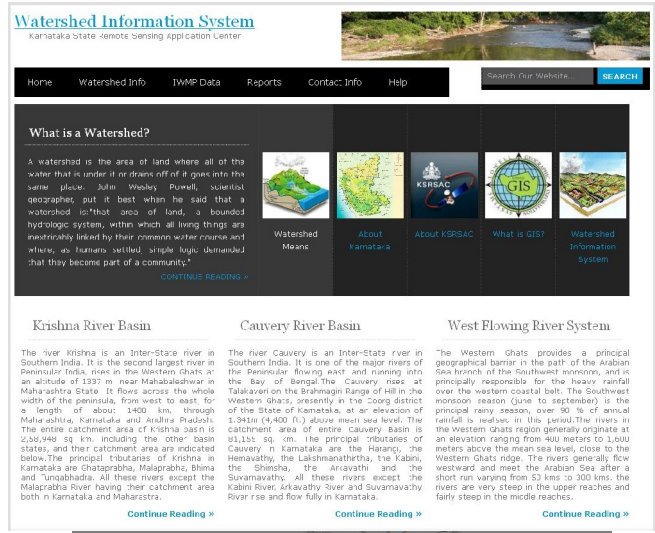


Fig 5 :Search by District

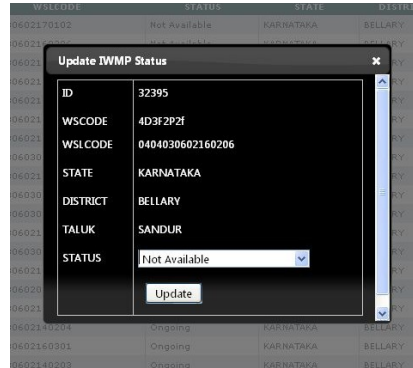
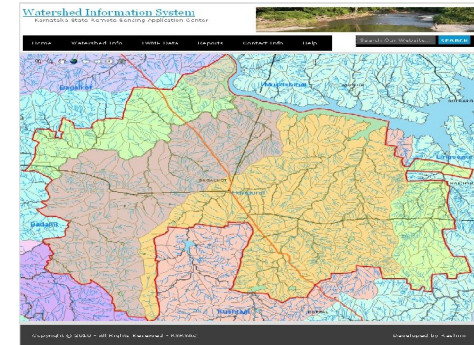


Fig 8:Update IWMP Status



Fig 9: Update IWMP Status Window