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A Web-based Marathwada Hydrological Information System (MHIS) Using ArcHydro

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Abstract*: This paper deal with a computer system capable of integrating, storing, analyzing, and displaying geographic information. Currently, the Geographic Information System is not only inadequate to cartography but also related to various data management such as natural resource management, environmental impact assessment, and etc.*

The study area is Marathawada region selected, the Hydrologic Information System can be developed using the selected data model Arc hydro. The ArcGIS Hydro data model Arc Hydro is a geospatial and temporal data model for surface water resources that operates within ArcGIS and supports hydrologic simulation models. Arc Hydro defines a set of water resources feature classes (classes with Point, multipoint, polyline, polygon, annotation or network features) in ArcGIS (such as watersheds, monitoring points) and the relations between these classes and stores them in a geodatabase. A geodatabase is a special form of a relational database that stores geospatial coordinate data of a GIS layer in one field in a relational data table. The complete model consists of five categories to divide water resources elements: network, drainage, channel, hydrography and time series. The Web-based system allows more geographic information sharing as many users can access at the same time. The Web-based GIS system including Management Information is a research and application area that utilizes the Web-based systems to facilitate the access, processing, and dissemination of geographic or non-geographic information.

In this study, the Web-based GIS application has been developed for the water resource management as it gives users better understanding of the overall Marathwada region watershed.

Keywords: *Web-Based GIS; Geographic Information System; Watershed; water resource management; Archydro*

I. Introduction

The study area is Marathawada region selected, the Hydrologic Information System can be developed using the selected data model Arc hydro. The ArcGIS Hydro data model Arc Hydro is a geospatial and temporal data model for surface water resources that operates within ArcGIS and supports hydrologic simulation models. Arc Hydro defines a set of water resources feature classes (classes with Point, multipoint, polyline, polygon, annotation or network features) in ArcGIS (such as watersheds, monitoring points) and the relations between these classes and stores them in a geodatabase. A geodatabase is a special form of a relational database that stores geospatial coordinate data of a GIS layer in one field in a relational data table [05]. The complete model consists of five categories to divide water resources elements: network, drainage, channel, hydrography and time series. This model is used for this research because it can automatically transfer a geodatabase into a Hydrologic Information System and therefore has great potential to be used for water resources studies. The model uses an ArcGIS geometric network to trace the flow of water through a stream network and can relate drainage, stream confluences, water discharge and monitoring points required in this research using ArcGIS relationship classes. A geometric network is a connectivity relationship between a collection of feature classes in a feature dataset and consist of two fundamental components: edges and junctions. An edge is a type of network element that has a length and through which commodities flow: in this case stream reaches. A junction occurs at the beginning, end and intersection of two or more edges or along an edge and allows the transfer of flow between them: in this case the confluence of stream reaches, water discharge points and monitoring points. Edges are always polylines and junctions are always points and in a network they are topologically connected to each other [06]. An ArcHydro toolset was developed by Maidment (2002) to help create and manage Arc Hydro data. These tools are used to derive several data sets that collectively describe the drainage patterns of a catchment and that are used to create the geometric network.

II. Hydrological Information System

The occurrence of water shows great variability in space and time and requires that adequate measurement networks are established to define spatial variability and that they are maintained over a sufficient period of time to define temporal variability of a water variable. Management of water services for domestic, industrial, agricultural and power generation - and protection from the vagaries of floods and droughts, requires information on storages and fluxes of water.

A Hydrological Information System (HIS) consists of the physical infrastructure, software and human resources to collect, process, store and disseminate data on hydro meteorological, hydrological, geo-hydrological and related variables. The physical infrastructure includes the data observation networks, laboratories for analysis of samples, communication systems, and data storage and processing centers. The human resources are the trained staff who observe, key-in, process, disseminate the data and maintain the equipment computers, etc.

The Principles of a Hydrological Information System are implied in the following paragraph :- Hydrological: Hydrology is the science of water in the Hydrological or water cycle and is concerned with its states, storages and fluxes in location, time and phase. Hygrometry is the sister science of hydrology which is concerned with the measurement of these states, storages and fluxes in the water cycle. It is a science because it is concerned with the scientific principles of repeatability and that measurements may be checked and validated.

Information:

Three key features of information are reliability, availability and presentation. Information is data which has been manipulated and processed to give them meaning and purpose. By definition, information serves a function and is created not simply because it is there to be measured or because of our curiosity alone. Unlike the mountaineer, we are not climbing Everest simply because it is there to be climbed- but because there is someone on the top who needs help.

System: The HIS is not simply a data collection or archive although it incorporates an archive. It is a logical and structured system to collect data which are subsequently entered into the computer, checked and stored and where also data may be compared, associated, related and combined to provide information in a form suitable to users. A system may also be seen as the integration of the user and the machine [98, 99].

III. Objectives

Development of technologies like Geographic Information System (GIS) has enhanced the use of RS data to obtain accurate geospatial database. GIS specializes in handling related, spatially referenced data, combining mapped information with other data and acts as analytical tool for research and decision making. Technological advances in the field of satellite remote sensing (RS) sensors, computerized mapping techniques, global positioning system (GPS) and geographic information system (GIS) has enhanced the ability to capture more detailed and timely information about the natural resources at various scales catering to regional level study. The main objectives of the project are:

- To map the wetlands on 1:50000 scale using two date (pre and post monsoon) IRS LISS III digital data following a standard water bodies classification system.
- Integration of additional theme layers (Rivers, Dams, Reservoir & administrative boundaries)
- Creation of database of the Marathwada and its GIS environment.
- Preparation of District-wise water bodies information atlases.
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IV. Research Methodology

The methodology to create the Marathwada level atlas of water bodies. Salient features of methodology adopted are:

- Generation of spatial framework in GIS environment for database creation and organization.
- Geo-referencing of satellite data
- Identification of water bodies as per the district using a knowledge based digital classification and onscreen interpretation
- Generation of base layers (Rivers, Dams, Reservoir & administrative boundaries) from satellite image and additional data.
- Mosaicing /edge matching to create district level database.
- Preparation of map compositions and generation of statistics
- Work was carried out using ERDAS Imagine, Arc/Info and Arcgis softwares.

Creation of Spatial Framework This is the most important task as the region forms a part of the frame work and covered in multiple map sheets. To create water bodies database, the standards is followed and four corners

of the 1:50,000 (15' x 15') grid is taken as the tics or registration points to create each map taking master grid as the reference.

Geo-referencing of Satellite Data In this step the raw satellite images were converted to specific map projection using geometric correction. This is done using archive geometrically corrected LISS III data. Standard image processing software was used for geo-referencing.

Mapping of Wetlands In the present study, the mapping of water bodies was done with digital classification and onscreen visual interpretation. There are various methods for extraction of water information from remote sensing imagery, which according to the number of bands used, are generally divided into two categories, i.e. Single-band and multi-band methods. Single-band method usually involves choosing a band from multi-spectral image to distinguish water from land by subjective threshold values. It may lead to over- or under-estimation of open water area. Multi-band method takes advantage of reflective differences of each band.

Conversion of the raster (indices) into a vector layer The information on water bodies extent, open water extent & reservoir extent was converted into vector layers using region growing properties or on-screen digitization.

Generation of Reference Layers Base layers like river network, barrages, drainage are interpreted from the current image or taken from other project data base. The administrative boundaries districts are taken from the known reference data.

Coding and Attribute Scheme Feature codification scheme for every input element has been worked out keeping in view the region wise administrative as well as natural hierarchy (Marathwada region-district-taluka) within the feature class for each of the theme. All data elements are given a unique name/code, which are self explanatory with short forms.

Map composition and output Map composition for atlas has been done at district level. A standard color scheme has been used for the water body's classes and other layers. The digital files are made at 1:50,000 scale.

Mapping of Water Bodies In the present study, the mapping of water bodies was done following digital classification and onscreen visual interpretation. Water bodies were identified based on visible hydrology and geography. There are various methods for extraction of water information from remote sensing imagery, which according to the number of bands used, are generally divided into two categories, i.e. Single-band and multi-band methods. Single-band method usually involves choosing a band from multi-spectral image to distinguish water from land by subjective threshold values. Multi-band method takes advantage of reflective differences of each band. In this project, five indices known in literature that enhances various water bodies characteristics were used (McFeetres, 1986; Xu Hanqiu, 2006; Lacaux et al, 2007; Townshend and Justice, 1986; Tucker and Sellers, 1986) as given below:

i) Normalised Difference Water Index (NDWI) = (Green-NIR) / (Green + NIR)

ii) Modified Normalized Difference Water Index (MNDWI) = (Green-MIR) / (Green + MIR)

V. Major Water Bodies Types of Marathwada

Major water bodies observed in the region are reservoirs/barrages, rivers/stream and Tank/pond. The appearance of these water bodies types in satellite image is shown in fig-1.

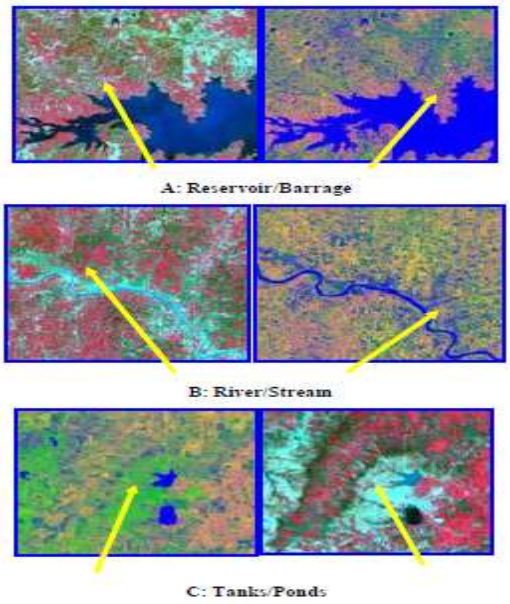


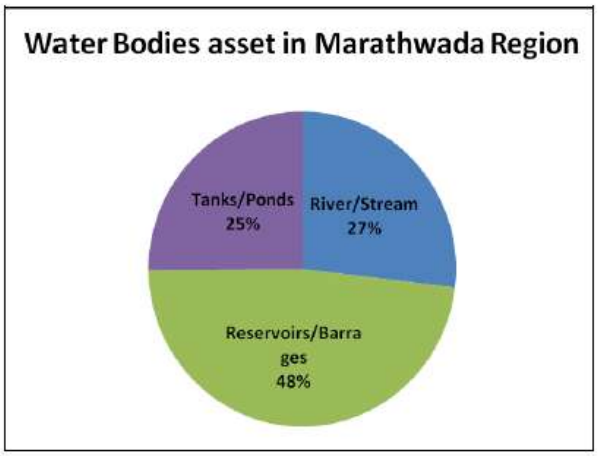
Figure 1: Major Water Bodies Types of Marathwada as Seen and Work Out From Remote Sensing Data

Water Bodies of Marathwada: Maps and Statistics

Area estimates of various water bodies categories for Marathwada have been carried out using GIS layers of district boundary & water-bodies. Total 5151 waterbodies have been mapped at 1:50,000 scale in the State. In addition, Total geographic area of marathwada region has 6459000 ha & the total wetland area estimated is 197780 ha that is around 3.06 per cent of the geographic area. The major wetland types are Reservoir/barrages accounting for 48.01 per cent of the wetlands (94968 ha), Tank/Ponds accounting for 25.11 percent of wetland area (49670 ha), river/stream accounting for 26.86 percent of wetland area (53142 ha).

Table 1 : Area estimates of Water Bodies of Marathwada

Sr. No.	Water Body Category	Number of Water bodies	Total Wetland Area	% of wetland area
1	River/Stream	721	53142	26.86
2	Reservoirs/Barrages	337	94968	48.01
3	Tanks/Ponds	4093	49670	25.11
	Total	5151	197780	100



Graph: Water Bodies in Marathwada Region

Marathwada Hydrologic information systems Traditionally, the term "water resources data" has meant the time series of water measurements recorded at gages and monitoring sites. As GIS has become more popular in water resources, geospatial information for water resources has become available, including GIS data layers for stream networks, watersheds, water bodies, and measurement station locations. Arc Hydro combines geospatial and temporal data in a relational database format.

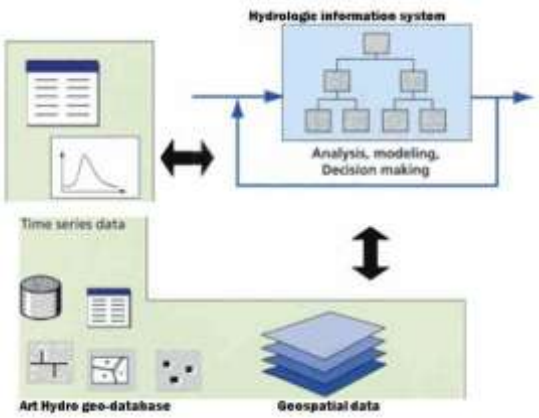


Figure 2: Relational database format of HIS

A Marathwada Hydrologic Information System is a Geographic Information System capable of hydrologic analysis & this research consists of three Features:

- The development of a MHIS for a selected study area as Marathawada region, which cover eight districts.
- Visualization of Godavari basin layer covered by Marathwada Region.
- Precipitation (Rain Fall), Evapotraspiration & water yield Position of selective rivers in Marathwada Region.
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Figure 3. River Network of Marathwada Region

VI. Methodology for MHIS

- GIS vector maps has been created in ArcMap.
- The vector maps of each district in marathwada has been developed.
- The river network has also be developed in ArcMap.
- Feature class of district, dams and rivers also having attribute data associated with it in vector maps.

Figure 4: Marathwada Hydrologic Information Systems

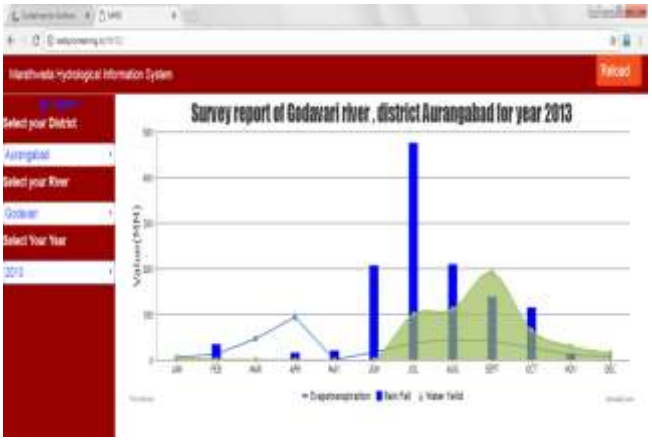

Figure 5: Godavari river- Hydrologic information systems of Aurangabad Region

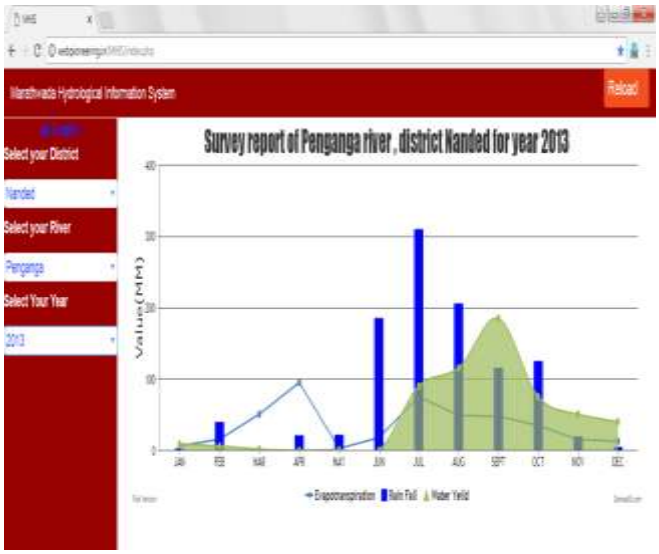

Figure 6: Rainfall, Evaporation & Water Level interpretation of Penganga River

VII. Conclusion

The era of mobile technology opens the windows to the android app. The websites are vanishing and the mobile phones are emerging. It's the time to change from conventional websites to apps, which has become part of our daily routine. We are introducing the android application software. It works not only as a website, but also it can work as a small Hydrological Information system for Marathwada region. Our multipurpose program is

considering the user such Irrigation Department, PWD and other Water supply Department in Maharashtra. Project gives total solution to everyone. The application becomes also a mobile version for this proposed project. It gives us more comfort and a better user interface. It acts as an overview about the River Network & Dam Position. Following screen shot shows the web-based application & graphical representation of River/stream, reservoir & Dam in Marathwada region with 8 districts. By using this GIS based platform we displayed the water yield position & evaporation of last four years (2013 to 2016) of various water bodies in Marathwada region. This statistical & graphical representation is useful for the planning, execution and monitoring of status of water resources. It is also helpful for Irrigation Department, PWD and other Water supply Department in Maharashtra.

References

[1] Arc Hydro: GIS for Water Resources by David Maidment(ESRI Press)
[2] Comprehensive Terrain Preprocessing Using Arc Hydro Tools: http://www.hydrosys.net
[3] M.B.AbbottandA.W.Minns(1998),"Computationalhydraulics"(2ndEd.)AshgatePress, Aldershot, 557p.
[4] https://www.tutorialspoint.com/asp.net/asp.net_tutorial.pdf
[5] J.G.Arnold R.Srinivasan, R.S.Muttiah, J.R.Williams 1998.Large area hydrologic modeling and assessment- Part 1:
[6] ArcHydroToolsOverview:http://downloads.esri.com/blogs/hydro/ah2/arc_hydro_tools_2_0_overview.pdf
[7] ArcHydroTools:http://ftp.swfwmd.state.fl.us/pub/GWIS/ArcHydroTools_v2.0/Doc/Arc_Hydro_GP_Tools_2.0_Tutorial.pdf
[8] Model development. Journal of the American Water Resources Association 34(1), 73-89.
[9] V.T. Chow,D.R. Maidment,L.W.Mays (1988). Applied Hydrology. McGraw-Hill, New Delhi4. J.A.York
[10] W.G.Gray, A.Leijnse, R.L.Kollar. C.A. Blain (1993), "Mathematical tools for changing spatial scales in the analysis of physical system." CRC Press, Boca Raton, FL, 232p.