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Development of information system for the appraisal of watershed management

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ABSTRACT : The information system (IS) is windows based interactive software developed in visual studio. The software components are watershed concept, watershed planning, watershed conservation, watershed development, watershed management and hydrological numerical solver. The watershed concept, planning, conservation, development and management comprises with quality information in text, photos, videos, animations etc. hyperlinked with each other. The hydrological numerical solver deals with execution of hydrological parameters namely precipitation and runoff. The special features of IS are quality information with photos, videos, standard tables; charts etc were hyperlinked with each other. The software is meant for agricultural engineers/water resource engineers in the line departments and planners, the IS will also find its use with officials of the state agriculture/watershed departments, NGO's and as a teaching aid in educational institutions etc.

KEY WORDS : Watershed planning, Conservation, Development, Management, Hydrological numerical solver.

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With the promotion of reforms in systems of agricultural science and engineering, agricultural research institutions are in urgent need to construct efficient information systems in order to continuously increase their own competitiveness in dissemination of quality education, research prioritisation and extension. However, the process of reaching the end users with needed data and information in the agriculture domain could be made possible through the present state of art technology gadgets including computer programming, optical fiber and satellite communication technology and television net work. The basic features of such systems are to help in decision making processes by facilitating required data and information preferably under single platform.

Information and communication technologies (ICTs) as applied to the agriculture sector, in the context of its present growth and complexity are essential for effective implementation and transfer of agricultural technologies. Even though, in the last six decades, many agricultural technologies and practices have been developed by the scientists, farmers and other practitioners involved to improve watershed productivity, a fewer attempts have been made to put the information together in a way that it could provide practical guidelines rather than location specific technologies. Further, there is also a need for transfer of such technologies which are applicable spatially under similar conditions elsewhere to sustain rainfed agriculture and at the same time for utilisation of research findings fully. The overall objective of the study is to develop information system on watershed and to use the developed information system for a few applications in watershed studies.

METHODOLOGY

The information system has been developed as a platform of large data sets and information collection using suitable computer architecture and interlinking them suitably to generate meaningful information system. It consists of the data types in text format, images, videos, photos, figures, graphs, monographs, with which the users can easily comprehend the aspects of "watershed". The photos and videos pertaining to relevant aspects of watershed would make user more informative. Further, the data types namely, graphs, maps, tables, charts, nomographs, internet links are used to develop a good network of specific information in a form of system. The sources from which the data are collected also include the reputed books, periodicals, seminars, course

materials, lectures and presentations.

In order to create a weave information network and to present in a compatible form the developed information system used the following software's namely, Microsoft window, C# Programming, Visual Studio 2010, Html, Asp.Net, IIS 7.0 and net framework.

The main components of system are divided into concept, watershed planning, watershed conservation, development and management as shown in Fig. A. Watershed concept is presented by explaining different components namely codification of watershed, delineation of watershed, and geometric representation of watershed and geomorphological characteristics of watershed. In order to explain details prevailing agro-ecological data sets are used. For example, codification and delineation of watershed has described using the example of Raichur sub watershed is taken (Fig. B). To explain the geometric and geomorphological characteristics, suitable sketches, figures, videos are included.

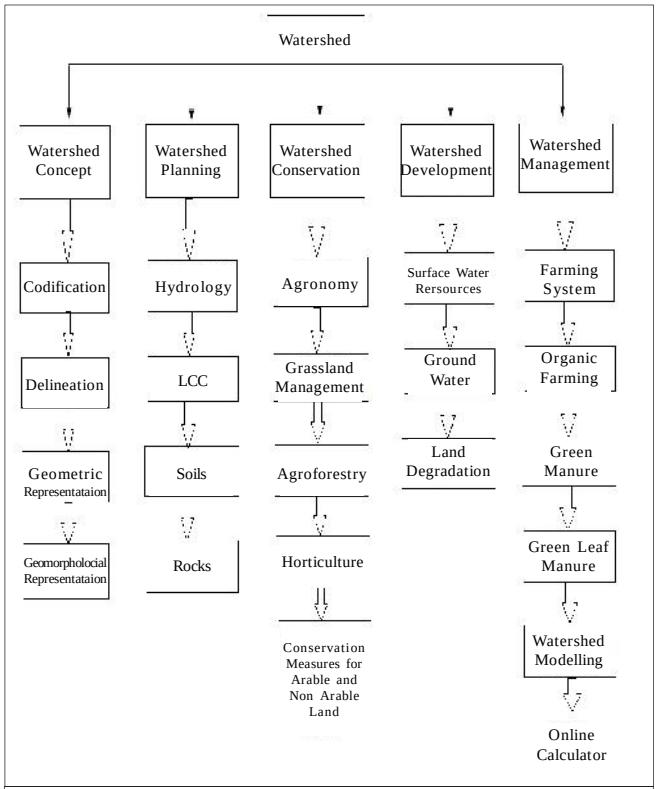

Fig. A : Developmental components of watershed tree

The subtopic on hydrology, the land capability classification deals with various topics like objectives, characteristic and different classes with respect to soil, climate etc. This sub-topic soil describes about the types of soils, soil orders, description on soil survey, soil erosion and many other relevant topics. The subheading rocks deals with different types of rocks. In brief the watershed planning components

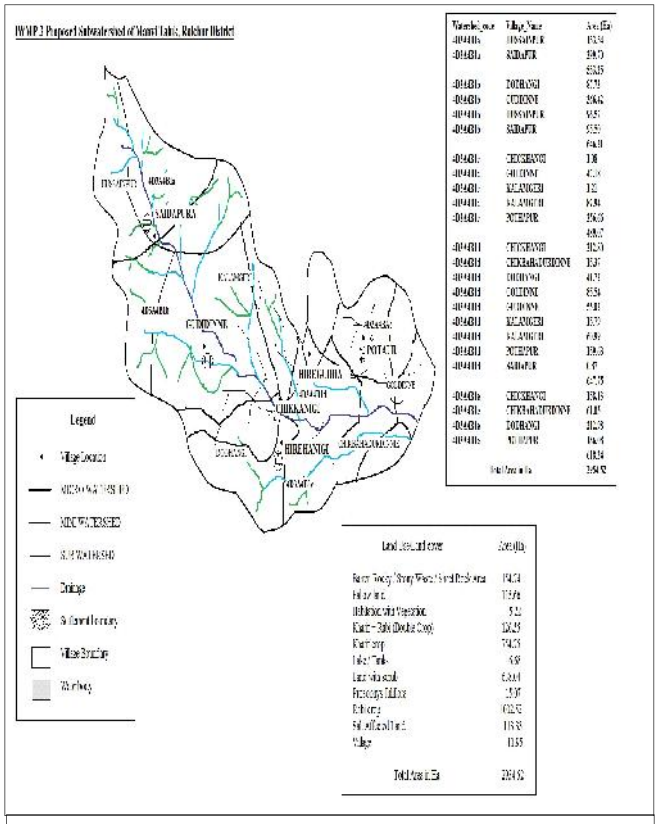

Fig. B : Depiction of watershed map of watershed in Raichur district for the purpose of understanding

namely hydrology, land capability classification, soils and rocks are explained with suitable photos, figures, videos, tables, graphs. The details of the topics forged in the system under watershed concept and analysis are as shown in the Table A. Similarly, the issues and details pertaining to planning, conservation, development and management enumerated in Table B, C, and D, respectively.

The information system components are watershed concept, planning, conservation, development and management. It also contains watershed modelling *i.e.* numeric solver for hydrological events like, rainfall, runoff and hydrographs. The rainfall measurement contains average depth of rainfall over an area solution which includes, average mean method, Thiessen Polygon method and Isohyetal method. It also contains calculations of plotting position by Weibull method. The estimation of peak rate of runoff was calculated by rational method. In case of hydrographs the method of direct runoff hydrograph is presented. The output of information system on watershed management is in the form of web pages where it includes text, photos and videos for better understand. There are totally 1,637 files in which it contains 492 numbers of photos, 81 numbers of videos. The total output information system contains the memory of 1.00 GB.

Table A : Detailed information of watershed concept

Sr. No.	Watershed analysis				
	Watershed	Delineation of watershed	Coding of watershed	Geometric representation of watershed	Geomorphological characteristics of watershed
1.	Objectives of watershed management	Topo maps and watershed boundaries	Procedure for coding of watershed	Bernard's grid representation of a watershed	Linear aspects of drainage networks
2.	Criteria for selection of watersheds	Reading Topo maps	Coding of Nagarjuna sagar catchment, Andhra Pradesh	Rectangular grid representation of a watershed	Areal aspects of watershed
3.	Activities for watershed development	Salient features of Topo sheet	Coding of subwatershed of Manvi Taluk, Raichur District, Karnataka		Relief aspects of drainage basins and chanel networks
4.	Guidelines for watershed development	Reading a map			
5.	Gram Sabha meetings, self help groups, user groups	Reading topography			
6.	Funding pattern, future perspectives,	Defining watershed boundaries on topographical map			
7.	Sources and links : www.agricoop.nic.in/agristatics, www.india.gov.in/sectors/agriculture/ministry_agriculture.php, www.watershed.nic.in www.sourveyofindia.gov.in/soi_geo.html, www.dst.gov.in/scientific_services/survey.htm, www.nh.nrcs.usda.gov.gov/technical/WS_delineation.html,				

Table B : Detailed information on watershed planning

Sr. No.	Watershed planning analysis			
	Hydrological components	Land capability classification (LCC)	Soils	Rocks
1	Hydrologic process (general)	Objectives of LCC	Soil composition, texture, structure	Petrology
2	Precipitation: Forms and types of precipitation, characteristics of precipitation and measurement of precipitation.	Soil profile characteristics for LCC	Soil forming factors, soil variability	Petrography
3	Evaporation: Factors affecting evaporation and methods of evaporation estimation.	Role of external and climatic factors for LCC	Soil profile horizons, soil pH, consistence, colour	Igneous rocks
4	Evapotranspiration: Factors affecting ET, estimation, measurement and equations (Penman, Thornthwaite etc.) of ET.	Mapping and colour notations for LCC	Soil survey, soil mapping legends, supplemental soil survey, slope analysis	Sedimentary rocks
5	Infiltration: Infiltration process, measurement of Infiltration and Infiltration Indices.	Characteristics of LCC (I – VIII)	Standard soil survey	Metamorphic rocks
6	Interception: Stemflow, canopy drip, throughfall and depression Storage.	Influence of soil depth, soil texture, slope, erosion conditions and climate on LCC.	Soil survey work plan	Composition of earth crust
7	Runoff: Runoff process, direct runoff, hydrograph and empirical equations.	Structure of the classification	Soil orders: Entisols - Vertisols	Rocks: Coal. dolomite, quartzite, sandstone, limestone, granite, silica sand etc.
8	Hydrographs: Unit hydrograph and its derivation and unit hydrographs of different durations.	Land capability sub classes	Soil erosion: Types of water erosion, causes and principles of gully erosion	Sources and links
9	Flood: Estimation of magnitude of a flood peak, regional flood frequency analysis, flood routing, flood control, flood forecasting and flood control In India.	Land use capability classification	Stages of gully development	
10	sources and Links: www.raitamitra.kar.nic.in/agriprofile/rainfall.htm, www.karnataka.com, ,www.pdfcari.com/department-of-hydrology-indian-institute-of-technology-roorkee.html,www.conservapedia.com/Land_capability_classification,www.india.gov.in/citizen/agriculture/soil.php, www.geosocindia.org/.			

Table C : Detailed information on watershed conservation analysis

Sr. No.	Watershed conservation analysis		
	Conservation measures for arable lands	Conservation measures for non – arable lands	Agronomic measures in soil and water conservation
1.	Contour farming, strip cropping	Contour trenching, gradonies	Land use and conservation agronomy
2.	Tillage practices	Temporary gully control structures	Grassland management
3.	Conservation cropping system	Permanent gully control structures	Agroforestry
4.	Mulching and crop residue management	Sediment retention structures	Horticulture
5.	Contour bunding, graded bunding, terraces, vegetated waterways, diversion drains, hydraulic structures	Improvement and management of grasslands	
6.	Sources and Links www.hydrosphere.com/services/hydraulic_structures.htm, www.parisara.kar.nic.in/PDF/Land.pdf www.agriculturemizoram.nic.in/nwdpra.html, www.mass.gov, www.en.wikipedia.org/.../Ministry_of_Environment_and_Forests_(India)		

Table D : Detailed information on watershed development and management

Sr. No.	Watershed development and management				
	Surface water resource and ground water resource	Land degradation	Farming system and production technologies in watershed	Watershed modelling	Remote sensing and GIS
1.	Water resource potential and development of water resources	Causes of land degradation	Farming system	Scope and technology of physical modelling	Electromagnetic spectrum
2.	Land and water resources of India	Effects of land degradation	Organic farming	Classification of watershed models	Cropping system analysis
3.	International indicators for comparing water resources potential	Climate change	Green manure	Analysis versus synthesis	Agro – ecological zone based land use planning
4.	Forms of subsurface water	Direct pressure	Green leaf manure	Error in modelling	Spatial data and non spatial data in GIS
5.	Aquifer properties, wells, groundwater budget	Soil erosion		Applications of watershed modelling	GIS data base design, errors in data
6.	Sources and links www.cgwb.gov.in, www.uttarkashi.nic.in/aboutDistt/groundwater_brochure.pdf, www.environmentandpeople.org/LandDegradation.html, www.csshome.com/sustainableagriculture, www.florabase.calm.wa.gov.au/science/timage, www.indiawaterportal.org/taxonomy/term/6607, www.iasri.res.in/.../e.../4-Remote%20Sensing%20and%20GIS, www.gislounge.com/agriculture-and-gis/.				

The aim of this information system is to provide quality information on watershed so that the users can gain knowledge and adopt the system so that the watershed can develop and managed. The query mechanism used in this information system is by method of hyper linking. The most of informative topics, buzz words are interlinked by network using hyper linking. From main topic to topic, from sub topics to topics, in which all matter in this system are directly or indirectly linked so that user can easily access and understand the matter without the gap of information. The method of operating text and image query system to open particular topic is shown in Fig. C and D.

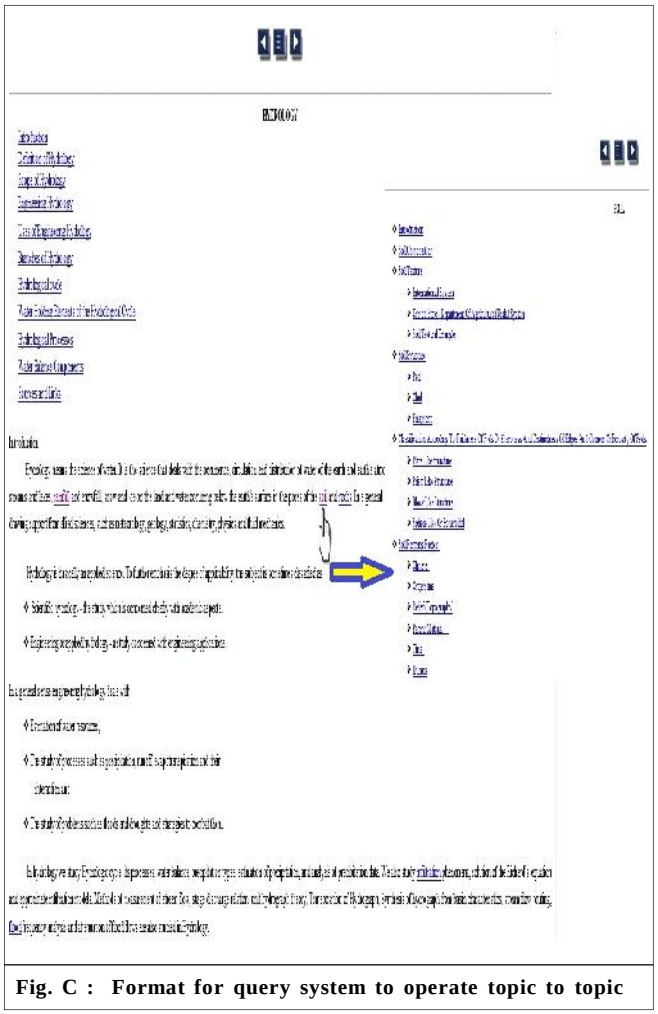

Fig. C : Format for query system to operate topic to topic

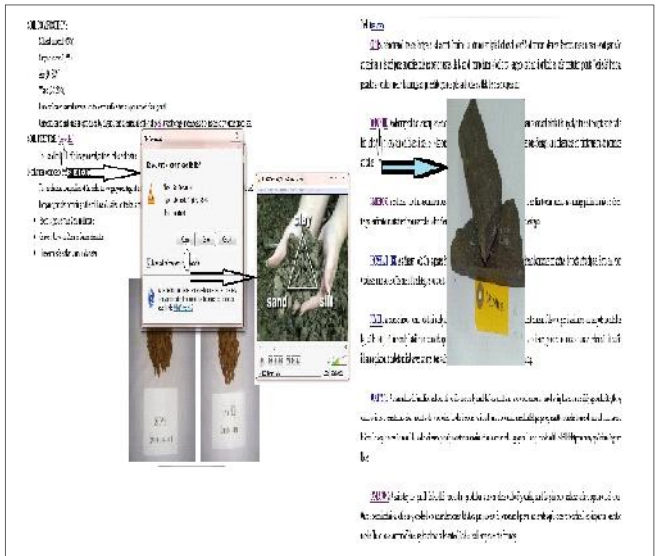

Fig. D : Format for video and image query system

■ RESULTS AND DISCUSSION

While carrying out watershed analysis using the information system, the users would be appraised and easily approachable to this information system as much of the information pertaining to watersheds is available. This study aims at the development of software, which covers different techniques for analysis of watershed, watershed planning, watershed conservation, watershed development and management. The software includes a graphical user interface (GUI) that allows the user to select and edit data, save and retrieve the output in text, graphical and tabular forms. The combination of pictorial view, text, image and video (in some cases) would help users to understand the topic in better way and in taking decisions. The numeric solver is checked by taking data of Raichur subwatershed and is matched with the manual calculation. The typical calculation that needs to be performed for calculation of runoff peak rate using rational method is depicted in Fig. 1.

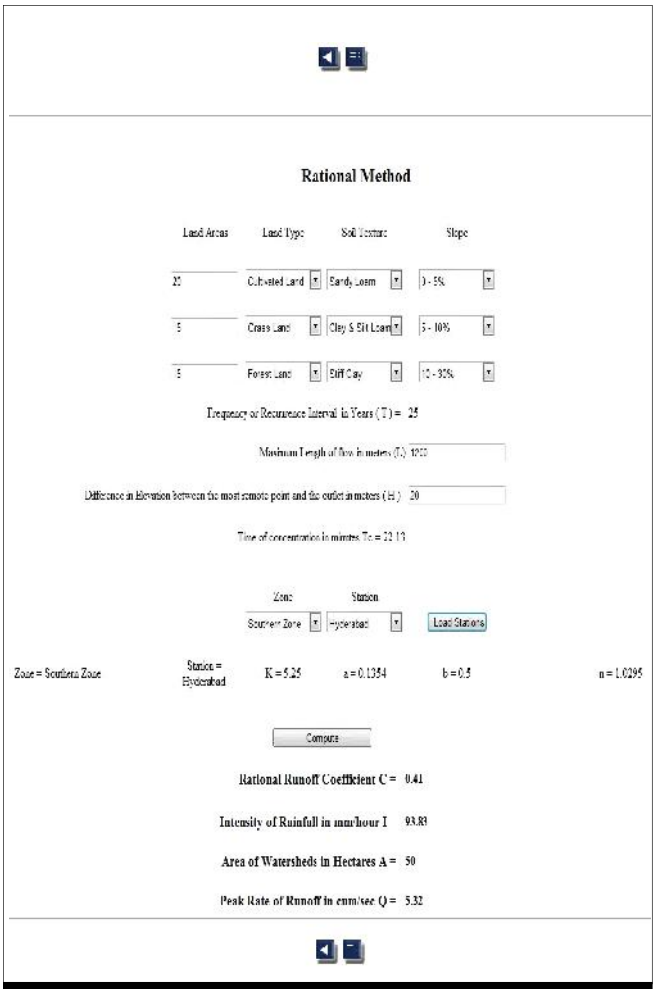

Fig. 1: Format for estimation of peak rate of runoff using Rational method

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