INCOH Sponsored Research Projects

INTEGRATION OF DIGITAL TERRAIN MODEL AND REMOTE SENSING DATA IN GIS FOR THE DEVELOPMENT OF A RUNOFF MODEL*

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PROJECT SUMMARY

Estimation of annual runoff yields from basins is a vital problem in the planning of river valley development projects. This requires a systematic compilation and analysis of observed discharge data for a number of years. When the number of basins is innumerable, it is not possible to gauge them all. So it often becomes necessary to make attempts to estimate runoff yield at some of the ungauged basins from data of neighboring basins, or use hydrologic models to predict the runoff of ungauged basins. In this study a modeling approach was developed for the estimation of runoff from ungauged catchment, using physical and meteorological catchment parameters collected from a variety of sources, such as field, maps, remote sensing etc. The study highlights the importance of runoff and parameters affecting the runoff as well as the effective use of remote sensing and Geographic Information System (GIS) to extract the catchment parameters for rainfall-runoff modeling.

The major hydrological models developed uptil now, are lumped in nature, whereas remote sensing data are available in raster format i.e. distributed in nature. This leads to incompatibility in data requirements. The recent hydrological models such as SHE, ANSWERS etc., are distributed in nature and are compatible to digital remote sensing data. The success of a distributed model however depends upon the establishment of a good database in GIS environment. Most of the GIS packages lack point operations to be carried out on pixel basis, which is of paramount importance in the routing of water and sediment at the outlet of the catchment. This study identifies those hydrologic parameters, which can be directly or indirectly assessed from satellite data on a spatial scale, affecting runoff and integrates this information with a digital elevation model in GIS environment in order to develop a distributed type runoff model.

The study area comprises the upper Narmada Catchment in the Madhya Pradesh State, which covers approx. 2500 km^2 area on the ground. A major part of the catchment lies in Mandla District and the remaining part in Sahadol District of Madhya Pradesh. Agriculture in the catchment is largely confined to valleys and upper parts of the catchment. Due to scanty irrigation facilities and low water storage, the area is mostly under rainfed farming. The Survey of India topographic

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maps were used for the identification of catchment, drainage, habitation, forested area etc. Rainfall data of five raingauge stations was used to study the rainfall distribution over the area. The basic information related to soil cover, soil depth and soil fertility was obtained from NATMO (National Atlas Thematic Mapping Organization) maps. The IRS LISS-II data corresponding to pre- and post-monsoon periods were used for the classification and identification of land use and land cover classes as well as saline and alkaline lands.

For rainfall-runoff modeling using ANSWERS model, the runoff and erosion in the study catchment were computed for six different representative rainfall events. To compute the input parameters of the model, remote sensing and ancillary data were used. From the study, it was concluded that pre- monsoon and post-monsoon IRS LISS-II data provide useful land use/land cover information that is useful in computing crop cover factor. The ANSWERS model can be successfully used for distributed modeling of runoff and erosion processes with only a few input parameters. The average values of erosion vary from 0.25 kg/m^2/year to 2 kg/m^2/year in the study catchment. Runoff in the catchment can be directly assessed from rainfall. The computed distributed values for erosion can be utilized for various studies including planning of soil conservation measures.

INVESTIGATION OF DROUGHT THROUGH REMOTE SENSING AND LAND INFORMATION SYSTEM*

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PROJECT SUMMARY

Drought and desertification are among the major natural calamities in India. Nearly 19% of the total land of the country is frequently affected by lack of rain. About 39% of cultivable area is drought prone. The Deccan plateau constitutes 50% of drought prone area and has suffered severe droughts during 1985, 1987, 1988 and 1992. For identification and execution of short and long term drought mitigation measures, information is required on the probability occurrence of an event from observation records and assessing their likely area, duration and intensity.

The main objective of this study was to use remotely sensed data and develop land information system for drought analysis over parts of Deccan plateau. A part of Nanded district, 190 km^2 area of sub watershed of Jhod nadi was taken up to demonstrate the use of remotely sensed data and land information system in assessment of drought conditions.

Spatial and site based information collected from various sources was utilized in the creation of a land information system. Temporal Indian Remote Sensing (IRS) satellite data were processed and visually interpreted to be used in (i) assessment of vegetation cover, open areas and degraded land over a period of five years; (ii) demarcation of major lineaments which aids in water accumulation; and (iii) computation of area of water spread in the reservoir and its surroundings. Spatial distribution of villages and their human and live stock population, open dug wells, crop area and production, land utilization and revenue information, irrigation facilities were collected from the local agencies. Meteorological information was collected from Indian Meteorological Department and rain gauge stations. The information collected from various sources was stored in the land information system. The land information system, thus, created, comprised the spatial and location attributes/variables required in the estimation of drought, which was subsequently used in the estimation of drought indicators viz. physical, meteorological, hydrological, agriculture and socio-economic indicators. For determining the possible drought duration along with its onset and termination as well as the drought intensity, monthly rainfall data was used.

The study brought out an integrated methodology for data collection from satellite and ground based system that proved useful in carrying out drought

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analysis for the selected study area. Synergistic use of drought indicators computed from meteorological, hydrological, agriculture and socio-economic data could be used in the potential drought assessment of the region. The land information system developed can be used in storage and dissemination of information for continuous monitoring and assessment.

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DESIGN AND DEVELOPMENT OF INSTRUMENTS FOR MEASURING SNOW/GLACIERS PARAMETERS FOR ASSESSING AND FORECASTING SNOW BOUND RUNOFF WATER*

Principal Investigator
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PROJECT SUMMARY

In India, snow and glaciers are the most potential sources of water. Large quantities of water are stored temporarily in the seasonal snow cover, which melts after the winter season. The melting of snow governs snow runoff and climatic changes. In forecasting models for snow-melt, snow runoff water, snow avalanche release and climatic changes, the required important parameters include snow cover thickness and temperature. In deep snow bound areas, the snow cover thickness and temperature change continuously because of the radiation, heat and climatic changes. Thus, for determining the quantity of water entrapped in snow cover and glaciers, the snow and meteorological parameters need to be measured continuously and regularly.

In view of above, it is considered essential to install a range of stand alone intelligent instruments in the Himalayan region for recording and processing snow and meteorological data uninterrupted throughout the winter. For this purpose, the Central Scientific Instruments Organisation (CSIO), Chandigarh, designed and developed three useful instruments, namely the Portable Snow Data Logger, Ambient Temperature Sensor, and Snow Depth Sensor.

Portable Snow Data Logger The Portable Snow Data Logger, designed and developed around 16 bit microprocessor 80C86, is used for recording and processing of snow parameters. The design of data logger is based on very low power consuming components (C-MOS Technology), which is suitable for field operation. The system has in built timing system. It has been interfaced with CSIO developed Ambient Temperature Measuring Probe. Apart from this Ambient Temperature Probe, the system is capable of handling 19 more sensors simultaneously. Since the developed instrument is to be used in high altitude snow bound areas with harsh weather conditions, specific kind of components have been used for operating the instrument in temperatures ranging from - 40^0C to +50^0C, humidity upto 100% and wind speed upto 200 km/h. The chassis cover of the system and outside connectors are hermetically sealed to avoid ingress of moisture and water.

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Ambient Temperature Sensor The Ambient Temperature Sensor measures true air temperature (free from the effect of solar-radiation, sun-light etc.) above snow surface. The harsh environmental conditions impose design restrictions on the instrument and require great performance reliability. Therefore, a suitable design as per the J55555 specifications with the components conforming to 883-B/JM38501 specification code was worked out to measure the air temperature. The sensor consists of one RTD sensor element enclosed in a self-aspirated shield. The complete signal conditioning circuit of this sensor is contained in one single unit. This is a weatherproof sealed unit to withstand low temperatures. The output of this signal conditioner is interfaced with a data acquisition system. It controls the sampling interval and multiplexing of 28 channels. The multiplexed signal is given to A.D. converter, which converts each analog value to the digital format. This digital data corresponds to temperature read by the corresponding sensor. The reading of temperature sensor is taken after a selectable timing interval. After every hour, the readings are used to compute the minima, maxima and average temperature of the air, which is stored in separate memory modules. Data can be retrieved when required from the Snow Data Acquisition system.

Snow Depth Sensor The Snow Depth Sensor has been designed to measure the snow depth based on non-contact measurement principle. The thickness of the snow cover is found with the help of ultrasonic pulse transit method. A short burst of ultrasonic pulses is transmitted by the transmitter, which is mounted on a pole with the sensors facing vertically downward towards the snow. The transmitted beam strikes the surface of the snow. Some of the energy gets reflected back and is picked up by the receiver. The time of travel between the transmission and the reception of the pulses is computed which gives the distance of snow cover from the sensor. Since the snow depth sensor is used in highly snow bound areas, the system is housed in a weatherproof cabinet made up of lightweight aluminium sheet with airtight ceiling. The sheet is painted shiny white to reflect maximum radiation.

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STUDIES OF WATER RESOURCES UTILISATION AND FLOOD DAMAGE ASSESSMENT OF MAHANANDA BASIN IN INDIA BY REMOTE SENSING AND GIS*

Principal Investigator
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PROJECT SUMMARY

The river Mahananda is a major northern tributary of the Ganga passing through Nepal, India and Bangladesh. The northern hilly region of the basin is covered by thick forest; down south the Tarai region, by various kind of plantations particularly tea gardens; and further south the alluvial plain formed by Ganga-Brahamputra river system, is covered by a variety of agricultural crops. The alluvial plain is very fertile and therefore when weather is favourable, bumper crops are produced. The soil is suitable for cultivating a variety of crops but agricultural lands are not fully utilized in summer and winter. To meet the growing food demands of the country, efforts need to be made to maximize the crop production in all seasons through proper water utilization. To achieve this objective, the present study was undertaken wherein the advantage of satellite Remote Sensing (RS) technology and Geographical Information System (GIS) could be utilized. Remote sensing gives the present land use/land cover and can monitor future changes in land use/land cover with increasing population and urbanization. GIS and RS along with ground information help in determining the present water utilization and probable requirements at ten-year intervals.

The main objective of this study was to evaluate the utilization of water resources of Mahanada basin and how this utilization is going to change in the next five decades with the existing cropping pattern and population growth. Block unit was chosen as micro unit for GIS since most of the information available was in block units. Mahananda basin is covered by IRS LISS I satellite data and Survey of India maps, and these data were used for land use and geomorphologic classification.

For the purpose of computing crop water requirement, the Duty-Delta Method was adopted. In the computation of urban and industrial water requirement NWDB norm was adopted by which 100% urban domestic and industrial requirement and 50% of rural domestic requirement will be met from surface water. If the municipalities do not follow the guidelines strictly and depend upon groundwater for water supply, scarcity of water will be on the rise and many more blocks will

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reach distress level by 2050. Very few municipalities in the basin area use surface water for urban water supply at present.

It was found that blocks namely, Siliguri, Kaliachak, Baisee, Kadwa, Barsoi, and Azamnagar will possibly be facing an alarming groundwater scarcity problem by summer of 2050. However, it may not be so severe because all these areas are flood prone and average depth of inundation is low. Therefore, production of crops will not be hampered for scarcity of groundwater as ground moisture level is very high. Hence, with the present crop production, the position of Mahananda basin vis-à-vis groundwater is marginally safe. However, if crop cultivation increases, import of surface water from rivers Teesta and Sankosh will be necessary and water from river Mahananda and its tributaries will have to be used by suitable watershed planning.

The proposal for a joint irrigation project from Bagdob barrage for irrigating areas in Purnea district in Bihar and in Malda district in West Bengal will solve to a great extent the surface water requirement of Katihar and Purnea districts of Bihar and Malda district of West Bengal. Further import from Sankosh Project, if materializes, will make the basin area water surplus.

Floods generally occur in Mahananda basin as a result of excessive precipitation in the upper catchment that results in an excessive quantity of runoff to carried through the river, which is inadequate for discharge. The river Mahananda and its tributaries pass through two states, Bihar and West Bengal, which have been ranked as first and third in respect of flood problems among various states of India. Flood damages have increased significantly since 1984. In view of this, proper land use planning is required so that high flood prone areas may be utilized for low damage potential uses like agriculture while less flood prone areas may be reserved for high value land uses. For this purpose, information regarding gradation of flood zones, spatial extent and depth of inundation and frequency of flood is required. Keeping this in view, a simple GIS Flood Hazard Zone Gradation Method was developed on the basis of Hazard Zone Index.

Hence, from the study of this water utilization project it is clear that there is no major water problem in the basin area, seasonally and block wise. Occasionally there may be scarcity of water in a particular month during sowing and growing period, which may be provided for by groundwater or by appropriate watershed management.

INDIAN NATIONAL COMMITTEE ON HYDROLOGY (INCOH)

(IHP National Committee of India for UNESCO)

Constituted by the Ministry of Water Resources in 1982

INCOH Activities Related to UNESCO's IHP-VI Program

India is actively participating in IHP-VI activities and a detailed program has been chalked out in accordance with IHP-VI themes towards preparation of reports, taking up research studies, organisation of seminars/symposia at national and regional level, and promotion of hydrological education in the country. It is envisaged to participate in all the relevant and feasible programs identified under the various focal areas of IHP-VI themes as given below.

India's participation in IHP-VI program

Theme	Selected Focal Area
1. Global Changes and Water Resources	Integrated assessment of water resources in the context of global land based activities and climate change
2. Integrated Watershed and Aquifer Dynamics	Extreme events in land and water resources
3. Land Habitat Hydrology	Dry lands
4. Water and Society	Raising public awareness on water interactions
5. Water Education and Training	Continuing education and training for selected target groups

INCOH Publications

Publication of Jalvigyan Sameeksha Journal

To disseminate information and promote hydrological research in the country, INCOH brings out the Journal '*Jalvigyan Sameeksha*' (Hydrology Review Journal). The papers published in the Journal are by invitation only. The Journal is widely circulated amongst major organisations and agencies dealing with water resources.

Publication of State of Art Reports

In pursuance of its objectives to periodically update the research trends in different branches of hydrology, state of art reports authored by experts identified by INCOH from various institutes and organisations in India, are published regularly. These reports are circulated free of cost to central and state government agencies including academic and research organisations.

JALVIGYAN SAMEEKSHA

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