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Rapporteur's report ***Theme VIII***

Remote Sensing, GIS and Hydrologic Instrumentation

S. K. JAIN
Scientist 'F', National Institute of Hydrology, Roorkee, India

The application of Remote Sensing and GIS has attracted the attention of a large number of professionals and consequently this field has seen rapid growth in the last decade. The technical session on this theme has 15 papers. Out of these, one paper is on identification of seepage points in a reservoir and two papers are connected with stream flow measurements. These three papers are not directly related to the theme of this session. The remaining 12 papers cover the remote sensing and GIS part; there is no paper on hydrological instrumentation. The 12 papers cover a wide spectrum of hydrological applications: snow melt modelling, drought, evapotranspiration, soil erosion, water harvesting, sustainable development, geomorphology and water resources management.

Since the remote sensing data has spatial attributes, a system to manage the spatial data is of tremendous help in analysis of satellite data. Due to this reason, these two techniques are mostly used in conjunction. Many software packages for remote sensing data analysis also contain modules for management and analysis of spatial data.

Seidel et. al (Paper 1) have modelled snow and glacier melt of a medium size basin located in high alpine region using a version of the snow melt runoff model (SRM). The snow cover area was mapped using Landsat – TM data which has a spatial resolution of 30 meters. The authors have also investigated the effect of climate change for two scenarios – year 2030 and year 2100. These scenarios are characterized by higher temperature and increased winter precipitation. The runoff in the river shows increasing trend during summer and the authors have emphasised the need for enhanced monitoring of seasonal snow cover. In a related paper, Morid et. al (Paper 4) have attempted to estimate spatial variation of snow water equivalent (SWE). They have used energy balance approach to monitor SWE. The temperature data were used to calculate solar radiation. Since no satellite imagery or air photo was available, the authors may like to elaborate on the reliability of SWE maps when presenting their paper.

Nagarajan (Paper 2) used satellite data to assess surface water availability and crop water requirement for an area in Maharashtra, India. The author has provided general details of the area and no analysis has been presented. The conclusions of the paper are also very general. The author may like to present the details of the analysis and demonstrate how the remote sensing data were processed and utilized.

Ambast et. al (Paper 3) have used remote sensing data to estimate evapotranspiration for an area. They have used a model based on aerodynamic concepts and have estimated the outgoing fluxes using remote sensing data. The technique was applied to a part of the Western Yamuna canal command in North India and it has been reported that the error is about 10% when compared with the Penman-Montieth approach. The modelling of fluxes could not be validated in absence of ground data. The remote sensing approach can obviate the necessity to collect large amount of hydrological data to compute ET. It is important to note that the ET component may account for up to 30% of the water balance and its accurate spatial assessment is very important in hydrological modelling.

Goel et. al (Paper 5) have assessed sediment deposition in Bargi reservoir in India using satellite data. The data of IRS-1C satellite, LISS –III sensor, having a resolution of 24 m were used. This approach has been applied to a number of reservoirs in India and the results are encouraging. The remote sensing approach is a quick and reliable alternative to assess sediment deposited as well as their pattern in the live storage zone of a reservoir. However, further work is needed to segregate water and land pixels near the reservoir periphery.

There are two papers related to soil erosion modelling. Kothyari (Paper 6) has described a procedure in which a catchment is divided into a number of cells and the erosion of each cell is estimated using USLE. The sediment delivery ratio for each cell is then assessed and a unit sediment graph is obtained. This graph, when convoluted with rainfall, gives the sediment yield of the basin. The results of application of this approach to a basin of 92 sq. km area have been presented. Jain (Paper 10) has used a distributed model (ANSWERS) to estimate sediment yield. The inputs to the model were determined using remote sensing images and the spatial data was managed using a GIS. There is a need for further improving the match between the observed and simulated discharge as well as sediment. The spatial distribution of sediment yield/deposition has also been presented. However, the correctness of this map remains to be established.

Jeyaseelan et. al (Paper 7) have described the use of satellite data for monitoring performance of an irrigation command area. The crop classification was performed using NDVI and a linear regression equation was established between crop yield and NDVI. The authors report that there was a general agreement of estimated crop area and the field reports.

The paper by Ramprasad et. al (Paper 8) describes a study in which GIS and remote sensing were used to identify potential water harvesting sites. The paper has not clearly brought out the use and role of remote sensing data in the study and the authors may like to elaborate it while presenting their paper. The paper by Kar (Paper 9) gives a generalised overview of use of GIS for sustainable watershed development. The ideas that have been presented in the paper are well known.

The papers by Mayya & Subrahmanya (Paper 11) and by Khanna & Rai (Paper 12) describe applications of remote sensing to water resources problems.

Cordery and Watson (Paper 13) have focussed their attention on the Gradex concept to define the high flow part of a stage discharge relation for basins. According to the Gradex concept, the rainfall and flood frequency relations should be parallel at large recurrence intervals. This concept has been around for quite sometime and looks interesting. The authors have applied this concept to a few basins in Australia and show that may be possible to extend the low-flow stage-discharge relationships to the regions of high flows using this approach. Adhikari et. al (Paper 14) have compared three techniques, viz. current meter, salt dilution, and Uranin tracer to measure discharge in a turbulent mountain stream. They conclude that current meter is least suitable for such streams and the salt dilution is the best technique.

Ramanujam (Paper 15) has described a study in which seepage points inside a reservoir were identified using piezometer data. This paper appears to be more relevant for ground water session.

To sum up, the papers included in this theme clearly indicate rapid growth of use of remote sensing and GIS approaches to water resources problems. A few of the studies included in this session can be termed as 'warm up' studies since the analysis that has been reported is preliminary. Nevertheless, they point towards a growing interest to use the latest tools. Although, remote sensing is being used for divergent applications, the technique is to be further perfected and standardized before it can be used by field departments. More efforts are needed to verify and cross check the results through ground truth. The potential of GIS in analysis, management, and display of spatial data is now firmly established but the researchers have to put in extra efforts to verify the correctness of the spatial pattern of the results and ensure that they are not misleading.