Himalayan water resource management: Role of geospatial technology

The Himalayan mountain system is the source of one of the world's largest supplies of fresh water. The Himalayan region contains the largest areas covered by glaciers and permafrost outside the Polar regions and termed as "*Water Tower of Asia*". Around 15000 glaciers, covering an area of 33000 km2 contributes to the stream flows of the Indus, Ganga and Brahamputra river systems of the Indian subcontinent (Hasnain 1989). The water resources from this area drain through ten of the largest rivers in Asia, in the basins of which more than 1.3 billion people live. Although, many big rivers originate from Himalaya, and have plentiful seasonal and annual water supply, despite this, mountain people living on the ridges and hill slopes have limited access to water for drinking and agriculture. Throughout the mountain region, glaciers are melting, springs are reported to be drying, and mountain agriculture has suffered from erratic rainfall and drought. The shortage of water has placed an increasing burden on mountain communities, particularly on women. Additionally, the mountain communities face loss of property and lives due to water-generated natural hazards. The water resources of this region are currently facing threats from a multitude of driving forces. Climate change has exacerbated the situation by creating uncertainty about the future water availability and water security. Managing water resource is a challenging task in Himalayan state due to complex terrain, lake of data and harsh climatic condition.

Himalayan water resource management: issues and challenges:

Management of Himalayan water resource requires an approach which integrate water quantity and quality concerns through an integrated system considering wide range of scientific, technological, social, and political issues associated with Himalayan water resources. Major challenges and issue faced by water resource managers in Himalayan region are: (i) Inadequate data: Most studies have excluded the Himalayan region because of its extreme and complex topography and the lack of adequate rain gauge data. Also, gap between water demand and availability put challenges in management and allocation of water resources; (ii) Climate change: Climate change has exacerbated the situation by creating uncertainty about the future water availability and water security; (iii) Knowledge gap: There are many components of water resource knowledge which needs to be linked for management of water resource. In Himalayan region, There is an urgent need to address the knowledge gap by establishing monitoring schemes for snow, ice, and water; downscaling climate models; applying hydrological models to predict water availability; and developing basin wide scenarios which also take water demand and socioeconomic development into account; (iv) Policy issue: Due to its physical setting, the Himalayan region is prone to various water-induced hazards (landslides, floods, glacial lake outburst floods, and droughts). Lack of supportive policy and governance mechanisms at the local, national and regional levels, and the lack of carefully planned structural and non-structural measures of mitigation lead to increased vulnerability.

In view of above challenges and increase in water demand with population growth there is critical need for an efficient and acceptable management of the Himalayan water resources. To provide fully effective water management, geospatial techniques provide tools to understand and predict the movement as well as availability of water, within all components of the hydrological cycle and to be able to simulate the impacts of various landscape changes on the distribution and availability of water. The conservation of water resources is essential and along with that the restoration of the quality of the water is also equally important. The region where the major river originates and quenches the thirst of millions of people, if faces the quality and contamination issues the scenario would be rather threatening for the downstream people.

Geospatial technology: A solution for water resource management:

Water resource has three aspects, one is related to excess water that creates floods, second is related with scarcity of water or water deficit that brings droughts, and third is related to climatic and natural process that control or affect water resources. Now-a-days, geospatial technology is playing a vital role for prediction, monitoring and management of floods and droughts conditions through stream flow prediction, flood delineation and assessment, frost risk assessment, precipitation and uncertainty. The geospatial techniques use Remote Sensing, Geographical Information System and Global Positioning System to facilitate 'water resources management' (Fig. 1). The principle concept of water resource management is to represent spatial pattern in social, economic, hydrological and geographic pattern to integrate the 3R concepts i.e. recharge, retention and reuse. This 3R concept with

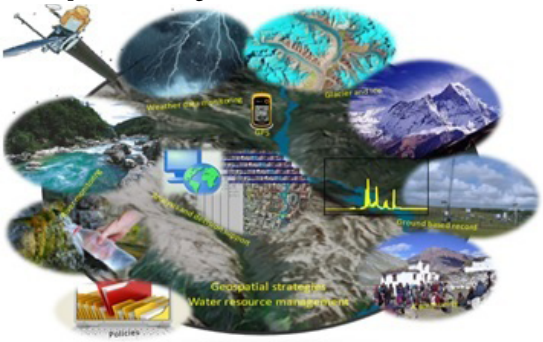

Fig. 1. An overview of water resource management using geospatial strategies

integrated GIS analysis can be used in calculating the current and future scenario for water. Geospatial techniques provide following capabilities in a single domain for water resource management and planning:

(i) Water accounting and appraisal: Provide tools for developing spatial and temporal information about the past and present use of water resources and distribution. This information will be used to develop water balances, water resource assessments, national water accounts and interactions of components of the water cycle at various scales; (ii) Water information systems: Provide tools for development of systems architecture for water information that is robust and evolvable with changes in data sources, applications and technologies. This includes a framework of open standards for exchange of information, data and computational services, visualization tools, analysis of historical data and real-time data from monitoring network and quality assurance; (iii) Forecasting and prediction: Hydrological forecasting service from continuous monitoring of flows, hydro-meteorological data, water supply and water demand, as well as water resources availability for one or more seasons; (iv) Decision-tools for water resources planning and management: Geospatial technologies provides tools for allocation of adequate water to the consumers at right time and place, protection from excessive water (e.g. floodwater), maintenance of acceptable water quality, diversion of excess water at appropriate route etc. Remote sensing satellites provide data on several key water-related variables (for example, rainfall, precipitations, water storage, soil moisture and evaporation) at various spatial and temporal scales for appropriate and reliable assessment where human access is difficult such as the Himalayan mountains.

References:

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Menu Rani (*menurani06@gmail.com*)
GBPNIHESD, Kosi–Katarmal, Almora- 263 643, Uttarakhand