STRIVING TOWARDS ASSESSMENT OF MOUNTAIN WATER RESOURCES

Z. W. KUNDZEWICZ AND D. KRAEMER
World Meteorological Organisation, 41 Av. Giuseppe Motta, 1211 Geneva 2, Switzerland

A large portion of the earth's surface is covered by mountains and a larger portion of the global water resources originates from mountainous areas.

There is a consensus on the lack of knowledge of mountain water resources and hydrology of mountainous areas on a global scale. There are a number of reasons for that, such as difficult access to numerous drainage basins, sparse settlements with limited services (electricity, telephone, etc), and the harsh environment, hindering the development of hydrological observations in many mountainous regions. These conditions make it difficult to install and maintain instruments. Often a special, more expensive design of heavy duty instruments is needed which is capable of withstanding the harsh conditions. Field studies of water resources in the mountains are, therefore, far more difficult and demanding than most other hydrological activities.

WMO's Guide to Hydrological Practices (1994) recommends that, because of the heterogeneity of the mountain environment, observation networks in mountain regions should be denser than in most other areas. However, the results of WMO's Basic Hydrological Network Assessment Project (BNAP) show that hydrological networks in mountainous regions are less dense than elsewhere. In addition, the operation of existing networks has been affected by budgetary constraints, and, in some cases, has resulted in the abandonment of hydrological stations, sometimes with long-term series of valuable observations, due to lack of funds.

An additional problem in the assessment of mountain water resources is connected to the boundaries between countries. Many mountainous regions form frontiers between neighbouring countries. Sometimes relations between nations on either side of a mountain frontier may be quite hostile, hence there is no willingness to cooperate. But even if relations between neighbouring

countries are very good, it is not uncommon for the data from two neighbouring countries to be incompatible.

Remote sensing offers considerable potential for studying the hydrology of mountainous areas. Because of difficult access and the expensive operation of hydrological stations, radar or satellite data are particularly appropriate, but, of course, ground-truth data are indispensable in the calibration and verification of data obtained by remote sensing.

Summarising the research and operational needs, one can say that the creation of a systematic data collection network for measuring precipitation in mountainous areas is urgently required. Gathering data on the hydrology of different hillslope types under various precipitation patterns is recommended. Improvement of the hydrological monitoring of streams and rivers within mountains is necessary in addition to the monitoring of the same rivers in the lowlands, which is done with far greater accuracy. Studies of processes are needed with an emphasis on field experiments. It is of paramount importance to try and launch a GIS-supported assessment of freshwater resources in mountain areas and to estimate the contribution of these areas to global water resources. Recommendations on data and information activities in Chapter 13 of the Agenda 21 (1992) devoted to managing fragile ecosystems, and in particular, to sustainable mountain development, read:

"...governments at the appropriate level, with the support of the relevant international and regional organisations; should ... maintain and establish ... hydrological ... monitoring, analysis and capabilities that would ... encompass ... water distribution of various mountain regions of the world,... build an inventory of different forms of ... water use ... and ... identify hazardous areas that are most vulnerable to erosion, flood, landslides, earthquakes, snow avalanches and other natural hazards".

Yet the practical results of the implementation of these Agenda 21 recommendations are, to date, nonexistent.