Integrated Hydrometeorological Network Design and Operation for Flood Forecasting

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Abstract
In this paper, the information requirements for flood forecasting are analysed and the key technical features of an operational information network are outlined. A case study of the Jiangxi provincial river basin forecasting system in China is given. Suggestions for enhancing the backbone of the regional information network in the HKH region are discussed.

The Meteorological and Hydrological Information Needed for Flood Forecasting

Operational flood forecasting needs both historical and real-time information. The type of information needed includes topographical and geographical data of the basin, hydrological data, and weather data.

Topographical and geographical data are used to divide a river into drainage basins. After the basins are so divided, the hydrological parameters must be defined. These include basin area, soil moisture parameters, and routing parameters. If snow accumulation and ablation calculations are to be included, parameters for those are needed as well.

The information needed for quantitative precipitation forecasting includes synoptic data, rain gauge data, doppler radar data, satellite data, and climate data.

The data that is the quantitative output of precipitation forecasting products, real-time meteorological data, and hydrological data are the basic inputs to any flood forecasting system. If there is a reservoir in the drainage basin, then reservoir inflow and release data should also be considered.

It is important to note that the flood forecasting function relies entirely upon automated data as opposed to manual observations. Data should be collected in a local database and screened for quality before being input to the flood-forecasting model.

Criteria for the Identification of a Meteorological and Hydrological Network

Operational flood forecasting involves four stages: 1) meteorological and hydrological observation; 2) data collection and exchange; 3) data processing and flood forecasting; and 4) making flood warnings available to the public and the government. The

information network is the key to each of these stages and is also the technical basis for regional cooperation in flood forecasting.
Such an information network should meet the requirements of:

- timely routine collection of observed data;
- automatic dissemination of scheduled products, both real-time and non real-time; and
- ad-hoc non-routine applications like requests for non-routine data and products.

The network should be:

- reliable;
- cost effective and affordable;
- technologically sustainable and appropriate to local expertise;
- modular and scalable; and
- flexible – able to adjust to changing requirements.

One example of such an information network is the World Weather Watch communication network, known as the Global Telecommunication System (GTS). GTS is one of the most successful projects of the World Meteorological Organization (WMO). As a result of decades of efforts by its members, the current GTS collects routinely observed data effectively and automatically disseminates scheduled products. There is a complete set of procedures for the operation of the GTS, which contributes to its reliability.

GTS has remained vital by adapting to changing requirements and available technology. Over the years, leased lines were gradually replaced by managed data communication network services; the data rate increased from 50 baud and 75 baud, to 64 and 128kbps; the dominant protocol changed from asynchronous, to X.25, frame relay and transmission control protocol/internet protocol (TCP/IP). In the beginning, only character data were exchanged, binary data exchange was supported in the 1980s, and now almost any type of data can be exchanged using a transparent file format. In addition to message switching, high frequency (HF) radio broadcasting, low speed satellite broadcasting, and high-speed satellite broadcasting were also implemented. As more categories of data, including hydrological data are exchanged on GTS, it is evolving into a more general-purpose WMO information network.

While the GTS is a real-time meteorological information network that runs continuously 24 hours a day and all the year round, few hydrological data are collected and disseminated in real time at present, and the accessibility to recent hydrological data is generally inadequate for regional flood forecasting purposes. GTS offers a reasonable choice as a communication backbone for information exchange for a regional hydrometeorological network.

Internet (email) technology can be used to collect site observation data and feed it into the GTS. The WMO Commission for Basic Systems (CBS) recently adopted a set of guidelines on practices for collecting observation bulletins via email. Other choices for data collection include the data collection platform (DCP) used by meteorological satellites, and the short message service (SMS) provided by commercial mobile phone networks.

Data broadcasting technology, especially satellite, can be used for the dissemination of data and warnings. Satellite-based digital video broadcasting (DVB) and digital audio broadcasting (DAB) data-communication techniques are highly cost-effective solutions that can be used to improve the implementation of meteorological and hydrological data-distribution systems. In areas where commercial mobile communication service is available, mobile phones and pagers are also cost-effective means for delivering warnings. Webpages operated by flood forecasting centres are very effective information portals, both for the public and for agencies involved in flood forecasting.

Data Flow and Operation of an Integrated Hydrometeorological Network

The operation of a river basin's flood-forecasting network depends on close coordination between its hydrological and meteorological services. A typical data flow is shown in Figure 1.

A flood forecasting system should be operated in a quasi-interactive fashion through a graphical user interface (GUI) which allows the forecaster to run, evaluate, and modulate the operation at each forecasting point.

To facilitate the seamless exchange of information, it is necessary to have standards in place for data format and identification; these can include, for example, data representation code forms and data file naming convention, all of which must be agreed upon by all participating stations and centres.

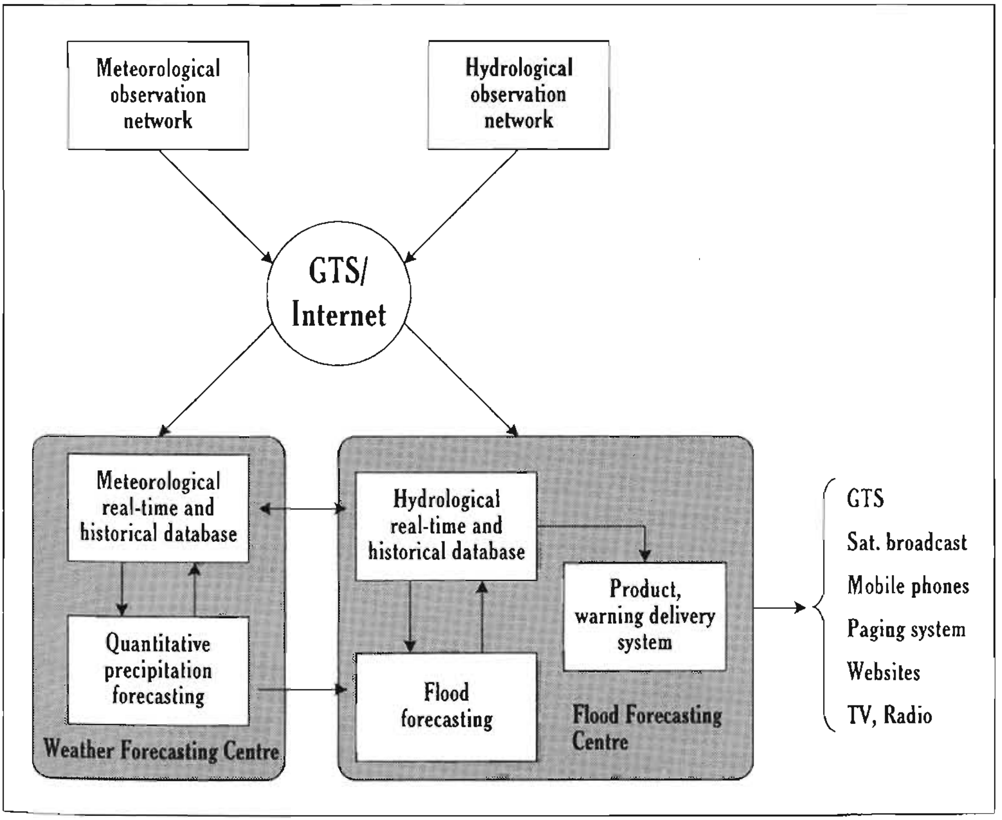

Figure 1: Data flow in an integrated hydrometeorological network

Case Study: The Provincial Basin Forecasting System of Jiangxi, China

Jiangxi province, located on the middle-lower reaches of the Yangtze River, is a region with several major rivers and frequent flooding. The provincial basin forecasting system project of Jiangxi was initiated in 1999, and by the end of 2000 one provincial basin forecasting centre and 12 city-level sub-basin forecasting centres had been established.

The basin forecasting centres receive real-time weather data from the national information network of the China Meteorological Administration (CMA) (which is based on VSAT (very small aperture terminal satellite) communication technology) and real-time hydrological data from the local hydrological services. Each centre maintains databases for real-time data and local historical data.

The data format and the data file naming convention for aerial observed precipitation data and for data from forecasting products were centrally defined. A basin-wide data exchange procedure was implemented and monitored by the provincial forecasting centre (Figures 2, 3).

River basin precipitation forecasting products are disseminated in the following ways:

- web servers run by forecasting centres;
- terminal access by selected important users;
- TV broadcasting and telephone information inquiry; and
- flood warning paging systems that cover the whole basin.

Suggestions for Enhancing Cross-boundary Information Exchange in the Hindu Kush-Himalayan (HKH) Region

As of January 2002, the GTS circuits used by the Regional Meteorological Telecommunication Network in Regional Association II (RAII) in the HKH region are of low to medium data rate (see Table).

Circuit between		Data rate
RTH New Delhi	RTH Beijing	9600bps
RTH New Delhi	NMC Dhaka	2400bps
RTH New Delhi	NMC Kathmandu	50baud
RTH New Delhi	NMC Yangon	50baud
RTH New Delhi	NMC Karachi	50baud

The exchange of meteorological and hydrological data among members in this region could be considerably improved by upgrading the 2400 bps and 50 baud circuits to at least 9600 bps (which is the basic requirement for supporting TCP/IP protocol over the circuit). The Beijing – New Delhi circuit is due to be upgraded to TCP/IP soon, and arrangements for increased data exchange, especially of numerical weather prediction model products, should be pursued.

Conclusion

An operational information network is the key to effective collaboration among countries for flood forecasting and warning in the HKH region. With improvement in circuit capacity and communication protocol, the current GTS can serve as a backbone for cross boundary meteorological and hydrological data exchange in the region. The Internet, satellite-based data broadcasting, mobile phones, and paging systems are all

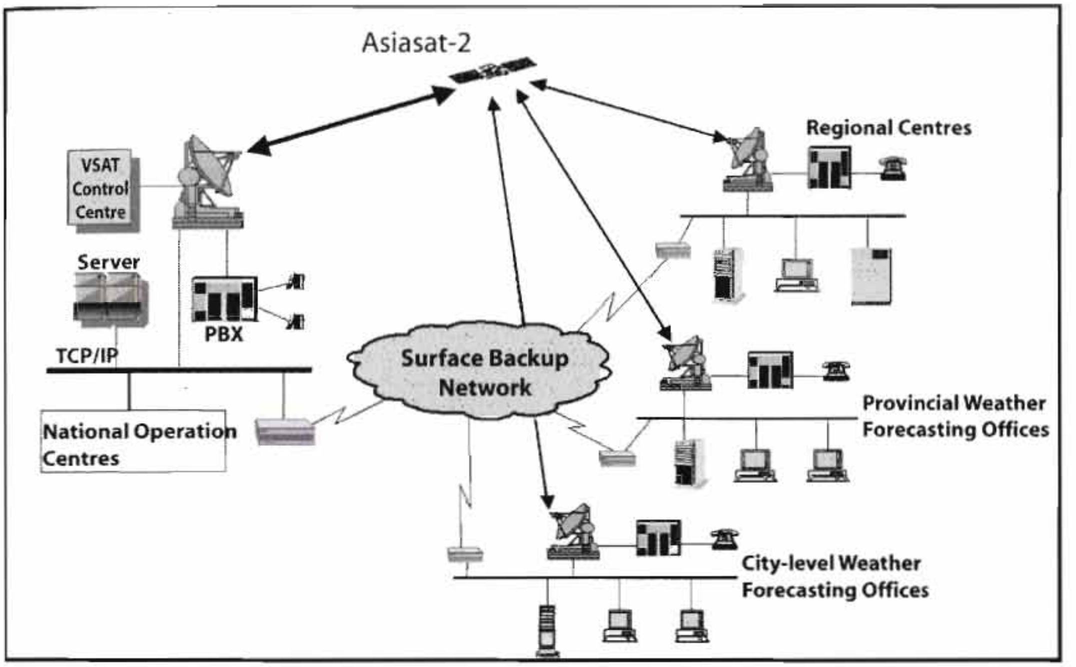

Figure 2: The China Meteorological Administration VSAT two-way information network

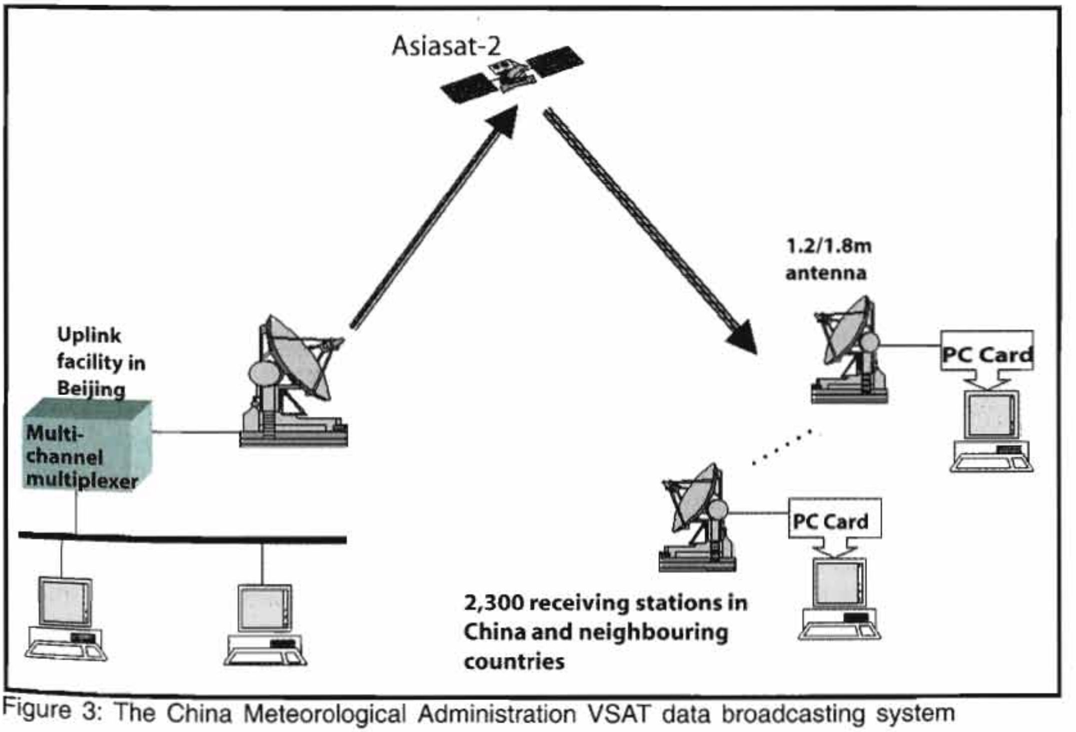

Figure 3: The China Meteorological Administration VSAT data broadcasting system

cost effective choices that can be used to disseminate forecasting and warning information. Operational management and coordination measures, such as those implemented by the World Weather Watch, should also be considered to improve real-time information exchange.

Bibliography

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