Forecasting Water Flows in Pakistan's Indus River

Most of the water in the Upper Indus River Basin comes from remote glaciers. (Photo courtesy of WAPDA)

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A Pakistan-Canada research partnership has led to the launch of a sophisticated forecasting system that promises to help Pakistani authorities accurately estimate how much water flows into the Indus River — the lifeline of one of the largest irrigation networks in the world.

The water forecasting system could ultimately help Pakistan to optimize water allocation at a national level by deciding how much water is used for irrigation, industry, and domestic purposes, states Naser Faruqui, a Senior Program Specialist at the International Development Research Centre (IDRC), who managed the final phase of the project for IDRC and the Canadian International Development Agency (CIDA).

Cumbersome process

Water management and distribution has always been an important but cumbersome process in this South Asian country, whose economy is based mainly on agriculture and related industry. Since most of Pakistan is arid or semi-arid, the Indus River System serves a vital national role. The watershed irrigates 80% of Pakistan's 21.5 million hectares of farmland, through a well-knitted network of canals. (The other 20% is fed by rainfall.)

Almost 90% of the water in the Upper Indus River Basin comes from remote glaciers tucked in the majestic Himalayan and Karakorum mountain ranges, which border China and India, and the Hindu Kush, which borders Afghanistan. The rest comes from rains, especially during the monsoon season from July to September.

Remote regions

"Those regions are so remote, so far away, and so difficult to get to, that [water authorities] do not know from day-to-day how much water is going to arrive, because they don't know what the weather conditions are up there. They don't know how much snow is falling, or how much snow and ice is melting," notes Faruqui. "The project is beginning to change this."

Faruqui adds that the forecasting system may help alleviate the impacts of a drought, which the country is currently suffering. In fact the situation this year is so dire that Pakistan's military government has suggested melting the northern glaciers faster by using lasers or dumping charcoal on them. Almost all Pakistani scientists are against the idea, as is Faruqui, who worries about the potential long-term environmental impact and climatological effects of this idea.

Diagnostic tool

Faruqui notes, however, that the forecasting system has already proven useful because water managers now know the reason for the drought: less snow in remote glacier-fed catchments. Moreover, the system will also tell them whether the drought will increase or decrease in severity. "This advance notice can help decision makers plan for and alleviate the impact of the drought by optimizing the timing of water releases from the reservoirs," he says.

The impetus for a forecasting system dates back to the 1960s and 70s, when the government-run Water and Power Development Authority (WAPDA) conducted research on snow and ice reserves in order to improve traditional water inflow forecasting methods. Although nothing concrete resulted, WAPDA realized the importance of accurate forecasting to help make the country's water distribution policies more equitable and fair for all four provinces of Pakistan.

Early days

In the early 1980s, Ken Hewitt, a Canadian geologist from Wilfrid Laurier University in Waterloo, approached WAPDA to explore the possibility of establishing a data collection network that could revolutionize water inflow forecasting methods. In 1969, Dr Hewitt had conducted research on a glacier in northern Pakistan. He was interested in doing a large scale study to assess and determine the role of glaciers and their relationship to water release in those areas, most of which form catchments for the Indus River System. His contacts and discussions culminated in the launch of the Snow and Ice Hydrology Project.

Initiated in 1985 with financial support from the IDRC and the Government of Pakistan, phase one involved ground surveys in all the Indus River catchment areas. Pakistani researchers and their colleagues from Wilfred Laurier and Manchester University in England braved below-freezing temperatures and altitudes ranging from 6,000 to 16,000 feet above sea level to survey one of the world's most rugged terrains. "They studied numerous aspects of glacier hydrology, their role in water release, and the mechanisms of water release," says Hasnain Afzal, a WAPDA engineer and the current project director, who has been affiliated with this work since its inception.

Phase two

When phase one ended in 1989, the research team sought to put their results to practical purposes. With funding from CIDA and the British Official Development Administration (now the Department for International Development), and technical support from IDRC and British Columbia (BC) Hydro, WAPDA launched phase two. The aim was to develop a snowmelt forecasting system to estimate water inflows to Pakistan's two major water reservoirs at Mangla and Tarbela, as well as the Kabul River, which meets the Indus River at Nowshera in North Western Frontier province. These reservoirs plus the Kabul River supply water to Pakistan's irrigation network during the winter season.

"Water inflows to these reservoirs and of course the Kabul River, if we could forecast them, have a direct bearing on our water management systems," stresses Afzal. "The supply of water depends not only on agricultural demand, but also on water availability and storage."

Data collection network

By 1997, the project had achieved all of its objectives, despite budgetary restraints and adverse environmental conditions. The main achievement was the creation of a network of 18 remote data collection platforms, which continuously transmit information on precipitation, temperature,

atmospheric pressure, relative humidity, solar radiation, wind speed and direction, and other key variables to WAPDA headquarters in Lahore. This data is transmitted via an innovative meteor-burst communication system, and then processed using a hydrological model developed in Canada, which was calibrated to meet local needs.

After 1997, the project faced severe financial difficulties due to a lack of government funding. However, WAPDA mobilized its own resources to foot the salaries of project staff. The team began forecasting water inflows in April 1999 and made forecasts on a 10-day basis for that year. "In the year 2000, we made 19 forecasts. We were out of synch on only four readings," says Asim Rauf Khan, a project engineer who manages the database and hydrological model. The longer the system operates, the more data will be available to calibrate the model.

Credible forecasts

By gradually improving its accuracy, the project team is increasing its credibility at institutions responsible for water management and distribution in Pakistan. The Indus River System Authority (IRSA), which allocates water to the provinces, has already started to use these forecasts in its decision-making.

"Our success is due to the zeal and volunteer spirit of the staff. The measure of this success is that we are running the project without any external support. We have sustained the project," concludes Afzal.

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