More reliable forecasts for water flows can reduce price of electricity

January 19 2010

Brazil, Canada, China, the US, Russia, Norway, Japan, and Sweden are among the largest producers of hydroelectric power in the world. One problem for hydroelectric power companies is that the great variations in the river flow and the lack of long-term forecasts make it difficult for power companies to determine how much water in their dams should be saved or released.

But by scaling down information from global climate models and combining it with local measurement data, researchers at the Lund University School of Engineering (LTH) have developed a method that yields four-month forecasts that are twice as reliable as similar methods for run-off forecasts. The findings are published in the coming issue of *Hydrology Research*, and the model will be tested by StatKraft in Norway.

In Scandinavia, dry and cold winters entail heating needs in general, as well as a risk that the levels of hydropower reservoirs are low by springtime as a result of high electricity consumption. If the melted snow is not sufficient to fill the dams, this can lead to drastically elevated electricity prices later in the year.

The power companies' need for long-term forecasting is often greatest now during the winter, even though there is also need for a somewhat earlier indication of coming water resources throughout the year.

"By predicting spring water resources as early as December-January, it is possible to steer electricity production so that water reservoirs are emptied more slowly, thus avoiding dramatic price hikes in subsequent seasons. The need to control water flows is all the greater because the value of water in the dams varies apace with the price of electricity," says Cintia Bertacchi Uvo, professor of water resources engineering at LTH.

Today there is no reliable way of knowing well in advance how much water will be available in Swedish and Norwegian rivers, and thereby in water reservoirs, following the spring snow melt.

The climate phenomena that are correlated in the computer-based model are natural variations in the powerful and constant low and high pressure systems that are found over the North Atlantic (North Atlantic Oscillation, NAO) and that are already known to be of great importance in determining whether the Scandinavian winter will be mild and rainy or dry and cold, which it has been in December and January. The model, that Lund scientists have developed in collaborations with South African researchers from the University of Pretoria and the South African Weather Service, also takes account of data on temperatures and on wind direction and strength, from which it is possible to estimate how much snow should accumulate during winter.

"The only thing needed to apply the method locally is to fill in historical data, as far back as possible, about water flows from the river that feeds the power station," explains Kean Foster, who holds a master's degree in water resources engineering. "It is possible to apply the method in different countries with varying time conditions depending on the country's climate."

The scientists have shown that it is possible to apply global climate models locally by correlating historical data over a fifty-year period from different global climate models with data on water volumes per second in Scandinavian rivers, such as the Torne River in the north, from the same period. To achieve good results, it is important to use multiple climate models simultaneously and to combine the results.

Today power companies use relatively accurate short-term run-off forecasts that are based on a combination of hydrological models and weather forecasts. But their long-term forecasts are less reliable. Their long-term run-off forecasts are calculated by running the hydrological models with two weather scenarios, one that yields low run-off and one that yields high run-off, which provides two extremes that the long-term planning can be based on.

“The problem with this method is that the run-off can wind up anywhere at all within this interval. A climate forecast like the one we have devised provides better probability for future run-off scenarios, which makes it possible to plan and prioritize different strategies,” explains Kean Foster.

“A concrete example that illustrates the need for forecasts occurred in the spring of 2003, when energy prices in Sweden more than tripled in a short time. The reason was that precipitation that normally comes in the autumn had not materialized. If the hydroelectric power stations had had access to relevant climate forecasts during the summer and autumn, they would not have emptied the water reservoirs prematurely, which is what happened,” concludes Cintia Bertacchi Uvo, professor of water resources engineering at the Lund University School of Engineering and the researcher who initiated the project.

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