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Storing excess water beneath the ground could alleviate a recurring cycle of floods and droughts

New study explores win-win approach that could boost agricultural production and contribute to flood control on the Chao Phraya River

VIENTIANE (12 NOVEMBER 2012) — Providing incentives to farmers to allow parts of their land to percolate floodwaters and storing that water below ground for times of drought could save Asian nations millions of dollars in revenue and potentially billions of dollars in damage. This is the major finding of a three-year project conducted by water experts studying Thailand's Chao Phraya river, which flows through Bangkok. Although endowed with generous water supplies, Thailand frequently suffers from damaging and costly floods and droughts. The paper's authors suggest that integrating how water excesses and shortages are managed at a river-basin scale could better balance water supplies for upstream and downstream users across monsoon and dry seasons.

"This approach has the potential to solve two problems in one go but has not been applied in this way before" explained Paul Pavelic, a groundwater hydrologist with the International Water Management Institute (IWMI), a CGIAR consortium center, based in Lao PDR. "Downstream-focused engineering solutions that are being used to protect the built environment of the Chao Phraya flood plain (which includes Bangkok) are vital, but do not necessarily capture the potential for agricultural intensification when floodwater is recognized as a valuable resource. Our aim is to divert water underground in upstream areas in very wet years and thereby turn it into an opportunity by enabling farmers to pump it out for irrigation of high-value crops in the dry season, when drought often causes crops to fail."

With its economy still largely based on agriculture and rural poor comprising 40% of its population, Thailand suffers badly when floods and droughts strike. The cumulative cost of damage from drought between 1989 and 2003 was around Baht 4474.4 million (US$122 million). Meanwhile the five major floods that occurred between 1983 and 2006 in the lower Chao Phraya river basin alone caused Baht 22,472 million of damage. In early 2010, low levels of water in the country's largest water store, the Bhumipol Dam, affected drinking water and irrigation supplies for tens of millions of people. By October, however, severe flooding was affecting all regions. The cost of damage by the inundation was estimated to exceed Baht 50 million.

Published this month in the Journal of Hydrology, the article: *Balancing-out floods and droughts: Opportunities to utilize floodwater harvesting and groundwater storage for agricultural development in Thailand* , suggests this vicious cycle of too much and too little water could be ameliorated by a strategically targeted program of managed aquifer recharge

(MAR). MAR is typically used to store wet-season flows in dry climates but has not been systematically employed to capture floodwaters to protect urban infrastructure in the tropics.

The collaboration of around a dozen scientists and postgraduate students from the Thailand Department of Groundwater Resources, Groundwater Research Centre of Khon Kaen University, Hydrogeosci and IWMI conducted field, laboratory and modelling studies to establish the techno-economic feasibility of recharging surplus canal water in one of the sub-basins of the Chao Phraya. The experts also analyzed the timing of actual flood events from data gathered between 1965 and 2009 which revealed that during this time there were 11 major floods.

The researchers estimated that, if harvesting only took place in those flood years, when the monthly wet season flow exceeded 5 billion m^3 per month, the amount of surplus water available would equate to a depth of just 5 millimeters if distributed across the basin. The actual volume of surplus water that could be harvested averaged just over 800 million m^3 per year and peaked at 6 billion m^3 per year. This volume is third in size when considering the major existing water storage facilities in the river basin (only the Bhimibol and Sirikit dams are greater).

The volume of water outlined above represents 28% of the Chao Phraya's average total annual discharge. At present, this water eventually discharges into the Gulf of Thailand. It was therefore important for the scientists to consider what impacts retaining such a large volume of water during flood years might have on the coastal environment. Fresh water and the nutrients carried by it into the Gulf are of vital importance for maintaining marine ecosystems, which in turn support industries such as fisheries and tourism. A minimum discharge is also important to ensure saltwater does not intrude upstream into areas where farmers pump out freshwater to irrigate their crops.

The scientists found that the levels of particulates, nutrients and other contaminants transported by the river today are higher than before the 1970s when major land-use changes began occurring in the basin. Therefore reducing nutrient volumes is unlikely to have a detrimental effect on the environment and could even benefit coastal ecosystems because of the associated reduction in pollutants from sewage and industrial outflows. Diverting wet-season flows in any particular year was unlikely to have a major effect on flows during the subsequent dry season. The trial of managed aquifer recharge under way in the Lower Yom River sub-basin of the Chao Phraya, meanwhile, has yielded recharge rates that are encouraging, and comparable to those encountered in similar systems around the world.

The livelihoods of farmers relying on rainfall to water their crops could be significantly improved if they had greater access to water in the dry season. In upland areas of Thailand, farmers tend to grow sugar cane, maize, cassava and orchards, while in the lowlands, rice, soybean and vegetable crops are prevalent. The approach to putting the system in place could range from installing small-scale equipment on private smallholdings through to larger-scale infrastructure on commercial farms or government land. However, the authors stress the need for careful governance to underpin the system's success. For example, farmers would need to be encouraged to forego land for recharge and become "stewards" who manage infrastructure for the benefit of downstream communities.

An economic analysis undertaken by the scientists shows that the system has the potential to recover its investment in 14 years, if moderate performance is achieved. It would generate around US$250 million annually in export earnings while helping to alleviate poverty. The researchers suggest that further work is required to test the system's viability. This would include: identifying and assessing areas with the greatest opportunity for floodwater harvesting; investigations to assess site suitability; engagement between farmers and the water resources sectors; and development of demonstration sites to illustrate feasibility. If the concept could be proven for the Chao Phraya basin, it could also be relevant for other river basins that discharge to the sea in Thailand and across Asia.

"This important study shows that surplus wet-season waters, could be used to lessen the damaging and costly impacts of floods and droughts while alleviating poverty and maintaining vital coastal ecosystems," said Jeremy Bird, Director General of IWMI. "Bringing the study to reality will require detailed investigations to determine areas where environmental conditions are suitable for aquifer recharge. However, provided a participatory approach is taken that unites farmers with water resources managers and flood protection authorities, this innovative idea could seed flood alleviation successes on the ground across Asia."

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The **International Water Management Institute** (IWMI) is a nonprofit, scientific research organization focusing on the sustainable use of land and water resources in agriculture to benefit poor people in developing countries. IWMI's mission is "to improve the management of land and water resources for food, livelihoods and the environment." IWMI has its headquarters in Colombo, Sri Lanka, and regional offices across Asia and Africa. The Institute works in partnership with developing countries, international and national research institutes, universities and other organizations to develop tools and technologies that contribute to poverty reduction as well as food and livelihood security. www.iwmi.org

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The **CGIAR Research Program on Water, Land and Ecosystems** examines how we can intensify agriculture, while still protecting the environment and lifting millions of farm families out of poverty. The program focuses on the three critical issues of water scarcity, land degradation and ecosystem services. It will also make substantial contributions in the areas of food security, poverty alleviation and health and nutrition. The initiative combines the resources of 14 CGIAR centers and numerous external partners to provide an integrated approach to natural resource management research. This program is led by the International Water Management Institute (IWMI). wle.cgiar.org