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RESEARCH NEWS

Sri Lanka's coastal water still undrinkable 18 months after the tsunami disaster

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Eighteen months have passed since the devastating Indian Ocean megatsunami of December 2004, which did considerable damage to Sri Lanka with much loss of life and property. Perhaps the most lasting long term impact of this event was the widespread destruction and contamination of coastal sand aquifers by seawater intrusion with inundation up to distances as much as 2 km inland in some areas. In Sri Lanka alone almost 50,000 drinking water wells were either destroyed or contaminated and the vast coastal population was suddenly left without any water for drinking and other uses. Considering that each well is generally used by several families, the number of people affected was quite large and a problem of enormous dimensions had to be faced by the state to provide alternate drinking water sources. Most of the rural and semi-urban coastal populations of the Indian Ocean region rely on groundwater taken from shallow wells. Several millions have been affected by the sudden loss of a valuable and free resource, which is essential for survival.

From February through September 2005, a team of United States, Sri Lankan and Danish water engineers and geologists surveyed the coastal groundwater resources to develop an understanding of the impacts of the tsunami and suggest recommendations for the future of coastal groundwater resources in south Asia. The study was sponsored and/or supported by the National Science Foundations of the USA and Sri Lanka (USNSF-SLNSF). The Sri Lankan study was to be a model to evaluate future impacts from similar disasters. In a paper expressly published in the prestigious American Geophysical Union journal *WATER RESOURCES RESEARCH* Vol. 42 May 2006 issue, the results of the survey is presented. The research team was lead by Tissa Illangasekera (AMAX Distinguished Professor of Environmental Engineering, Colorado School of Mines, USA), who was recently appointed as Head of the Hydrological Sciences Division of the US-NSF in Washington D.C.

The study reveals that up to September 2005, the two monsoons were not effective in flushing out the seawater from the sand aquifers. Tsunami inundation surveys indicate that almost 1200 km of the coastline was affected. Preliminary calculations indicate that ~22 percent of the total aquifer area was contaminated. Follow up work carried out by Sri Lankan research teams (Funded by the SLNSF) indicates that up to June 2006, the groundwater salinity remains little changed with drinking water being supplied to the coastal population daily and at great cost to the state (Water Supply and Drainage Board).

Significantly, the coastal aquifers found in parts of India, Indonesia and Thailand are similar to Sri Lanka and the results of the survey can be extended to these countries as well. The objectives of the survey team were (1) to investigate the impacts of the tsunami on coastal groundwater resources and review all well cleaning methods and their impacts, (2) to develop a conceptual understanding of the seawater-freshwater mixing phenomenon in coastal aquifers after the tsunami event, (3) to investigate the medium and long term impacts of the tsunami on coastal groundwater resources, (4) to develop a joint programme to study the regional aquifer hydrology and hydrogeology of Sri Lanka and (5) to transfer knowledge about coastal aquifer vulnerability to other nations. Transoceanic tsunamis are very low frequency (once every hundred year's recurrence interval?), high impact events. Hence, this has provided a very unique opportunity to study the impact of such a high energy oceanographic event on a critical natural

resource such as groundwater. In the absence of a similar study in the past from elsewhere, the Sri Lankan survey will be a benchmark for future research on coastal aquifer contamination.

The aquifer groundwater quality since the tsunami has been monitored by regular salinity measurements and in relation to the monsoons, which indicates that restoring normality will take many years. Many of the areas that were affected by the tsunami did not receive substantial rainfall for almost a year with insufficient aquifer recharge. The N-E monsoon did bring in sufficient rains during October 2005 to January 2006 causing even long term flooding in some areas. The recovery of the aquifers may take several years. Using the available data, conceptual numerical models have been developed and laboratory physical modelling carried out to evaluate quantitatively the short and long term impact of the tsunami on coastal groundwaters. The results of such modelling will be invaluable to water planners.

The extent of the disaster continues to impact the social and political structure of the region eighteen months after the event. The various Tsunami Housing Schemes that have come up to resettle the affected people are continuing to face water supply problems. The availability of potable drinking water is still a major concern for relief efforts and relief agencies, both from the perspective of life requirements and the potential spread of waterborne diseases from contaminated supplies. Unscientific well cleaning methods and over pumping over the following months, appears to have aggravated the problem even further with seawater intrusion from below. Water supply to the coastal zone will be a long term problem for the government, as the costs of the ongoing operations are enormous and may not be sustainable. The continued sustainability of these small and fragile aquifers for potable water will be difficult because of rapid population growth and human activities in the coastal areas, resulting in increased groundwater pumping and pollution. Long term sustainability of the aquifers is in doubt due to a decrease in sand replenishment to the beaches caused by intensive inland river sand mining and continuing coastal erosion. Planning is now underway to provide piped water to the coastal villages, to supplant the individual, and vulnerable, open dug wells. Other social responses should include expansion of centralized sewage collection.

An outcome of this research, hopefully, would be the use of new modelling techniques for integrated management of surface and groundwater for sustainable water resources in Sri Lanka. Around the world, devastating floods, cyclones, hurricanes, storm surges and rising sea levels can also impact on groundwaters. The researchers urge all water scientists to participate in formulating emergency planning procedures that could greatly reduce human suffering in the future. Documenting the hydrologic impact of such disasters is the first step towards defining international emergency guidelines for treating contaminated water supplies and for long term and planning tools for managing coastal groundwaters in areas subjected to seawater inundation. Unfortunately, there is no formal water-control monitoring system in Sri Lanka. Neither is there any programme to establish minimum drinking water quality standards in the privately owned wells. The research team discovered that the coastal zone population really did not know "what they were drinking". The team visited many affected areas around the country to make their observations and talk to the affected people. Given the scale of the disaster, it is not surprising that there was no adequate level of preparation. Such an event was unknown in Sri Lanka's recorded history until December 26th 2004.

The opportunity afforded by this project to the local scientists to interact with experienced experts in the field will help develop long-term collaborations and educational programmes to address critical water supply issues in the region. The research highlighted the need for developing local expertise and capacity building in areas of groundwater modelling, data management and sub-surface aquifer characterization for integrated water management. Water is bound to be a critical issue in the very near future. With impending climate warming and increasing demand for more water as living standards improve across the world, the cost of water will also increase. Like cheap oil, the era of cheap water will soon be over. Water security will have to be addressed by all countries.

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* This paper appeared in a new format of the *Journal of Water Resources Research*, entitled *Rapid Communications*, in which timely and important breakthroughs in hydrology are accorded both accelerated independent peer review and priority in publication. This new format is designed to make high impact research findings quickly available to the scientific community and those responsible for water resources management *(the American Geophysical Union).*