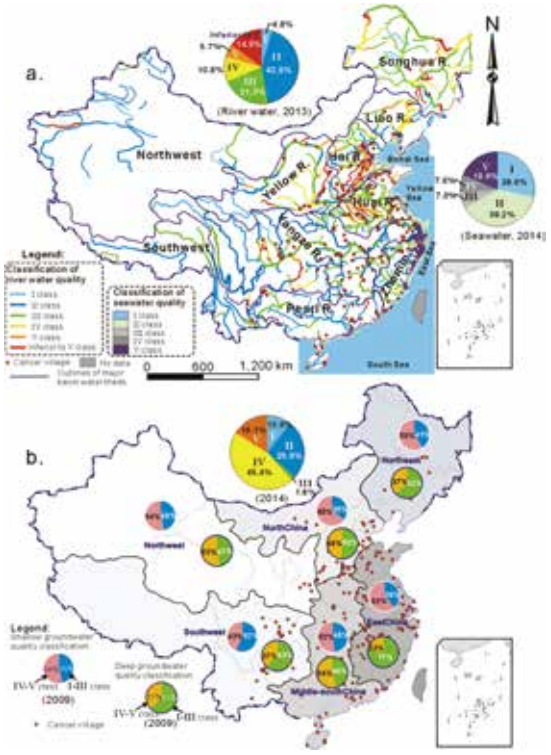
Research Sheds New Light on China's Water Pollution Crisis

With China's rapid industrialization over the past couple of decades, it has become the world's largest producer and consumer of inorganic and organic chemicals. As its agricultural sector is a major user of chemical fertilizers and pesticides, the biggest side effect has been the widespread pollution of both groundwater and surface water. In recent years, the Chinese government has released harsh plans to control and prevent water pollution. However, the lack of comprehensive data on the scale and extent of pollution in ground and surface water basins makes it difficult to identify the sources and pathways of pollution.

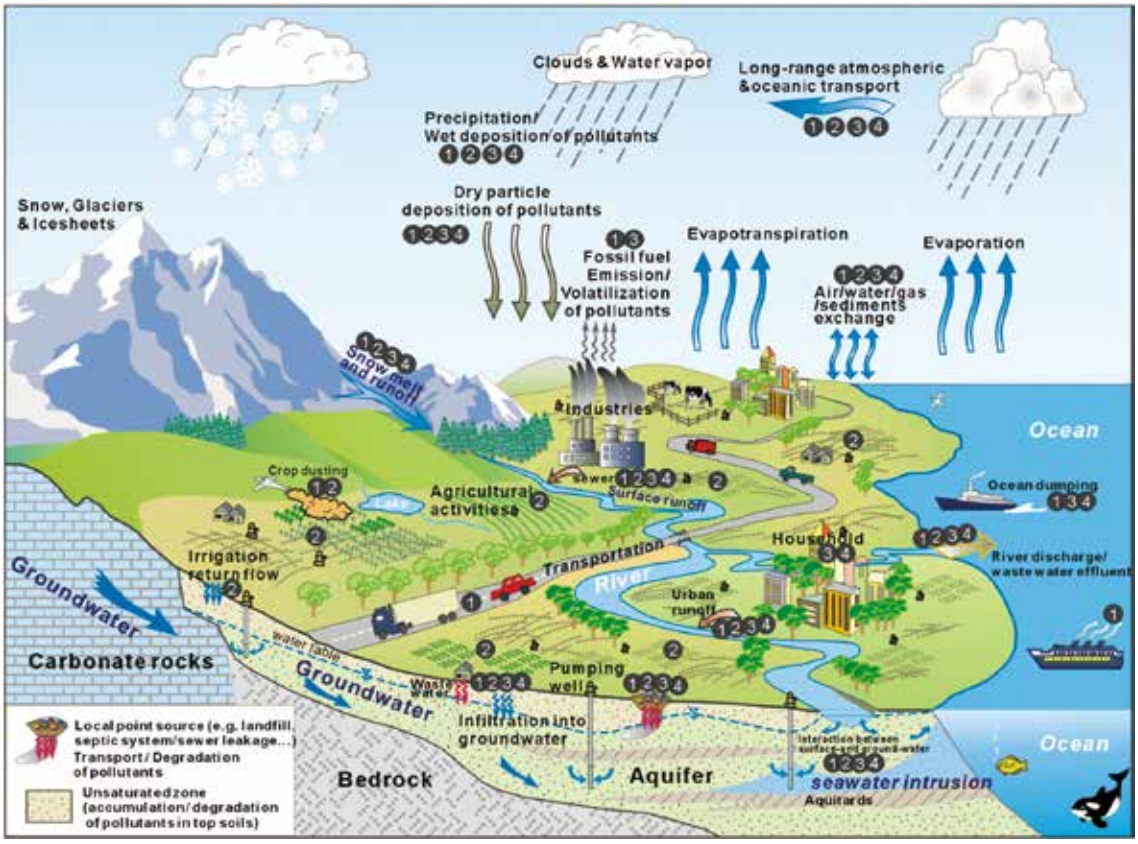
Three articles recently published as a result of research collaboration between the CAS Institute of Geographic Sciences and Natural Resources Research (IGSNRR) and the Royal Melbourne Institute of Technology (RMIT University)'s School of Engineering have shed new light on the severity China's water pollution crisis in both groundwater and surface water, and discussed the important factors and mechanisms that have contributed to the problems.

A review paper published in *Environmental Pollution* examined the concentrations of nitrate in groundwater for 52 major groundwater basins in China, including shallow and deep aquifers. The data show that the 90th percentile nitrate concentration exceeds the US EPA maximum contaminant level (10 mg/L NO_3-N) in 25 out of 36 shallow aquifers, and 10 out of 37 deep aquifers. At certain basins, the median nitrate concentration even exceeded these levels. Particularly serious nitrate contamination occurs in the northern coastal regions of China (such as the coastal regions near Bohai Bay). Analysis of the stable isotopes of nitrogen and oxygen in nitrate reveals a range of sources of nitrate pollution, including chemical fertilizers, as well as domestic wastewater and manure. Of particular concern is evidence that nitrate, a common "indicator pollutant", has reached deep aquifers, through mechanisms such as bypass flow along faulty wells. These aquifers are generally assumed to be relatively safe sources of drinking water. Researchers argue that a program to identify, fix and maintain deep wells throughout China is needed to protect these aquifers from further pollution.

Their second paper, published in *Science of the Total Environment*, focused on persistent organic pollutants (POPs) in China's waterways – including



Status of water pollution in China based on recent government statistics – A) Surface water (major rivers and seawater) ranked according to the 6-class water quality classification and seawater quality of offshore areas ranked according to the 5-class classification; B) Groundwater ranked using the 5-class system in 6 sub-areas of China, including shallow and deep groundwater. Overall percentages in each class for each water source in China are shown as the large pie-charts. Both maps have been overlain with the locations of known "cancer villages".



Schematic figure showing sources and transport processes for persistent organic pollutants, and their interaction with the hydrological cycle. Numbers indicate classes of POPs reviewed in this study; 1 = Polycyclic aromatic hydrocarbons (PAHs); 2 = Organochlorine pesticides (OCPs); 3 = Polycholorinated Biphenyls (PCBs); 4 = Perfluorinated compounds (PFCs).

rivers, reservoirs, lakes, groundwater and marine water. These are toxic compounds that are highly resistant to breakdown in the environment, and can accumulate in ecosystems and humans. The compounds are so far not routinely monitored in China's waterways. The review of data from more than 200 published studies found that organo-chlorine pesticides (OCPs) occur in China's waterways at similar levels to other countries in Asia and around the world. However, polycyclic aromatic hydrocarbons (PAHs) and Poly-chlorinated biphenyls (PCBs) occur at elevated levels relative to other regions of the world for which data are available (e.g. PAH levels were between 15.1 and 72400 ng/L; PCBs between 0.2 to 985.2 ng/L).

Using diagnostic ratios, the researchers found that PAH pollution is largely due to the intensive fossil fuel combustion occurring in China, which is also responsible for chronic air and soil pollution. Serious PCB pollution in China's waterways appears to be due to emissions and waste from China's intensive manufacturing sector, as well as global trade in e-waste, which results in hazardous materials being shipped to China. Areas of China with particularly serious POPs pollution include the Yangtze River basin, Pearl River Delta and Zhejiang province. These are all areas of intensive industry, including manufacturing and chemical industries, in China's southeast.

In their third paper published in *Environment Magazine*, researchers explored the international links to China's water pollution crisis. They described how the rapid growth of China's economy had made the country as an international destination for many energy intensive and polluting industries, contributing to the pollution China currently faces. They also presented how "displacement of environmental harm" across international boundaries was encouraged by trade agreements and policies of the international community and China. The "winners and losers" from these developments were examined, in the context of major ongoing health and environmental impacts in China.