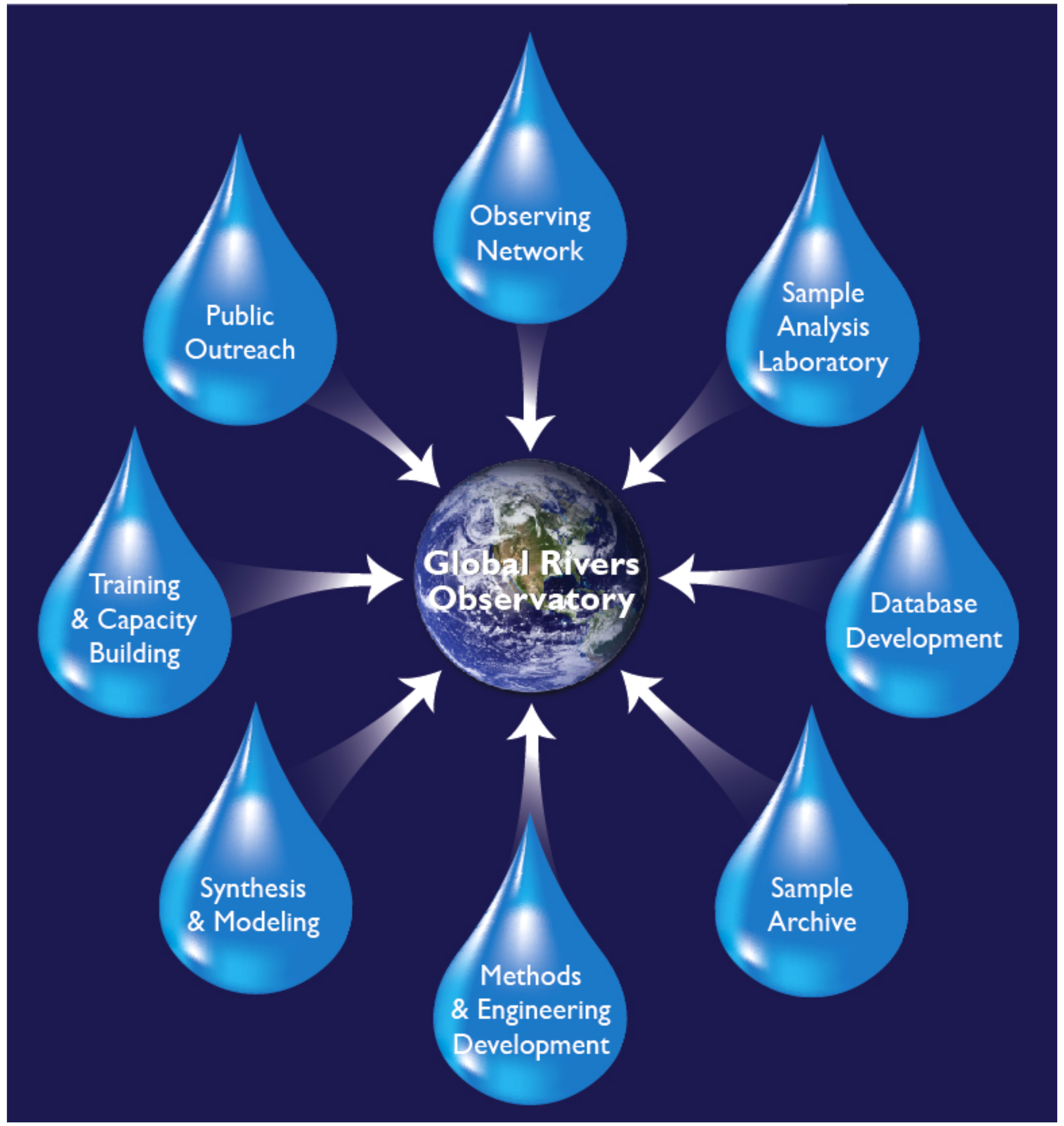
A Real-Time Global Rivers Observatory

Bernhard Peucker-Ehrenbrink

Woods Hole Oceanographic Institution, Woods Hole, MA 02543

Abstract

The rise in global air and ocean temperatures over the coming decades and centuries permits testing of important climate-regulating feedbacks. Among them is the hypothesis that warming accelerates mineral weathering that helps sequester carbon dioxide, mainly in the ocean. Growing human civilization is also changing the face of the continents through ever growing utilization of the landscapes we depend upon. To understand and document these changes we need to gauge their impact on river basins and the coastal ocean by using the integrative power of fluvial networks to transmit landscape signals, even far from the coast, to the mouths of large rivers where they connect to the ocean. We need a network of real-time sensor-based observing stations – supplemented by human sampling and automated adaptive sampling – on important river systems to assess land-derived inputs into the coastal ocean and test the above hypothesis. We also need to preserve a physical record of changing rivers by building archives of river water and sediment to give future generations a chance to ask novel questions as changes become deeper and more widespread, and to seek answers with new methodologies.



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Challenges addressed

CHALLENGE 1

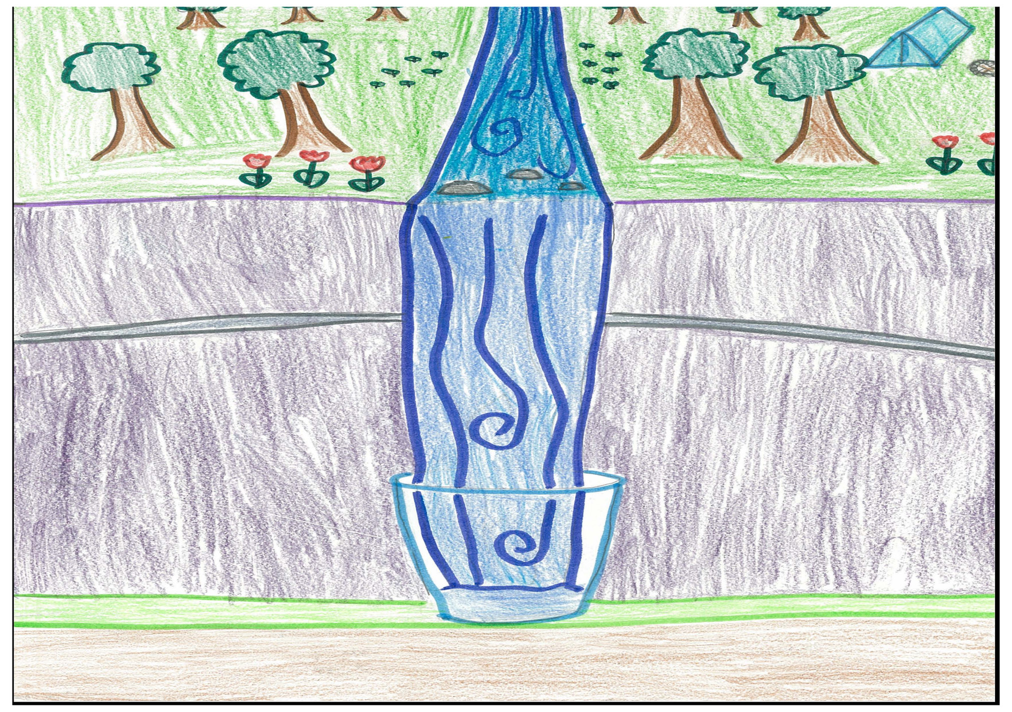
Understand and map land and sea-based sources of pollutants and contaminants and their potential impacts on human health and ocean ecosystems, and develop solutions to remove or mitigate them.

CHALLENGE 5

Enhance understanding of the ocean-climate nexus and generate knowledge and solutions to mitigate, adapt and build resilience to the effects of climate change across all geographies and at all scales, and to improve services including predictions for the ocean, climate and weather.

CHALLENGE 6

Enhance multi-hazard early warning services for all geophysical, ecological, biological, weather, climate and anthropogenic related ocean and coastal hazards, and mainstream community preparedness and resilience.



CHALLENGE 7

Ensure a sustainable ocean observing system across all ocean basins that delivers accessible, timely, and actionable data and information to all users.

CHALLENGE 9

Ensure comprehensive capacity development and equitable access to data, information, knowledge and technology across all aspects of ocean science and for all stakeholders.

My River My Home student art

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Vision & transformative impact

VISION

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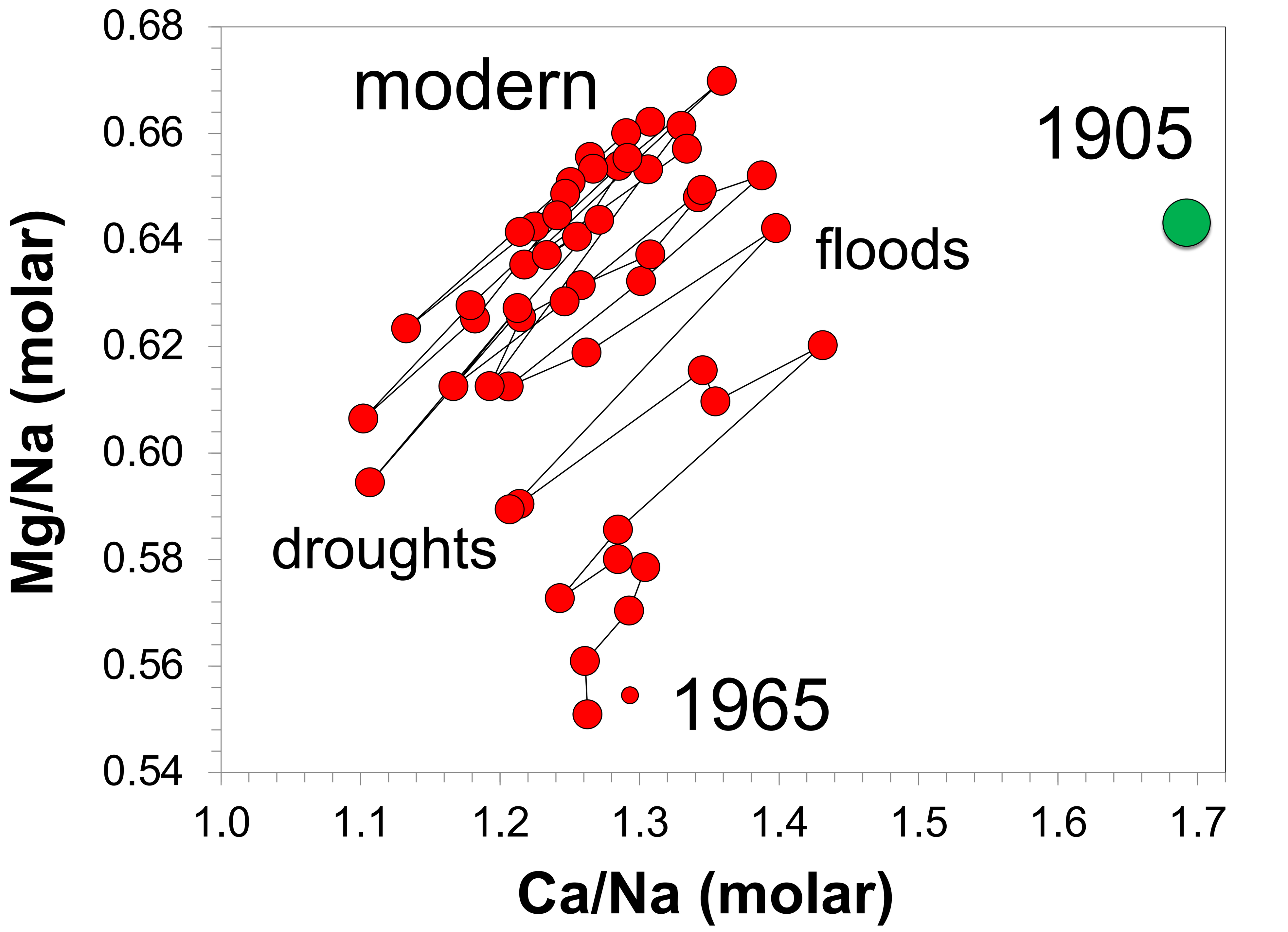
Example: Mississippi river water chemistry



- Why have sodium concentrations increased since 1905?
- Why did magnesium concentrations increase more strongly than sodium since 1965? Does this reflect road management, water treatment, corrosion control, or does it reflect a change in weathering in the river basin?

Data: USGS & Stone, 1906

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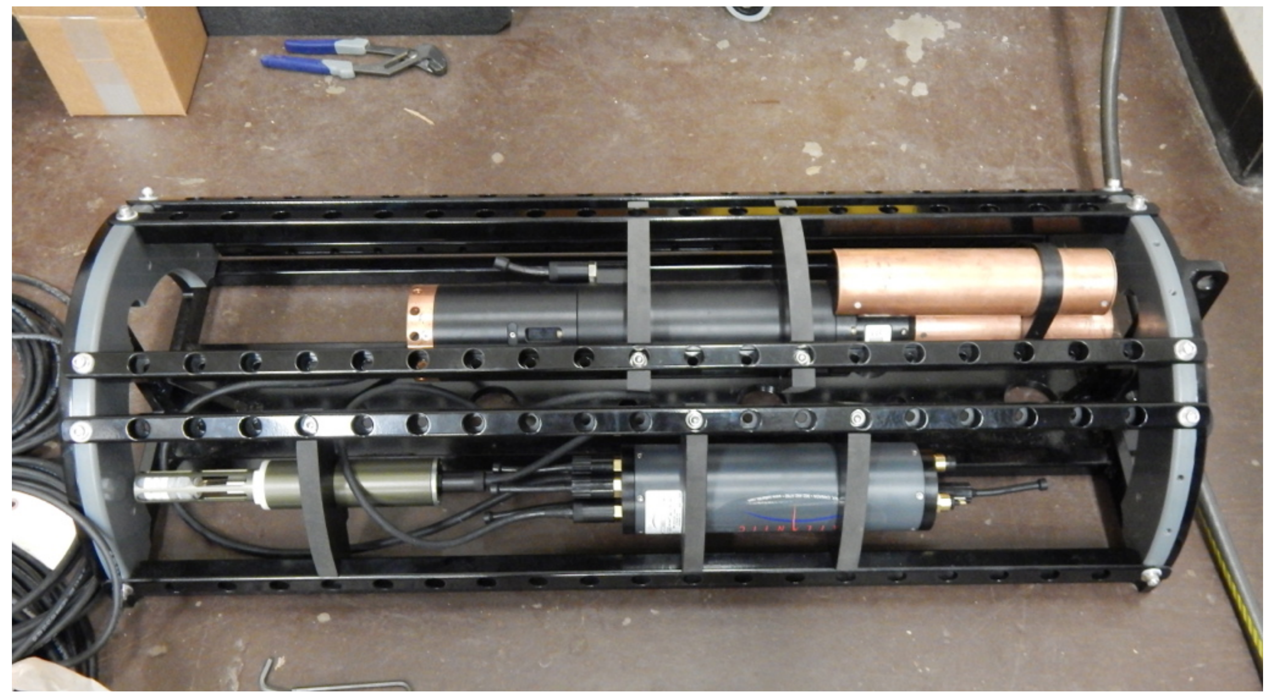
Connections to existing infrastructure, technology, and partnerships

REALIZABLE

The USGS, EPA and other agencies and organizations already have existing networks of gauging stations, some equipped with real-time sensor systems and supplemented by monthly or less frequent sampling. However, most mission-focused agencies are down-sizing their once-impressive observing networks. Sensor technology continues to develop rapidly, both for analyzing dissolved chemical species and for the quantifying the suspended sediment load. A global network of real-time observing stations with automated adaptive sampling capabilities would provide timely environmental data for the public use, including policy- and decision-making. Sample archives for water and sediment require an infrastructure similar to seed vaults.

ENGAGEMENT

The program relies on the integration of the entire hydrological cycle – from the ocean to terrestrial hydrology. As such, the program engages freshwater hydrology communities, including state and federal agencies in participating countries, as well as a well-established and easily replicated framework of citizen science. Sampling and sensing in dynamic freshwater environments pose different technological challenges compared to marine environments, thus spurring technological developments that are not only essential for the testing of fundamental scientific hypotheses, but also serve society as early warning systems.



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Opportunities for international collaboration and capacity-building

US and ABROAD

International participation and collaboration is at the core of this program. Collaborators – from state and federal agencies to citizen scientists – are key to operating and maintaining an international network of real-time river observing and sampling stations. The precursor program – the *Global Rivers Observatory* – is a collaboratory operated by a distributed network of scientists, foreign agencies and private citizens aimed at sampling large rivers approximately once every month. The *Global Rivers Observatory* has been operational since 2009, with collaborators in the U.S., Canada, Russia, China, Viet Nam, India, Papua New Guinea, The Republic of the Congo, Brazil and Colombia.

CAPACITY-BUILDING

The multi-decadal timeline of the program provides a natural connection to education, as successive generation of environmental scientists would become the future leaders of the program. One example of a successful mechanism of early engagement in the program is the student (K-12) art project "My River My Home" that builds on the connection young students living near large rivers have to their environment. This program – active as part of the *Global Rivers Observatory* – has led to student art and science exhibitions in the US and abroad.

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Collaborators

Tulane University

UN UNIVERSIDAD DEL NORTE

IIT KANPUR Indian Institute of Technology, Kanpur

USGS science for a changing world

University of the Fraser Valley

Woodwell Climate Research Center

Map artwork: Greg Fiske, WCRC

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- Madin (2012) River Quest – Sampling the world's rivers to assess our planet's health. Oceanus Magazine, Vol 49, No. 3, 26-31.
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