Coastal Ocean Institute
Final Project Report

Exploring the Nitrogen Cycle in the Ganges-Brahmaputra Estuary

PI: Valier Galy, MC&G

What were the primary questions you were trying to address with this research? (Or, if more appropriate, was there a hypothesis or theory that you were trying to prove or disprove?)

The project aimed at studying processes affecting organic matter in the estuary of one of the largest river system on earth: the Ganges-Brahmaputra river system. We studied two types of samples: 1) river sediments collected along a transect from the mixing of Ganges and Brahmaputra Rivers in Bangladesh downstream to the northern Bay of Bengal and, 2) a sediment core documenting the past 65 years of sediment transfer to and deposition on the Bengal Shelf.

What have you discovered or learned that you didn't know before you started this work?

The project led to two major discoveries. First, contrary to our hypothesis, organic matter isn't significantly altered (i.e. behaves conservatively) during sediment transit through the Ganges-Brahmaputra estuary. Second, the historical record shows a dramatic change in the composition of organic matter delivered to and deposited on the Bengal Shelf. This change has started in the late 80s and is most likely resulting from a doubling in rice production in Bangladesh and northeastern India from 1990 to 2010 (figure 1).

What is the significance of your findings for others working in this field of inquiry and for the broader scientific community?

Our study sheds light on two important mechanisms. First, organic matter seems to behave conservatively in one of the largest estuary in the world. This is seemingly surprising as many studies showed notable transformations of organic matter in other estuaries. We hypothesize that very efficient export through the estuary coupled with low salinity (derived from very large freshwater discharge) prevent any large transformation of organic matter within the Ganges-Brahmaputra estuary. Second, we show that human activities can impact the nature of organic matter exported by even the largest rivers on earth.

What is the significance of this research for society?

More than half a billion people leave on the banks of the Ganges and Brahmaputra Rivers. They critically rely on the river for cultivation and transportation. As such it is critical to understand how the river system is affected by both natural and anthropogenic factors. In particular, soil fertility critically depends upon sediments and organic matter carried annually by the rivers.

What were the most unusual or unexpected results and opportunities in this investigation?

Both the conservative behavior of organic matter in the Ganges-Brahmaputra estuary and the sharp increase in crop-derived organic matter over the past 25 years were totally unexpected!

What were the greatest challenges and difficulties?

Sampling the Ganges and Brahmaputra – two very large and dynamic rivers - in Bangladesh was a major challenge. Collaborators from the University of Dhaka made it possible and thus played a central role in this study.

When and where was this investigation conducted? (For instance, did you conduct new field research, or was this a new analysis of existing data?)

All analyses were preformed in PI Galy's state of the art organic geochemistry laboratory at WHOI. River sediments were collected by PI Galy and his colleagues from CRPG-CNRS (France) over more than a decade. Sediment cores were collected in 2006 during R/V Sonne Cruise SO-188 and samples were graciously provided by collaborators from Bremen University (Germany).

Is this research part of a larger project or program?

PI Galy has been studying the Ganges-Brahmaputra river system for more than a decade and this project is the natural continuation of his work. In addition, this project is integrated into the broader "Global Rivers Observatory" spearheaded by scientists from WHOI (including PI Galy) and the Woods Hole Research Center.

What are your next steps?

Analysis of plant DNA preserved in the sediment core samples would greatly help to pinpoint the mechanism by which land use change has impacted the composition of organic matter delivered by the Ganges-Brahmaputra system to the Bay of Bengal. In addition, radiocarbon dating of individual organic molecules would allow exploring potential remobilization of ancient soil organic matter.

Please provide photographs, illustrations, tables/charts, and web links that can help illustrate your research.

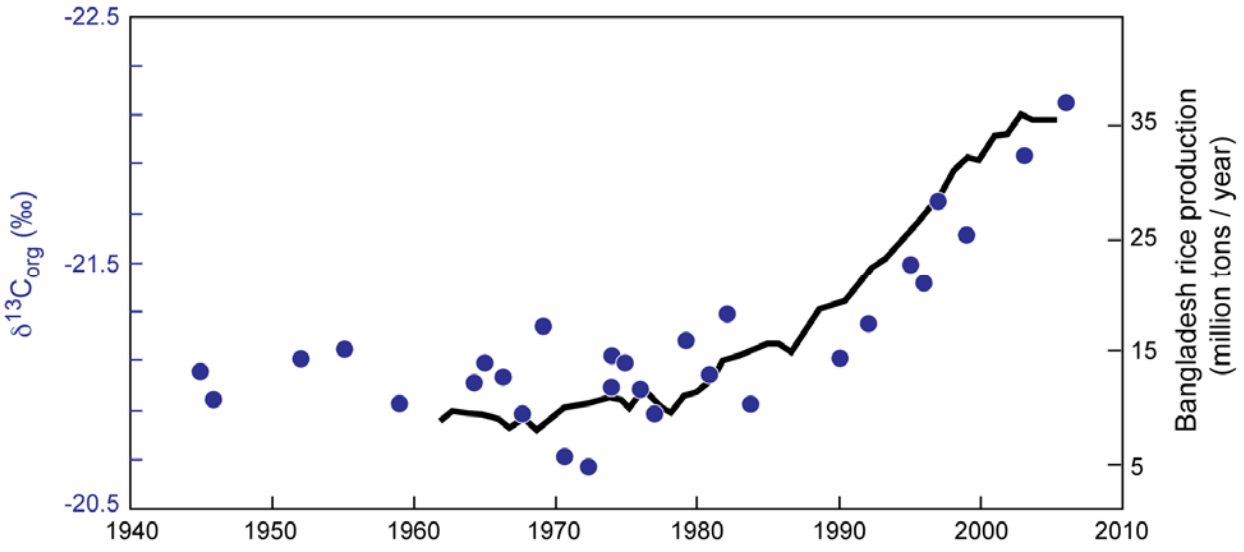

Figure 1: Historical record of the stable isotopic composition ($\delta^{13}C_{org}$, blue dots) of organic matter delivered to the Bengal Shelf. A trend towards more negative $\delta^{13}C_{org}$ values has started in the late 80s and is coeval with a sharp increase in rice production in Bangladesh (black line).