In this issue

Reactive nitrogen in Indian agriculture, environment and health

This issue carries a special section on reactive nitrogen, which highlights the human alteration of the nitrogen (N) cycle and its implications for India's agriculture, environment, health, climate change and much more. The global N cycle is one of the most important nutrient cycles that sustains life on earth. It is also perhaps the most affected by human activities, as they add 1.5 times more reactive forms of nitrogen (Nr) to the environment than all natural terrestrial processes put together. The various inorganic forms of Nr include NH_3, NH_4^+, NO_x, HNO_3, N_2O, NO_3^-, all of which participate in various reactions of the global N cycle. The accumulation of Nr far beyond nature's ability to neutralize them has profound consequences for the health of both ecosystems and people. Unfortunately, agriculture contributes 80% of all the anthropogenic Nr globally, mainly due to environmental leakages from legume cultivation and fertilizer use (whether chemical, organic or biological), while dairy industry, fossil fuels and industrial processes contribute the rest. Unlike many other human activities in which N is a byproduct, Nr is an essential input for agriculture, constituting up to 70% of the total fertilizer material used in India. India is currently the third largest producer and consumer of fertilizers in the world, after China and USA. Moreover, N-use efficiency in Indian agriculture is low, ranging from 18% (bad weather) to 49% (good weather). While there is no escape from the use of fertilizers to sustain food production, at least in the near future, it is possible to improve the N-use efficiency in agriculture. India also has the largest livestock population in the world, and their contribution of Nr is yet to be systematically estimated and minimized.

Though carbon dioxide makes most of the climate change news, scientists estimate that over a hundred year period, emission of N_2O (300 times greater greenhouse gas potential than CO_2) will play a key role. Minor increases in the concentration of N_2O could lead to major increase in global warming. N_2O also contributes to stratospheric ozone depletion, while NO_x causes tropospheric ozone depletion. Yet, the magnitude and scope of the challenge involved in managing the changing N cycle remains inadequately appreciated both in scientific and policy circles. The four International Nitrogen Conferences held in various parts of the world over the last decade, leading to the formation of the International Nitrogen Initiative (INI) in 2003, have played an important role in highlighting the issues related to reactive nitrogen at different levels. Even in the US, it is only recently (February 2008) that management of N cycle has been identified as one of the 14 grand technological challenges of the 21st century.

In the last five years in India, after several scientific discussions on Nr and the formation of the interdisciplinary 'Indian Nitrogen Group' of scientists in 2006 under the Society for Conservation of Nature has enabled a rigorous examination of the current state of knowledge on reactive nitrogen in India and the challenges ahead. As would be evident from the ten articles in this special section, our understanding of the nitrogen cycle in India is at best a tentative one, owing to the large range of regions, ecosystems, agricultural conditions, developmental changes, etc., while being studied from several disciplines and up to various levels of detail. Yet, even this tentative picture gives us clear glimpses, for the first time in any journal, about what we know so far about Nr in India, what are the strengths and limitations of whatever we know and what else do we need to know for a clearer and more quantitative understanding of the various sources, sinks, flows and fluxes of Nr in the 'Indian' nitrogen cycle, their impacts and the ways to mitigating them, forming a greater part of these articles.

Galloway *et al.* (**page 1375**) provide a thematic overview of the problem of Nr at the global, Asian and Indian levels, and also describe the recent Indian initiatives that provide the background context to this special section. They indicate that Asia in general and China and India in particular may become global hotspots for Nr in the coming decades, unless Nr accumulation is retarded through timely interventions. Bijay-Singh *et al.* (**page 1382**) provide the soil scientists' perspective on the N inputs into agriculture, the poor N-use efficiencies and leakages of Nr from the agro-ecosystems and groundwater pollution in different parts of the country. They also bring out the huge regional variations in fertilizer use/losses and indicate the regional hotspots, as well as provide various management options such as leaf colour charts, chlorophyll meters and optical sensors for increasing agricultural N-use efficiency in India. From the biological and biotechnological point of view, Pathak *et al.* (**page 1394**) argue that though the form and amount of N available to the plant can be improved by managing fertilizer–soil–water–air interactions, the inherent efficiency of the crop plant to utilize the available N has to be tackled biologically. They review the current worldwide understanding of the physiological and molecular basis for N-use efficiency in plants as well as the limited successes from transgenic efforts made so far, involving N transporters, primary and secondary assimilatory enzymes and the biotechnological options ahead.

Raghubanshi (**page 1404**) goes beyond agriculture to address the broader aspects of nitrogen cycling in natural terrestrial ecosystems, and the role of litter, soil microbial biomass and other natural processes. He highlights the need for a more detailed quantitative understanding of anthropogenic impacts of land-use change, slash and burn agriculture, pollution and species invasion in Indian terrestrial aspects of the N cycle. Subramanian (**page 1413**) points out that the average nitrate-N content in South Asian rivers is far above the global average, with huge variations for different Indian rivers. He estimates that though the causes of riverine Nr are yet to be quantified well, the overall contribution of Nr by Indian rivers into marine environments could be several fold higher than N-contaminated rivers in other parts of the world. Purvaja *et al*. (**page 1419**) bring out that most of the riverine Nr loaded from the terrestrial ecosystems tends to be denitrified (into neutral N_2 or gaseous forms of Nr) by natural processes long before it enters into the open oceans, primarily within the rivers, followed by estuaries and continental shelves. However, coastal environments are more seriously affected by Nr loading with severe impacts on fisheries and coastal ecosystems. Nr loading in oceans as well as terrestrial ecosystems also comes from atmospheric deposition through dry and wet precipitation of Nr, which requires proper quantification of its emissions as well as deposition, as brought out by Sharma *et al*. (**page 1439**). They provide some tentative estimates in this regard, which show that the total contribution of Indian agriculture to the global N_2O emission is only 2.7% and NO_x emission is also very low, though the agriculture sector is the main contributor to the total NH_3 emissions from India. On the other hand, NO_x emissions from India are largely attributed to fossil fuel combustion in the industrial and automobile sectors.

Chanakya and Sharatchandra (**page 1447**) draw attention to the urban and peri-urban lifestyles and ecosystems that discharge large fluxes of Nr through human excreta, sewage, garbage, etc., adversely impacting the immediate geo-, hydro- and atmospheres. They estimate the magnitude and flux of such Nr for Bangalore, a typical Indian city, and provide an insight into its origin, dispersal, losses and accumulation, as well as options for its mitigation. Coupled with automobile, industrial and atmospheric fluxes, such studies could give a better understanding of the urban N cycle. Eventually, the construction of an 'Indian' nitrogen cycle would require nationwide data covering all possible sources, sinks, flows, fluxes, emissions and depositions including the soil, water and air as well as seasonal and other changes. Velmurugan *et al*. (**page 1455**) attempt to construct such a regional N cycle for India with the sketchy data that is currently available, as a conceptual N model for further research. Lastly, Gupta *et al*. (**page 1469**) review the range of health problems caused by Nr in air, water and food. They include respiratory and intestinal disorders, cancer, abortions, birth defects, infant mortality, etc., indicating that reduction of Nr in our air and water is also critical for our health.

By themselves, these reviews are only indicative of the range of topics, issues and disciplines that encompass this field and are by no means an exhaustive catalogue of the available knowledgebase, even within the Indian context. Nevertheless, *Current Science* is uniquely placed to serve such interdisciplinary needs in India, and is glad to provide such a platform through this special section on reactive nitrogen. As Nr becomes one of the emerging foci in the international climate change negotiations, as well as in the run up to the fifth International Nitrogen Conference being hosted by the Indian Nitrogen Group in Delhi in 2010, it is hoped that such articles would trigger appropriate research and policy cascades that would better prepare the country to tackle the problems that loom large.

Y. P. Abrol
N. Raghuram
H. N. Chanakya
Guest editors

Coastal sediment dynamics

In the past centuries, the knowledge of sediment process in the coastal zone is limited to coastal geomorphologists. Later, over the past half century, the sediment transport is increasingly the interest of coastal engineering and coastal oceanographers. Currently the coastal sediment dynamics is primarily intriguing marine biologists, because the suspended sediment in the water is the primary source of nutrient and factor controlling the optical property of water column important for the productivity of coastal ocean. Spatial and temporal changes in the sediment concentration in the water column require time series data on large scale. Advancement in the satellite remote sensing, especially with high ocean colour data help the study of large scale and time varying coastal sediment processes especially coastal suspended sediment dynamics in the coastal waters of Bay of Bengal. Sridhar *et al*. (**page 1499**) provide a quick look on the Oceansat-I, OCM data derived suspended sediment dynamics during different seasons and tidal cycles.