24th M R Sahni Lecture 2006

24TH M. R. Sahni Memorial Lecture
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"RESPONSES OF EARTH SYSTEMS TO CLIMATE SHIFTS: FOCUS ON CONTINENTAL RECORDS OF MONSOONAL REGIONS"

Abstract

The Earth is a dynamic planetary body; its surface and near-surface domains include the atmosphere, hydrosphere, biosphere and lithosphere. These coupled systems of the Earth have been evolving through the Precambrian and the Phanerozoic. Near surface earth systems have responded to past climate shifts that were driven by coupled earth – sun processes.

In the past few decades, there has been a growing realization that anthropogenic factors are contributing, to some extent, to contemporary climate change involving global warming. The anthropogenic factor(s) are superimposed on a 'moving' and dynamic climate system. It has been concluded by IPCC (2001) 'that there has been a discernable human influence on global climate'; and that the temperature increase over the next century is at the rate of about 25-50 times as great as that which took place between LGM and the present. The impact on eco-systems of climate belts shifting at that rate can only be extreme, and an enormous problem for societies to cope with (Reitan and Reitan, 2001).

Earth systems have responded at certain rates to the past climate shifts that were driven by coupled earth – sun system processes. Ruddimann (2000) states that 'the simplest way to define this response rate is by the amount of time it takes for half the remaining warming needed to achieve equilibrium to occur. It is common knowledge that various climate system components respond on different time scales for example – atmosphere (hours to weeks), land surface (hours to months), ocean surface (days to months), vegetation (hours to decades / centuries), sea – ice (weeks to years), mountain glaciers (10-100 years), deep ocean (100-1500 years) and ice sheets (100-10,000 years).

Against this background, it has been established that the monsoonal system has also periodically weakened and strengthened (Prell and Kutzbach, 1987; Overpeck et al., 1996). The long term variability structure of the monsoonal system has been related to Milankovitch scale periodicities (Prell and Kutzbach, 1987) and to sub-Milankovitch bands such as millennial and century time scales (Overpeck et al, 1996; Anderson et al, 2003).

The monsoon system is complex and involves changes in seasonality, wind strength, temperature change, precipitation, freshwater discharge into the oceans, and sea surface salinity considerations, amongst many other variables. The civilisational history of India and its contemporary economic concerns are centered around rivers – both big and small. Rivers along with other continental systems also constitute response systems, and respond to climate shifts. This has an obvious impact on water resources, both regional and national. So, it is a matter of great importance that we must understand the responses of fluvial systems to climate shifts *on various time scales*. The history of the responses of fluvial systems to past climatic shifts is archived in river deposits. Hence, such studies are rooted in physical stratigraphy, geochronology, and the reconstruction of climatic history through the study of proxy – indicators of monsoonal shifts. Our work was concerned with small rivers such as the Sabarmati and Luni (Tandon et al., 1997; Jain and Tandon, 2003; Jain et al., 2005) and part(s) of a big river system, the Ganga (Gibling et al 2005; Tandon et al; in press).

Our understanding of the responses of different types of river systems to climate change is extremely limited, and we should step up efforts in this direction in order to improve our understanding of the responses of river systems to monsoonal shifts, and thereby fulfill some part of the obligation of earth scientists to society.

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