In this issue

Three views of a river – Vedic Saraswati

This issue of *Current Science* carries three articles concerned with the river Vedic Saraswati under different categories; the first – a correspondence item, the second – a review article, and the third – a book review.

The first is a letter by A. V. Padhye (**page 1154**). While his arguments 'in no-way reject that a river from the Himalayas traversing the Vedic period lands in north-western India and opening into the Arabian Sea was lost in the desert', the letter is about the nomenclature of the river. Padhye believes that Saraswati of the Vedic period traversed elsewhere, in erstwhile USSR and not in India, based on his interpretation of Vedic slokas. His views are along lines given by anthropologist Calvin Kephart, in his *Races of Mankind: Their Origin and Migration* (Peter Owen Ltd, London) published about 40 years ago.

The second is a review article. Study of remote sensing data from satellites during the past two decades has revealed a number of palaeo-channels in the Thar Desert region of Rajasthan. These palaeo-channels are presumed to be the relics of a river system that drained Western Rajasthan at different times during the Quaternary geologic age. The Luni river that flows through the south-eastern part of the Thar Desert region also once drained into this Himalayan river system, formed of the erstwhile fluvial regimes. Kar, through his detailed studies has traced eight major faults in the Luni basin. The movements which occurred along these faults are said to have 'caused drainage anomalies like channel branching or obliteration, channel incision and shifting of courses'. On **page 1188** A. B. Roy and S. R. Jakhar review these and other aspects related to Late Quaternary drainage disorganization and migration and extinction of Vedic Saraswati. Aridity of the desert land is said to be the cause of extinction of the river, according to many researchers. However, according to Roy and Jakhar, this is highly unlikely when one considers that the Nile, even to this day, flows through one of the most arid regions of the world, namely the Sahara Desert. They also point out that there is absolutely no scientific basis for the belief that River Saraswati is now a subterranean river. They state that 'we are left with the only alternative, which suggests migration of the river either to west south-west direction to join the Indus river system or to merge into the Ganga river system in the east'. They point out that the gravel spreads in pockets, the palaeo-channels, etc. indicate the presence of a mighty river system flowing close to the foothills of the Aravalli mountains. This river is said to have migrated westward with western shifting of the palaeo plains of the Aravallis. Further, westerly shifts of the Vedic river occurred due to major neotectonic movements. Finally its extinction was the result of several tectonic activities, as described in the article.

The third is a book review. B. P. Radhakrishna, one of the doyens of geology in India, reviews (**page 1248**) the book *Saraswati* by S. Kalyanaraman – the first volume running to some 1200 pages, of a set of five books. Radhakrishna has given a glimpse of the variety of data and information contained in this *magnum opus*. The book is a vast source of information collated very diligently and pertaining to a non-existing river. Radhakrishna remarks 'taking note of the importance of the work already initiated, learned academies should now take interest in initiating multi-disciplinary studies, not only to probe the beginnings of Indian Civilization, but also help in the development of a region which has now become a desert, restoring it to its past glory'.

River Saraswati seems to haunt the conscience (emotionally and scientifically) of many, because it is identified with a period of our past that witnessed the maturity of a great civilization.

Predicting climate changes

Weather is defined as the state of the atmosphere at a place and time as regards heat, cloudiness, dryness, sunshine, wind, rain, etc. Climate is the prevailing weather condition of an area. Climate changes affect the earth globally, as the atmosphere respects no national boundaries.

Forecasting climate is met with what is referred to as the 'Butterfly effect', or more technically the 'sensitive dependence on initial conditions', essentially what in physics is referred to as the phenomenon of chaos. The Butterfly effect surfaced in a talk by Edward Lorenz of MIT in 1972, titled 'Predictability: Does the Flap of a Butterfly's Wings in Brazil set off a Tornado in Texas?' delivered at the AAAS meeting at MIT. It is now well known in meteorology that a simple initial disturbance like the flapping of a butterfly's wing will create another one, that in the chaotic motion of the atmosphere, will become amplified eventually to change the large-scale atmospheric motion, so that the long-term behaviour becomes impossible to forecast.

Several factors affect climate changes; currently it is believed that 'greenhouse gases', cloud cover, surface temperature over land and surrounding seas, etc. have a bearing on the climate and hence on the weather.

Short, medium and long-range weather forecasting seems to be somewhat mysterious. There are so many opinions, studies and forecasts which seem to contradict each other, that it leaves a layman bewildered.

Let us consider the concept of 'global warming' – a currently fashionable attribute related to weather forecasting. One view refers to 'global warming' as part of a 'natural cycle' during which sea levels go up and down on scales of millennia. One can think of those cycles this way[1]: Consider the earth to be wrapped in a blanket of gases. These gases can be grouped into two categories: naturally occurring gases and gases from anthropogenic (human) activities and sources. The gases include N_2, O_2, water vapour, CO_2 produced by plants, animals and human beings, methane – a natural gas and a host of other gases, including nitrous oxide, ozone, chlorofluorocarbons, hydrofluorocarbons and perfluorinated carbons. This blanket insulates the earth by trapping heat, a lot like panes of glass in a greenhouse. Human activities also aid in the warming up of the atmosphere to some extent. But do we understand how much and in what way this addition of greenhouse gases is taking place?

What are the impacts of increased global warming? According to the environmental doomsayers[2], the next 100 years are perceived as a time of traumatic environmental change.

- As far as impact on land is concerned, the current boundaries of year-round farming are pushed farther to the north and south, as temperatures moderate. But the lands considered to be the bread-baskets of the world will be left with reduced crop yields. The deserts found in the mid-latitudes are also expected to expand, as already observed in Sahara, North Africa.
- According to a 1996 WHO report, malaria and dengue fever could reach epidemic levels and spread farther from the equator as a result of warmer climate. In addition, habitats for some animals may shrink and the range of insects may expand.
- As far as impact on water is concerned, the result of melting polar ice caps and water expansion from increasing warmth, are the most widely anticipated consequences of a warming world. The United Nations Intergovernmental Panel on Climate Change projects a rise in average global temperature of about 1–3.5°C and also that the world's oceans will rise anywhere from 15 to 95 cm by the year 2100. This means that at the high end of that scale, a low-lying nation like Bangladesh may lose over 20% of its arable land or parts of Florida in the US may be submerged. At the lower end, coastal erosion may increase and heighten the damaging effects of hurricanes and other coastal storms. Encroaching salt water has the potential to

contaminate the water supplies that coastal cities and farms depend on.
- As far as impact on air is concerned, clouds closer to the earth's surface reflect sunlight, producing an overall cooling effect. Clouds higher up in the atmosphere, however, have the effect of trapping heat and warming the planet.

But the cause for confusion for the layman lies in the views of the so-called skeptics, the scientists who question the supposed link between anthropogenic global warming (which they accept) and what nature is doing.

- Richard Lindzen of the MIT, USA referring to retreating glaciers says, 'the cause of this is said to be global warming. But then you look at the markers and you see that the retreat began around 1820. That's not due to global warming, at least not from man.' In other words, these things are said to happen.
- In the summer of 1988 James Hansen, chief of NASA's Goddard Institute, and other climate experts predicted a catastrophic global warming in the next century, if no limits were placed on the emission of carbon dioxide and other greenhouse gases as a byproduct of human activity[3]. This culminated in the Kyoto Protocol, which required the US and others to reduce drastically, their emissions of carbon dioxide. After ten years, Hansen and co-authors stated that predictions of climate change in the next century are meaningless. According to them[4]: 'The forcings that drove long-term climate change are not known with an accuracy sufficient to define future climate change'.
- As recently as 23 August 2001 a group of some 50 scientists gathered in Halifax at an International Conference, stated that human beings are not the cause of climate change, and expensive global efforts to reduce greenhouse gases will not stop the ice caps from melting or the planet from warming. Petr Chylek, chairman of the Conference said, 'It is quite possible that we can cut carbon dioxide emissions to zero, and we'd still have global warming'.
- The dissenters say fluctuations in the ultraviolet emissions of the sun, as well as natural climatic modulations that have occurred for thousands of years, are mostly responsible for the temperature change. The anthropogenic gases are making only a minute contribution to climate change.
- Forcings such as greenhouse gases, on the average, alter temperature over two decades by only a few tenths of a degree, while chaotic oceanic fluctuations are several times larger. Thus the forcings, even from a strong El Nino, can modify the probability of unusual temperature or precipitation by a modest amount, but they do not allow for a reliable definitive forecast of seasonal climate.

Scientific modelling produced by some of the world's most advanced supercomputers has depicted a series of scenarios that might result from global warming. The modellers are neither doomsayers nor skeptics. 'They are the ones who are interested in primarily presenting sobering forecasts for the next one or two centuries, assuming the way humanity is expected to evolve over this period and accepting that we are in a global-warming cycle'.

In this issue Murari Lal *et al.* (**page 1196**) predict several changes that can occur in the winter and summer rainfalls over the next 50–100 years based on monsoon simulation using 'atmosphere-ocean global climate model (AO-GCM)'.

With increasing population, technological developments, global economy and new economic policies, life patterns on a global scale seem to be changing at a break-neck speed. Changes in fossil to non-fossil fuel consumption, greenhouse gas emissions, increased chemical pollution, and new standards to manage the environment have led to some crystal-ball gazing about the environment itself. As a result, some scenarios likely to occur during the next 50–100 years are outlined. These 'marker' scenarios have the potential to affect the future climate significantly. So the authors have studied the nature of climatological changes that are likely to occur under the assumed 'marker' scenarios.

The resolution with which one can provide parameters associated with various regions of the land determines the accuracy of the predictions that one can make using the various models. The parameters include regional characteristics like vegetation cover, inland water basins, orographic features, thermal structures of adjoining seas/oceans and temporal variations in some of these parameters.

The forecasts are only as good as what the results of the simulation models can correlate with already observed/measured features of the monsoon over the past 50–100 years. Hence the study by Murari Lal *et al.* covers the climate over the past 50–100 years, before embarking on a forecast. A comparison between the simulated and observed data over the past 100 years has shown that the AO-GCM model has been successful in this respect, as there is good correlation between the data.

Some of the important conclusions of the studies by Murari Lal *et al.* are: (i) winter rains in India may decrease by between 5 and 25%, (ii) date of onset of summer monsoon over India may vary in future, (iii) intense spells of rainfall over the land may be more in the future. They have noted in particular 'the decline in wintertime rainfall over India is likely to be significant and may lead to droughts during the dry summer months'.

1. http://www9.cnn.com/SPECIALS/1997/global.warming/causes/
2. http://www9.cnn.com/SPECIALS/1997/global.warming/signs/
3. http://www.marshall.org/globalfax.html
4. *Proc. Natl. Acad. Sci.*, 1998.

K. R. Rao

Mammalian origins in space and time

Going back in time, the question of human origins basically presupposes the origins of mammals in general. The questions that come naturally to mind are *when* did this event happen and *where* and *how*? We now know that mammals originated some 200 million years ago in the Triassic and arose from the therapsid reptiles after a great deal of evolutionary experimentation in which several reptilian (mammal-like) lineages became extinct. However, the question of whether mammals arose in Laurasia or Gondwanaland, remains a much debated issue.

Most of the early work on mammalian origins was undertaken by scientists in Europe and North America and hence most of the hypotheses for the origin of mammals were specific to the northern continents, where these investigating scientists worked. It was then believed in the absence of any credible data from southern Gondwanaland, that early mammals were conspicuous by the paucity of their fossil record. However, the last two to three decades have focused attention on the ever-growing record of early mammals from the southern continents (South America, Madagascar, Australia and India). So much so that there has been a radical change in our thinking on the origins of mammals in the spatial context. The earliest record of mammals is now thought to be Pangean and fairly cosmopolitan in distribution.

The paper by Prasad and Manhas (**page 1235**) is another step in recording in India what was previously believed to be a Laurasian form, further supporting the globally widespread distribution of early mammals. After the pioneering efforts of the Geological Survey of India in documenting some of the most primitive mammals from the Kota Formation in sediments of the Pranhita–Godavari Valley, there seems to be a great potential or further work in this area not only in the area of origins of mammals, but also in studying the diversity of mammal-like reptiles that are found in abundance in the Indian rock record.

Ashok Sahni