Climate changes: Projections and prospects

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Models predicting climate changes in the new century in the wake of emission of greenhouse gases and consequent global warming and shifts in precipitation patterns, CFCs and ozone holes–UV radiation press panic buttons. Our planet has witnessed at least three glacial–interglacial phases during the Quaternary which did affect the flora and fauna, resulting in their migration as revealed by fossil and palynological evidence. Interglacials corresponded to pluvials and glacials to interpluvials with lesser rains though the noted geologist D. N. Wadia was of the opinion that the turbulence over the glaciers in higher latitudes was responsible for higher rains in lower latitudes. Animals which seek niches with special microclimates were probably less subject to the vagaries of weather and climate than the plants. North-south oriented mountain chains like the Western Ghats and the Andes provided more convenient corridors for migration than the east-west oriented ranges like the Himalayas and the Pyrenees, which proved mighty barriers to cross from north to south and vice-versa. Hill ranges with higher elevation provided a passage of convenience for ascension than the mountains of lesser altitude. Though the international literature on climate change is very vast[1–3], in the present work focus is only on India.

Legris[4] plotted the existing forest types of Peninsular India within a framework bearing mean temperature of the coldest month on one axis and a precipitation index (hydric balance) on the other. On this graph he demonstrated how the vegetation types would shift with a drop of 6°C or with a rise in precipitation by 500 mm, scenarios quite likely during glacial and interglacial phases, respectively.

There are models that predict sensitivity of temperature to greenhouse gases within a range of 1.5 to 4.5°C and the rise in sea-level by about 20 cm within the next 5 to 10 decades. These figures of projected higher temperature probably pertain to mean annual temperature. Higher temperatures, contrary to the popular belief, promote the growth of tropical species, though the direct impact of a climate change of the projected magnitude may be of greater consequence for the boreal forests of higher latitudes than for the tropical forests. However, as high temperatures are generally associated with hot deserts, the misconception prevails. It is the mean temperature of the coldest month that decides the distribution of forest types in India in many cases, the critical level of temperature being most important. Many miscellaneous tree species of deciduous forests are common in the zones with the mean temperature of the coldest month above or below 15°C, the sal tolerating somewhat lower temperatures than the teak. It would be interesting to compare the floristic composition of a deciduous forest near Warangal (Andhra Pradesh) with the one in the vicinity of Varanasi with a difference in mean temperature of around 3 to 4°C between the two stations.

However, these are not just temperature and rainfall measures that are the factors determining the vegetation types as supposed by Champion[5]. The length of the dry period and the seasons of occurrence of rain play an equally important role[6]. For example, the distribution of sal tree *Shorea robusta* is linked to timely arrival of rains when ripe seeds are available. The tropical dry evergreen forest is confined to the Coromandel coast where the rainfall regime is dissymetric[6] with the bulk of rains during the north-east monsoon (October–December).

Again, the climatic data used in predictive models are collected from meteorological sheds located in urban environments whereas most of the forests are relegated to the hills as the plains are taken up for cultivation. Due to their elevation and microclimate generated by the tree-cover, the temperatures differ considerably from the meteorological cabin. Under a scrub-woodland near Pondicherry, the temperature recorded one afternoon in June was 30°C but over the neighbouring barren red ferrallitic (slightly lateritic) soil it was a whopping 60°C. Mann[7] cites similar figures for Gambia; 34°C under shade trees and 67°C on barren ground at 1400 h during the dry season.

The temperature in a grassy blank near Kodaikanal, a hill station, on a winter night was – 9°C but under the nearby shola (tropical montane forest), it was above 0°C (ref. 8). The tree canopy does not allow the cold air to settle on the forest floor. During dry spells, low relative humidity in grasslands favours fires, but higher humidity under Shola prevents fires from entering the forest. Likewise, the existence of grasslands amidst the pristine Silent Valley forest appears an enigma but the humidity value recorded in grasslands one afternoon in March was 0 per cent. The strike of a match stick suffices to set the grasses on fire. Meteorologists may not agree with our way of setting up hygro-thermographs at the ground level but then city-based observatories do not reflect the ground truth.

Palynological evidence of vegetation changes during the Holocene period tends to evoke climate change, though in some cases the real cause may be different. It was a disease that led to the disappearance of the elm in Europe rather than a temperature change. The indicator value of species may not have been properly assessed[9] in suggesting wetter climates. Shifts in courses of rivers may account for moister or drier vegetation types rather than onset of wet or arid phases[10]. Caratini *et al.*[11] noted a distinct change from forest to Savanna in Uttara Kannada district around 3000 B.P. The change was more likely due to the use of fire to clear land for agriculture[12] and destruction of mangroves to raise paddy in the estuaries[13] rather than the commencement of a drier climate as suggested by Caratini *et al.*[11].

The rising sea-level is attributed mainly to the global warming but the geomorphic perturbations, though slow-acting, like subsidence, tilting of land, sea-floor spreading centred around the Carlsberg ridge in the Arabian Sea, man-made disturbances like construction of harbours and jetties generating long-shore drift, sand mining for minerals, and land filling programmes cannot be altogether ignored. Places where sea-erosion is active as in South Gujarat have been subject to invading monsoon tides for over half a century. The damage occurs within a few days at the peak of the rainy season, especially during the years marked by very strong monsoon storms.

In conclusion, anthropogenic interference in the geo-biosphere has its repercussions on the environment on a two-tier scale. At the global level, indication is of warming of the earth to the tune of 2 to 4°C over half a century or so. On the other hand, at a local scale, an operation like major deforestation or land-use change brings about a shift of greater magnitude in terms of temperature and humidity over a much shorter time frame.

Though the climate may have warmed in the Quaternary, the current rise in the global mean temperature is of great concern because unlike in the past, the burgeoning human population today exerts heavy pressure on the ecosystems. The combined effects of the two forces may not permit the intrinsic ability of the species to adjust to the disequilibrium; the threat of mass extinction hangs like the sword of Democles.

As side effects of global warming are often cited increase in the frequency, intensity and more importantly the havoc wrought by cyclones, droughts and fires.

Though these phenomena also occurred in the past, the ravages caused by them did not attain devastating proportions then because of human disturbance on a much lower scale. For example, the current rate of destruction of mangroves has exposed the coastal zones to the full fury of hurricanes. Man-induced earthquake activity is also on the rise due to the impounding of water over the geological faults but is in no way related to the global warming.

Other anthropogenic activities like deforestation result in immediate drastic changes in the microclimates providing conditions not conducive to reinstallation of forest over the degraded land. Available evidence also suggests that major deforestation affects the hydrological cycle, reduction in rainfall (mainly of convectional origin)[14] and hastens soil erosion.

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