Repercussions of climate change on forest types

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Legris[1] was one of the first to describe possible migration of forest types with a drop of 6°C temperature as was the case during Ice age or with an increase of rainfall during the Pluvial phase.

This article is inspired by the series on 'Climate change and India' in *Current Science*, particularly the paper concerning the forests by Ravindranath *et al*[2]. Very interesting and informative as this paper is, it is also thought provoking necessitating certain comments. First, these authors assess the impact of global warming on vegetation using two systems of forest classifications alternately, and without establishing a correspondence between the two systems, one of forest survey of India and another of BIOME model. Further, the terms forest types and vegetation types are used alternately: table 1 has 11 forest types but figure 2 has 22; again table 2 has 11 vegetation types whereas figure 3, 14. Also there is a mix-up of physiognomic and floristic criteria in deriving the types. Whereas blue pine, chir pine, teak, sal, bamboo in table 1 and spruce, deodar, fir, khair, salai, diplerocarp in figure 2 represent the latter, savanna, scrub, evergreen, semi-evergreen and deciduous types are physiognomy based in their table 1 and figure 2. In the bargain, some of the classical forest types like the tropical dry evergreen type of Coromandel coast do not come into the picture at all. Ravindranath *et al*. (loc. cit.) could instead have used Champion's[3] classification that is so familiar in India, in spite of its certain shortcomings[4]. Anyway, whatever the classification, it does not alter the conclusion of Ravindranath *et al*. of possible shifts in forest types affecting the biodiversity but increasing biomass and timber productivity with global warming, envisaged under two scenarios, a moderate and another severe. Under the former, CO_2 concentration would rise to 575 mm by 2085 AD accompanied by increase in temperature of about 3°C and an average rainfall of 200 mm, with higher amount in forested areas. The corresponding figures under more severe scenario are 740 ppm CO_2 concentration, 4.2°C temperature rise and 300 mm of rains; considering moderate rise, colder forests would be subjected to a greater increase of about 3°C as against 2.4°C in the evergreen forests of the Western Ghats; even under the more adverse scenario the latter forest type would be subject to a change of 3.3°C (Ravindranath *et al.*, loc. cit.).

Climate and eco-climate

The climate change is generally assessed only through one anthropogenic activity, viz. global warming. The more serious impact on regional climate brought about through deforestation is given secondary role. Meher-Homji[5] has dealt with the likely effects of large-scale forest clearance on regional rainfall. He has also shown the drastic change in eco-climate or micro-climate on forest removal. For example, in the Palni hills, the temperature under the shola (montane) forest remains above 0°C on winter nights but in the neighbouring grassland minus 9°C is measured by a thermograph the same time. The seedlings of shola tree species that may have germinated in the grassland are eliminated by the winter frost. Another inimical factor is the low value of relative humidity prevailing in the grassland during the dry months. Fires sweep through the grasses in this season, once again destroying the seedlings. Thus once cleared, the shola's return is blocked by winter frost and fires of dry season.

In the savannas of the Silent Valley (Kerala), the relative humidity recorded in the afternoon in the month of March was zero per cent favouring spread of fire. And this in a humid region! In a scrub-jungle near Pondicherry, the temperature registered under the tree-cover was 30°C at the height of summer in June afternoon. At the same time in a nearby clearing, the thermograph showed a reading of a whopping 60°C.

Another point worth noting is that the climatic parameters (rainfall, temperature, humidity) registered in an observatory located in a town (in the plain) may not be valid for the neighbouring forest, as the latter is usually confined to the hills and hillocks.

How menacing is the proposed climate change?

The projected rise in temperature then is of the order of 2.5 to 3.9°C. However, higher temperature by itself is not inimical to the vegetation. If the desert is bereft of the plant-life, it is because of lack of water. The highest expression of vegetation, viz. a rain forest occurs in the equatorial and tropical humid zones with high rainfall and high temperature. The latitudinal expanse of the sub-continent from the equatorial level to 36°lat. North and the Himalayan heights provide scope for the forest types to shift northwards or altitudinally from tropical to temperate and alpine belt as aftermath of warming; of greater concern is the melting of glaciers.

Varanasi and Warangal (Andhra Pradesh) would have a temperature difference of the order of 3°C as far as the minimum of the coldest month is concerned, and it is the minimum rather than the average or maximum temperature that is the limiting factor for the vegetation. However, the floristic composition of the deciduous forests around these two localities does not show a marked difference. This might show that the forests could absorb the change in temperature of 2 to 3°C, though at the limits of two major types tropical to subtropical or subtropical to temperate, the change may be significant. This brings me to the next salient point that autecological studies on most of forest species are lacking to add further precision in this matter. For agricultural crops like wheat the effect of temperature on seed setting and consequently on yields is well documented. Production suffers from higher than normal temperatures in January–February.

Significant factors missed out in climate change

The climate change refers principally to warming and secondarily to rainfall amount. However, the closely associated factors like the length of the dry season or the time (season) of occurrence of rains (regime) are ignored.

Kochi in Kerala may be receiving 2 to 3 m rains annually with a dry season of 2 months. Agumbe, considered to be Cherrapunji of South India, on the other hand, registers 8 m with at least 4 to 5 months dry season. The vegetation types along the Western Ghats right from Kanyaku-

mari to Maharashtra are linked to the rainfall amount and the number of dry months[6].

Further, there is compensation between the rainfall amount and the length of dry period. For example, Mumbai has annual average of 2000 mm spread over 4 months. Bangalore and Mysore on the other hand receive about 800 mm only but over 6 to 7 months. Consequently, the Sanjay Gandhi National Park near Mumbai and the Bannerghata sanctuary near Bangalore or Bandipur near Mysore are all clothed with deciduous forests. Compensation does seem to play a role.

The time or season of occurrence of rains and its influence in determining a given forest type is a factor seldom taken into consideration. The tropical dry evergreen forest type[3] of the Coromandel-Circar coastal regions essentially differs from the peninsular deciduous type as far as environmental factors are concerned in the rainfall regime. Whereas the regime is typically tropical with June to September rains from south-west monsoon in the deciduous forest belt, the tropical dry evergreen type experiences bulk of rains in October–November from cyclones and depressions[5] under a dissymetric regime. The economically important endemic tree red sanders (*Pterocarpus santalinus*) is confined to the Nallamalai Hills and the Cuddapah Basin in Andhra Pradesh, where a transition is taking place from the dissymetric type of Coromandel to the typical tropical type of the Deccan[7].

Again one of the main factors intervening in determining sal and teak forests in Central India is the time of occurrence of rains. Seeds of sal have a viability of 10 days or so and rains should coincide with this short period of viability. As the eastern part of the peninsula receives rains from the Bay of Bengal branch of the south-west monsoon, which arrives earlier than the Arabian Sea branch, the germination of sal seeds is favoured and the tree dominates the eastern half of the peninsula; consequently the western counterpart is marked by the dominance of teak. This example reveals how delicate the link could be between the climate and the geographic distribution of species within a bio-climatic framework.

Concluding remarks

Need we be too pessimistic about the effect of climate change on forests through burning of fossil fuels and attendant increase in green-house gases? At least some authors like Michael Crichton in his *State of Fear* do not attach much importance to global warming and its effect on climate change. On the other hand, another major anthropogenic interference with Nature, viz. large-scale deforestation could have serious repercussions on rainfall pattern, more on number of rainy days than on rainfall amount[5].

To understand the effect of climate change, precise data on the links between weather phenomena and phenological phases of forest species at autecological level should be the first priority. Besides a change in the temperature, shifts in rainfall amount and distribution (number of rainy days, length of dry season, and regime, i.e. time and season of occurrence of rains) need consideration to predict migration of species and consequently of vegetation types.

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