The need for establishing long-term ecological research stations network in India

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Global human population has been expanding exponentially, from 2.5 billion in 1950 to ~6 billion in 2000, and is likely to reach 10 billion by 2050, and thus the demand for natural resources is significantly increasing. It has resulted in rapid, extensive and persistent changes in earth ecosystems, more in the past 50 years than at any time in human history[1–4]. The global change phenomena particularly altering patterns of land use, climate, nitrogen deposition and acid rain, biotic exchanges and atmospheric carbon dioxide concentration are considerably affecting the structure and functioning of the ecosystems[5,6], and thereby their ability to provide goods and services to mankind[4,7]. These environmental challenges faced by society demand solutions that can meet human needs and protect essential ecosystem functions that vary in complex ways across different temporal and spatial scales[8]. A broad body of literature reports communities (representing small species pool within controlled conditions) response to certain environmental factors on the basis of short-term, small-scale field experiments through which making predictions for the whole ecosystem is difficult as the experiments do not incorporate natural processes[9]. Thus, ecologists and environmentalists need a new interdisciplinary effort to detect change, understand its basis and impacts on socio-ecological systems, and come up with tenable solutions by analysing and understanding the ecological patterns, processes and phenomena that vary over long temporal and large spatial patterns[7,10–12].

The National Science Foundation of United States has initiated establishing Long Term Ecological Research (LTER) station network since 1980 from 5 sites to collect detailed information on various ecological patterns, processes and phenomena that vary over a long term and on a large scale to acquire knowledge and predictive understanding that is necessary for the proper management of ecosystems and their services. As of 2007, a total of 26 LTER network stations (with annual budget of over $ 50 million) have been established in a variety of ecosystems throughout the US[13] (http://www.lternet.edu/). Ecosystems around the world are interconnected through a globally mixed atmosphere and the ecosystem changes in one location can have dramatic influences on both adjacent and distant areas, either at fine or broad scales[14] as a result of human transport of propagules, pollutants, and diseases, as well as anthropogenic disturbances and changes in land use[4,15,16]. Hence, in 1993, the establishment of International LTER (ILTER) stations has been initiated to cover greater range of ecosystem types over the world and it has become the 'network of networks' by joining a total of 38 countries (each having number of LTER stations) as of 2008. Efforts are being made to use the internet to link many sites (e.g. >600 to date; www.p2erls.net) in order to enhance the number of sites from ecologically diverse locations that include common measurements at the continental scales. About half of the existing networks are located in the European countries having relatively similar climatic conditions and degrees of anthropogenic stress and the remaining half are distributed in North America, South America, Australia, Africa and quite a few in Asian countries like China, Japan, and Philippines (http://www.ilternet.edu/). China has initiated establishing long-term ecosystem research stations since 1988 under the sponsorship of Chinese Government and World Bank loan, and is one of the founding members of ILTER by having 36 such stations for various ecosystems including agriculture, forestry, grassland and water bodies. Research output from these stations has been found useful in controlling desertification, soil erosion, salinization and eutrophication.

India is a vast country endowed with great variations in climate and vegetation, showing a wide variety of ecosystem types but lacking such network stations. It is high time to initiate such long-term ecological observations in different ecosystems in India to record long-term large-scale response of ecosystems in the changing environment scenario in the 21st century. It would be of great ecological significance if the Ministry of Environment and Forests, New Delhi, India takes an initiative to establish LTER stations either by joining the ongoing ILTER networks or by establishing its own network in different ecoregions of the country, where detailed ecological observations[8,10,17,18] like long-term changes in climate, vegetation dynamics including phonological observations[19], forest disturbance and evolutionary patterns; comparison of community, population, and plant architectural responses to human and natural disturbance; forest–atmosphere trace gas fluxes; organic matter accumulation, decomposition and mineralization; element cycling[20], fine root dynamics and forest microbiology can be recorded. Long-term studies on these aspects are highly limited in different ecosystems in the country and need immediate attention.

Selected existing biosphere reserves/sanctuaries in the country may be considered as potential sites for establishing such network stations. To represent the range of variations in climate and vegetation in the 1st phase, at least five such network stations are suggested, out of which four should be in the areas known for biodiversity hotspots like Western Ghats, Andaman Nicobar Island, Western Himalaya and Eastern Himalaya (i.e. Indo-Burma region). The information from these network stations should be gathered in collaboration with the experts from adjoining universities and institutions as nodal centres. Besides, another station would be of great ecological value at the ecotonal region of the Punchmary Forest Reserve towards Singrauli–Sonbhadra area at a forest–savanna–cropland gradient to cover a variety of dry tropical forests and derived ecosystems having peculiar environmental conditions and diverse indigenous flora and fauna facing high degree of anthropogenic pressure. Six years of continuous N and P input in forest and derived ecosystems in this region has contrasting effects on soil organic matter and aggregate structure[21] that have profound effects on their carrying capacity. Testing of such hypothesis through LTER would give us

new insight into the phenomenon of eutrophication.

The data gathered from the above mentioned networks can be suitably linked/exchanged with the ongoing ILTER programme. The expansion of LTER network in countries like India would make it possible to represent a greater range of ecosystem types that are being influenced by changes in climate, biogeochemistry and biodiversity. Also, it will complement developing National Ecological Observatory Network in area where either no such research work has been undertaken or poorly coordinated long-term research is in progress.

In addition, Long Term Agricultural Research network stations can also be developed by the ICAR (Indian Council of Agricultural Research, New Delhi), that can record the data from the agroecosystems in different parts of the country that would be helpful in modelling and predicting agricultural information towards sustainable agriculture. Finally, the aim of all these network stations should be widened to collect the long term socio-economic research data from various natural (i.e. forest) and derived ecosystems (i.e. savannas, grassland, cropland, etc.). The large-scale, long-term data generated through these network stations can be integrated to represent a valuable document for scientists and the society.

These long-term site-based integrated observations will be highly valuable and significant in the analysis and management of long-term environmental consequences on ecosystems and their services[22] which are considered as one of the most precious resources on this planet that cannot be restored, if degraded, and the coming generations have to pay huge penalty for this. Moreover, such information will significantly contribute towards solving ecological, environmental and socio-economic problems at regional, national and international levels through problem-based research. These long-term ecological data can be linked with site-specific socio-economic factors responsible for changes in ecosystems and their services that can be helpful in evaluating the site-specific socio-economic and environmental problems of the country.

Recently, Janzen[23] has pointed out significance of the long-term ecological sites as the 'listening places', where we press our ears to the earth and strain to hear its pulse, and emphasized the need for establishing such sites throughout the world especially in developing countries in coming decades to encounter mounting stresses on the ecosystems due to human influences. He has presented his musings by way of seven questions about how best to look after the long-term sites so that they remain intact, relevant and enlightening for the future generation.

Note added in proof: More recently, India's submissions through the Ministry of Environment and Forests to the United Nations Framework Convention on Climate Change (UNFCCC) held at Copenhagen in December 2009 have reflected climate change as a major challenge for the economic growth and social development of the country, and thus the nation's priority of poverty eradication. Particularly, India has put forth an innovative proposal on forestry-related emissions that has emphasized the need to reduce deforestation, and enhance forest conservation, sustainable forestry management and forest carbon stock[24]. Thus, establishing such stations network in India would be an important component of efforts in achieving one of the major objectives of India's submissions to UNFCCC 2009.

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