MEETING REPORT

Biodiversity and climate change*

Biodiversity is continually transferred by a changing climate. Conditions change across the face of the planet, sometimes slowly, sometimes in larger increments leading to rearrangements of biological associations. Now, a new type of climate change brought about by human activities is being added to this natural variability, threatening to accelerate the loss of biodiversity already underway due to other human stressors. The carbon cycle and the water cycle, arguably the two most important large-scale processes for life on earth, both depend on biodiversity at genetic, species and ecosystem levels and can yield feedbacks to climate change. Maintaining and restoring healthy ecosystems plays a key role in adapting to and mitigating climate change through biodiversity conservation, sustainable use and sustainable land management and yields multiple environmental, economic and social benefits.

The International workshop (https://erp.iitkgp.ernet.in/InfoCellDetails/resources/external/cepdata?course_id=CP/CSC/17-18/CL/2194) was attended by 200 participants, wherein two-tutorials were given on 'Species distribution modelling' and 'Ecophysiological measurements' on the first day to about 100 students and young scientists. During the next two days 175 abstracts were presented, 11 plenary and 9 keynote talks were delivered, and a field excursion was arranged on the fourth day.

The workshop was specifically set up around open discussions and consensus on key challenges. There were seven sub-themes (Technical Sessions) to cover the main theme, i.e. (i) Climate change and functional biodiversity, (ii) Biodiversity and geomatics tools, (iii) Himalayan biodiversity, (iv) Ecology,

environment and biodiversity, (v) Biodiversity and biotechnology, (vi) Food security, adaptation and mitigation, and (vii) Ocean, atmosphere and climate.

M. D. Behera (Centre for Oceans, Rivers, Atmosphere and Land Sciences (CORAL), IIT Kharagpur) introduced the topic of the workshop, and narrated on how our planet earth is at a suitable/ideal location in the galaxy to support life/biota and that the oxygenation event is important. He also discussed the five glaciation and de-glaciation phases that have altered in the past 500 million years ago and cautioned to take appropriate measures to slow down the recent pace of anthropogenic-induced global warming. He also highlighted the research done at the Spatial Analysis and Modelling (SAM) Lab, CORAL, Indian Institute of Technology Kharagpur, such as (i) climate-sensitive vegetation type map of India, (ii) vascular plant diversity map of India at 1 and 2 degree grids, (iii) major vegetation types and their plant diversity vis-à-vis temperature and precipitation anomaly, (iv) environmental heterogeneity and their contribution to plant diversity distribution and specifically in hotspot and Himalayan region, and (v) latitudinal and longitudinal profile of vascular plant diversity of India.

Delivering the first plenary talk on 'Beyond island biogeography theory', K. N. Ganeshaiah (formerly at University of Agricultural Sciences, Bengaluru) elaborated on Indian archipelagos and focused on island biogeography theory to discuss 'how with increased island size, the number of species increases'. He pointed out critical findings of species area relation (SAR) and informed that the Indian Andaman & Nicobar Islands do not follow the basic expected pattern of increase in species from north to south. A. K. Raha (formerly at West Bengal State Forest Department, Kolkata) delivered his plenary talk on the 'Impact of climate change on Sundarban Tiger Reserve – A time series study'. He highlighted that projected sea-level rise could threaten the livelihood of ~4.5 million people in 54 islands, and that increased salinity could irreversibly affect mangrove forests in 48 islands, including

species composition. A. K. Parida (Institute of Life Sciences (Department of Biotechnology), Bhubaneswar) delivered the third plenary talk on 'Sustainable management of coastal ecosystems'. He focused on the significance of coastal ecosystem as a link between terrestrial and water ecosystem and the potential sustainability loss of these ecosystems in response to climate and anthropogenic stresses. He also emphasized the use of transgenic crops with an example of AmSOD rice transgenic to cope against salinity and water stress along with the species, e.g. *Salicornia brachiate* (saline-tolerant), *Atriplex* sp. (saline, drought and waterlogging tolerant). The plenary talk by S. K. Barik (CSIR-National Botanical Research Institute (NBRI), Lucknow) on 'A future road map for ecological research in India' highlighted the importance and fundamental need of new ecological sciences and addressing the societal, conservation or economic problems utilizing ecological interaction knowledge through technologies and products, particularly in a developing economy. Delivering a plenary talk on 'Patterns in Himalayan treelines and research needs', S. P. Singh (Central Himalayan Environment Association (CHEA), Nainital) highlighted the importance of treeline ecotone region and research negligence in the Himalaya due to remoteness. He also presented the treeline (connects the highest trees of each transect) and timberline (tree crown cover is at least 30%) demarcation of *Abies densa* (fir) in Sikkim.

P. S. Roy (University of Hyderabad) delivered an extempore plenary talk on 'Biodiversity in the Anthropocene' and discussed on how plant diversity is threatened due to the greed of the *Homo sapiens*. He also emphasized on the utilization of geospatial and modelling tools for integrated study of biodiversity in a warming world for comprehensive understanding and mitigation. S. P. Adhikary (formerly with FM University, Odisha) delivered a plenary talk on 'Biodiversity of cyanobacteria in biological crusts and their adaptation strategies in stressed habitats due to climate change'. He underlined the significance

of cyanobacteria as a component of the biological crust, that acts as a reservoir of plant nutrients, influences the structure of the substratum and activity of other microorganisms, and as agents for incorporation of organic carbon and nitrogen through photosynthesis and nitrogen fixation. D. K. Upreti (CSIR-NBRI, Lucknow) in his invited talk focused on 'Indian lichen diversity with reference to environmental pollution and climate change'. C. Biradar (International Center for Agricultural Research in the Dry Areas (ICARDA), Cairo, Egypt) delivered a invited talk on 'Quantification of agro-biodiversity for food and nutritional security under changing climate' and highlighted on the agro-biodiversity and diverse farming systems and inclusive agroecosystems for sustainable development. He pointed out the sustaining indigenous pollinator biodiversity and enhancing pollination services, using the farming with alternative pollinators approach. Delivering a invited talk on 'Plant adaptation to stress: insights from cell and seed priming', Brahma Panda (Berhampur University) discussed on plant perception and response to abiotic stress factor associated with climate change. He pointed out that prior priming of *Guizotia abyssinica* seeds with a low dose of γ-irradiation, would help mitigate Al phytotoxicity and genotoxicity to a considerable extent. U. C. Mohanty (School of Earth, Ocean and Climate Sciences, IIT Bhubaneswar) in his invited talk highlighted the increasing frequency of extreme weather events in the recent decades of rapid climate change.

Vishwas Chitale (ICIMOD, Nepal) delivered his keynote talk on 'Climate resilient forest management system in Nepal', and discussed the vulnerability assessment of the high-altitude forests towards forest management and planning at a micro level. Amit Chawla (CSIR-Institute of Himalayan Bioresource Technology, Palampur) in his keynote talk 'Predicting climate change effects on high-altitude vegetation from plant functional traits' focused on the hypothesis 'functional traits distribution could shift towards abundance of tolerant genotypes, with large intraspecific variability' with reference to the Himalayan range. C. Patnaik (Space Applications Centre (ISRO), Ahmedabad) emphasized on the application of synthetic aperture radar for vegetation monitoring. Anzar A. Khuroo (University of Kashmir) in his keynote talk on 'Alpine ecosystem dynamics and climate change in Himalayas: insights from Kashmir Himalayas', reported the following findings: (i) decrease in species richness (SR) and soil temperature with increase in altitude along alpine summits; (ii) the southern aspect exhibits the highest values of both SR and soil temperature; in contrast, the western aspect exhibits the lowest values of both SR and soil temperature. C. Sudhakar Reddy (National Remote Sensing Centre (ISRO), Hyderabad) in his keynote address 'Earth observation data for assessing biodiversity conservation priorities in South Asia', emphasized the need to identify priority areas representing the range of forest ecosystems and sustaining biodiversity. He used 10 ecological criteria to identify areas for biodiversity conservation and pointed out the high ecosystem irreplaceability in Bhutan followed by Nepal, India and Sri Lanka. He concluded that systematic planning of priority areas is crucial to achieve the most cost-effective conservation. Subrat Sharma (G.B. Pant National Institute of Himalayan Environment and Sustainable Development, Almora) emphasized on the need for strategic research at the interface of biodiversity and climate change in the Himalaya that offers a natural laboratory for postulate testing and hypothesis formulation.

Ten awards were given for the best student presentation in oral and poster categories, with a prize money attached. Two appreciation awards were given (from among the participants) in the categories of best question asked and best suggestion made.

Several presentations were made in the seven technical sessions, which can be summarized as follows: Climate change is a rapidly increasing stress on ecosystems and can exacerbate the effects of other stresses, including from habitat fragmentation, loss and conversion, over-exploitation, invasive alien species and pollution. Human-induced climate change could shift the net natural carbon cycle towards annual net emissions from terrestrial sinks and weaken ocean sinks through temperature rise and CO_2 concentration, thus further accelerating climate change. Functional diversity can explain and predict the impact of organisms on ecosystems and thereby provide a mechanistic link between the two. Critical points in developing predictive measures of functional diversity are the choice of functional traits with which organisms are distinguished, how the diversity of that trait information is summarized into a measure of functional diversity, and that the measures of functional diversity are validated through quantitative analyses and experimental tests. Global modelling has been useful in obtaining an overview of possible gross changes in growth form and vegetation distribution. Yet, conservation planning requires information about species range shifts at specific sites and within specific regions. Accordingly, more detailed regional modelling of biotic changes is of fundamental importance in understanding the impacts of climate change on biodiversity.

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