Terrestrial carbon studies and Earth observation data†

The Indo-UK seminar on terrestrial carbon studies held recently was attended by 20 early to mid-career scientists from India (15) and the UK (5).

The programme was specifically set up around discussion and brainstorming for specific sub-topics rather than a 'mini-conference'. This maximized open discussion, debate and consensus on key challenges. There were five sub-themes (topics) to cover the main theme – (i) terrestrial carbon cycle, models, field measurements, (ii) Earth observation data to quantifying carbon cycle, (iii) vegetation response to climate and implications on carbon cycle, (iv) validation, scaling-up, flux-towers and (v) multi-sensor data integration, intercomparison for carbon cycle modelling. Each topic had 1 h of scientific seminar focusing on recent developments and challenges in the specific topic, followed by 3–4 short presentations on specific case studies. This was then followed by a brainstorming session involving all participants to address some of the challenges raised during the main seminar. Each session was then wrapped up with a summary. On the third day of the seminar, the possibility of potential (i) joint academic publications between Indian and UK scientist and (ii) funding opportunities for joint research and collaboration were discussed.

Field observation, particularly long-term continuous data on gas and energy flux, physiological and structural properties and phenology of ecosystems is crucial to understand the dynamics of bio-geochemical cycles and response of natural vegetation to environmental and climatic stressors. Until recently, India had no initiative to collect such data in an organized manner and complement the existing international observation networks such as Ameriflux, Carbo Europe, Asia flux, etc. However, two national-scale initiatives, i.e. ISRO's flux towers and CSIR's long-term ecological record sites are important milestones in this field. There is no doubt that these will provide the first ever data to characterize ecosystem function and in turn to quantify carbon exchange. However, efforts must be made for continuous observation and to extend these sites to other unrepresented ecosystems across India through combination of the existing initiatives and low-cost approaches such as 'Phenocams'. There is a need to provide standardized protocol for data collection, quality control and data portal for wider scientific use. In addition, there are several field observations across various local sites in India to monitor short- and long-term phenology. These represent a rich dataset and if aggregated at the national level could provide key information to differentiate plant functional types (PFTs) and their response to climatic changes.

Discussion also focused on the development of a country-specific dynamic vegetation model (DGVM), which could provide actual and potential carbon sequestration through natural vegetation under future land use and climate change scenarios. Most of the existing DGVMs are not able to provide accurate simulations of vegetation dynamics in India because of improper representation of tropical and subtropical vegetation found in the country and poor characterization of rain-driven phenology. Therefore, efforts should be made either to modify the existing DGVMs or develop an India-specific 'community vegetation dynamic model' which can later be integrated with a land surface–atmosphere–ocean model. Data derived from both satellite and ground observations as mentioned earlier can be used to parametrize and run the model to derive current and future carbon dynamics.

India has a strong space programme and under the current national carbon programme, data from these satellite sensors are seen as a key input in monitoring and mapping vegetation carbon stocks. In addition, with availability of data from other international space organizations such as NASA, ESA and JAXA, there is a potential opportunity to integrate multi-sensor data. Efforts should be made to develop robust algorithms of satellite data integration to estimate carbon sequestration by vegetation. Methods should be developed to scale-up the field observation of carbon and energy fluxes to satellite data in order to provide a detailed spatial representation. Rather than only focusing on mapping and monitoring, research should also focus to find potential areas of carbon sequestration through restoration by combined use of satellite and field observations.

The consortium was informally named as 'Indo-UK terrestrial carbon group' (IUTCG). Three specific areas were identified for national and international research and collaboration: (a) observation, (b) modelling and (c) monitoring. This would lead to better understanding of ecosystem function, robust estimation of national carbon stock and identify areas for ecosystem restoration. In order to achieve the above goals, it was realized that combined research efforts are necessary which span over many scientific fields, i.e. climate, ecology, space science, etc. A dedicated funding mechanism and a national governing body would enable timely execution of these tasks. To our knowledge there has been no earlier attempt to bring such diverse groups of scientists to discuss how Earth observation data can be used to monitor terrestrial carbon dynamics in India.

†A report on the Indo-UK Seminar on 'Quantifying Terrestrial Carbon Uptake from Earth Observation Data: Challenges and Opportunities' organized by the Centre for Oceans, Rivers, Atmosphere and Land Sciences (CORAL), Indian Institute of Technology, Kharagpur during 19–21 December 2012. The seminar was supported jointly by the Department of Science and Technology, Government of India and UK Royal Society, London and coordinated jointly by the Department of Business, Innovation and Skills (BIS) through present authors.

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