Earth System Analysis for Sustainability. Hans Joachim Schellnhuber *et al.* (eds), MIT Press, 5 Cambridge Centre, MA 02142-1409, USA. 2005. 454 pp. Price: US $38.

The volume under review is the outcome of a Dahlem workshop. The Dahlem workshops were named after a district of Berlin, known for its scientific spirit and culture. This is where Albert Einstein conducted research, and it is now home to several scientific institutions, including the Max Planck Institute. The goal of these workshops is to search for new perspectives in order to help, steer and direct international research programmes. One such perspective, the study of global changes, both past and future, has taken on a new significance for developing strategies for management of the global environment.

In this context, the goals of the Dahlem workshop were: (i) To evaluate whether the current geophysical hypothesis is testable in the light of astrobiology. (ii) To gain a structural understanding of the earth's functioning during the Late Quaternary. (iii) To clarify the prospects and boundary conditions of global (e.g. carbon or water) cycle management. (iv) To discern which type of global institutions will be necessary to implement such a strategy.

Earth System Analysis and Sustainability is organized into four parts, and includes group reports on (a) long-term geosphere – biosphere evolution and astrobiology, (b) possible states and modes of operation of the Quaternary earth system, (c) earth system dynamics in the Anthropocene, and (d) sustainability. Apart from several chapters authored by leading figures in the areas of geology, climatology, evolution, biogeochemistry, macroeconomics, and institutions theory, Clark, Crutzen and Schellnhuber touch upon the need for a new paradigm, i.e. science for global sustainability. These authors begin by defining the concept of Anthropocene: 'a new geologic epoch in which humankind has emerged as a globally significant – and potentially intelligent – force capable of reshaping the face of the planet'. Humans have been known to alter their local environments, but their role in influencing global-scale processes is for the most part a phenomenon of the past few centuries. As a consequence, the concept of 'sustainability' has attained significance, and more so as a 'normative concept regarding not merely what is but also what ought to be the human use of the earth. Recently, Steffen *et al.*[1] concluded that 'perhaps 50% of the world's ice-free land surface has been transformed by human action; the land under cropping has doubled during the century at the expense of forests, which declined by 20% over the same period'. More than half of all accessible freshwater reserves have come to be used by humankind. Fisheries remove more than 25% of the primary production of the oceans in the upwelling regions and 35% in the temperate continental shelf regions. Some estimates show that in the next half century, human population may increase by 50%, and with attendant increases for food production by 80%, for urban infrastructure by 100%, and for energy sources by more than 200%. Clark *et al.* point out that 'depending on the scenarios of the future energy use and model uncertainties, the increasing emissions and resulting growth in atmospheric concentrations of CO_2 are estimated to cause a rise in global average temperature by 1.4–5.8°C during the present century, accompanied by sea-level rise by 9–88 cm. The earth has not witnessed such rapid rates of change in several million years; as a consequence of these rapid rates climate may depart significantly from natural over the next centuries and millennia. What then would be the responses of the various earth systems, and what would be the consequences for the biosphere? In this context, several questions are raised in this volume: What are the major dynamical patterns, teleconnections, and feedback loops in the planetary machinery? What are the critical elements (thresholds, bottlenecks, switches) in the earth system? What are the characteristic regimes and timescales of natural planetary variability? What are the anthropogenic disturbance regimes and teleperturbations that matter at the earth system level? Which are the most vulnerable regions under global change? How are abrupt and extreme events processed through nature–society interactions? What are the accessible but intolerable domains in the coevolution space of nature and humanity? What are the equity principles that should govern global environment management? What are the best techniques for analysing and possibly predicting irregular events? What are the most appropriate methodologies for integrating natural science and social science knowledge? What is the structure of an effective and efficient system of global environment and development institutions? Answers to these questions will hold the key in the future to ensure sustainable use of the planet.

This volume has used US NRC[2] reports to show that nature (earth, biodiversity, ecosystems), and life support (ecosystem services, resources, environment), and (community/cultures, groups, and places) are to be sustained against a background of development of people (child survival, life expectancy, education, equity, equal opportunity), economy (wealth, productive sectors, consumption), and society (institutions, social capital, states, regions). Such an approach for integrating sustainability and development will require a 'new contract between science and society for planetary stewardship'.

This book interestingly draws upon the lessons that are archived in the geospheric – biospheric interactions of the past (geologic time), the Anthropocene (Industrial Era), and goes on to assimilate the lessons learnt in the past century. A discussion of the strategies for the future is then attempted.

The book provides the reader with a philosophical and comprehensive account of the 'driving forces behind global change' and aims towards an enlightened new stewardship for sustainable development. This is a volume that should be read widely by environmental engineers and scientists, earth scientists, atmospheric scientists, climatologists and those interested in global change and sustainability.

1. Steffen, W. *et al.*, *Global Change and the Earth System: A Planet under Pressure*, Springer, Berlin, 2004.
2. *Our Common Journey: A Transition towards Sustainability*, Natl Acad Press, Washington DC, 1999.

S. K. TANDON

Department of Geology,
University of Delhi,
Delhi 110 007, India
e-mail: sktandon@rediffmail.com