Journal of Vegetation Science 13: 297-450, 2002

SPECIAL FEATURE

IGBP/GCTE terrestrial transects: Dynamics of terrestrial ecosystems under environmental change

Editors
Canadell, J.G.; Steffen, W.L. & White, P.S.

The papers presented in this Special Feature result from the IGBP Terrestrial Transects Workshop that took place in Darwin, Australia, on July 12-16, 1999.

Contents

Special Feature

IGBP/GCTE terrestrial transects: Dynamics of terrestrial ecosystems under environmental change – Introduction

Canadell, J.G.[1*]; Steffen, W.L.[2] & White, P.S.[3]

[1]*GCTE-GCP International Project Office, CSIRO Land and Water, PO Box 1666, Canberra, ACT 2601, Australia;*
[2]*IBGP, Royal Academy of Sciences, Box 50005, SE-10405, Stockholm, Sweden;*
[3]*Department of Biology, CB #3280, University of North Carolina, Chapel Hill, NC 27599-3280, USA;*
[*]*Corresponding author; Fax +61262421512; E-mail pep.canadell@csiro.au*

The realization that human-induced environmental changes often have impacts at continental and global scales has prompted the development of new ways to address large-scale and complex research problems. These new research approaches need to deal with an unprecedented level of integration and coordination of multiple disciplines and data streams generated by different scientific communities, institutions and countries (Canadell et al. 2000).

In the early 1990s, the Global Change and Terrestrial Ecosystems (GCTE) project of the International Geosphere-Biosphere Programme (IGBP) developed the approach of terrestrial transects for global change research as a way to address large spatial phenomena with both regional and global implications (Steffen et al.1992; Koch et al. 1995; Steffen et al. 1999). The IGBP Terrestrial Transects were established in critical regions of the world in order to cover most environmental conditions and biomes/ecotones with special attention to highly sensitive regions (e.g. high latitudes due to global warming and tropical regions due to rapid land use change) (Fig. 1a).

The transects run for more than 1000 km along specific environmental gradients such as temperature or precipitation, and along more conceptual gradients of land use intensity. They often cross ecotones such as tundra-taiga which are believed to be highly sensitive regions with strong feedbacks to global change.

The transect approach is well placed to provide the critical mechanistic and process level information required for regional and global analyses. Combined with appropriate field experimentation to untangle the often confounding factors along single environmental gradients, transects are powerful testing beds of the mechanistic knowledge critical for model development and validation. A number of papers in this special issue show the value of this approach to study processes and drivers over biophysical continua such as temperature, precipitation, and soil texture as controls on carbon and nitrogen dynamics (stocks and turnover), and community structure and net primary productivity. In addition, large-scale biophysical continua are critical to identify nonlinear responses and thresholds, and to study biotic controls on plant distribution and ecotone/boundary dynamics.

Modelling and spatially explicit information (including remote sensing data) can then scale transect information to the appropriate regional, sub-continental and global levels. The large size of transects made them ideal to scale terrestrial processes to global analyses with grid cells that match those used in global models such as Dynamic Global Vegetation Models and Global Circulation Models.

From an organizational viewpoint, the IGBP Terrestrial Transect approach has proved to be successful at addressing the inherent problems of large scale research projects including issues of standardized protocols, effective network design, and methodological and sample biases which are often problems preventing the integration and synthesis of individual studies embedded in large scale experiments.

The transects are currently used along with other IGBP research approaches in order to gain the necessary mechanistic information and appropriate spatial and temporal coverage to deal with specific regional, continental or global scale analyses. In this regard, remote sensing testing sites (Fig. 1b), process-studies networks (Fig. 1c), observational networks (Fig. 1d), and other transect approaches to understand paleo-environmental changes (Fig.1e) are all critical elements that will yield the necessary process and spatially explicit information.

This special edition on the IGBP Terrestrial Transects presents 14 research and review papers ranging from the high latitudes of Alaska and Siberia to mid-latitude regions like Patagonia and Inner Mongolia where little is still known to the tropical regions of Amazonia and Sumatra.

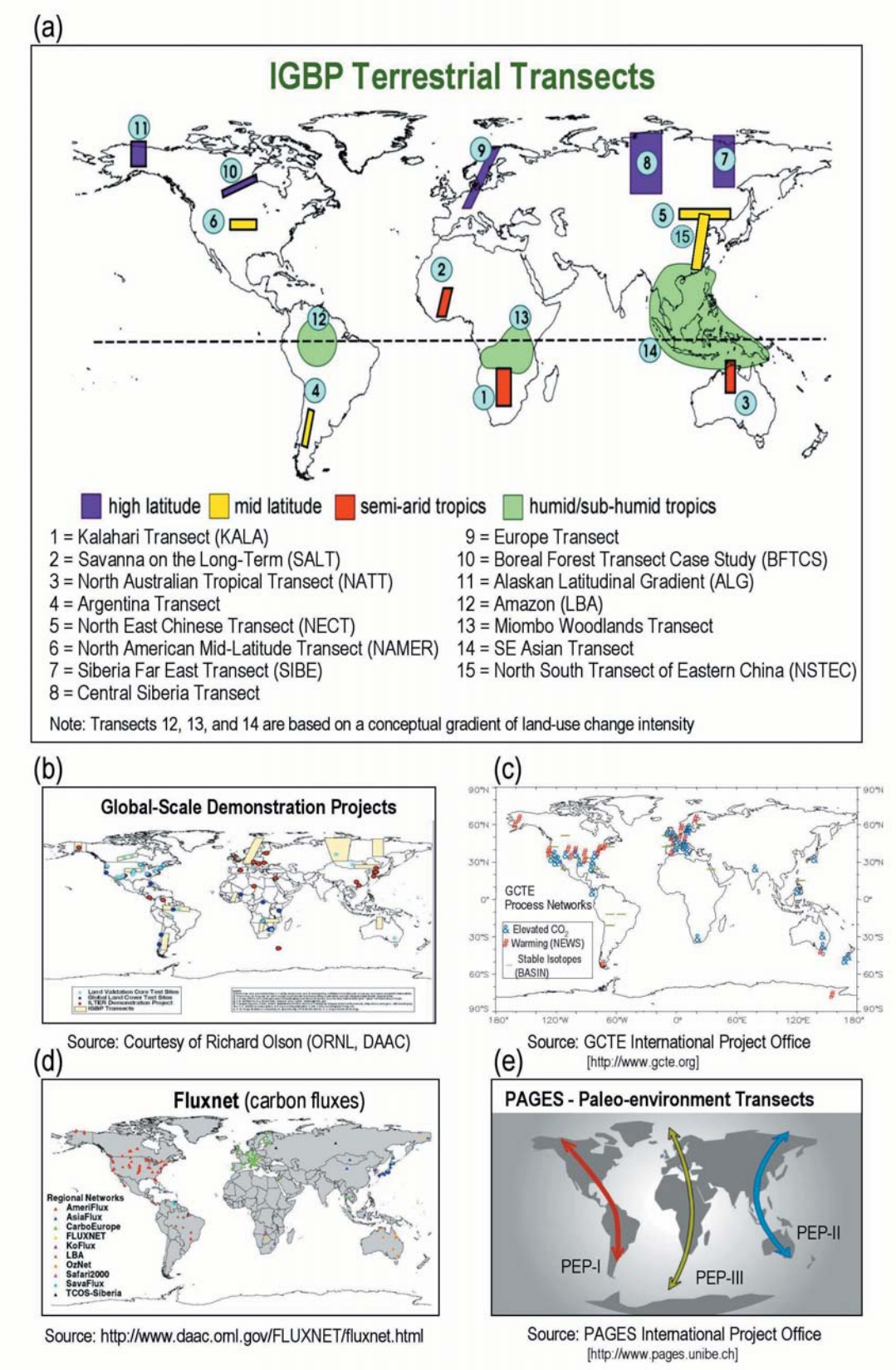

Fig. 1. IGBP research approaches for global change research:(a)IGBP Terrestrial Transects; (b) Remote sensing testing sites (ORNL-DACC); (c) GCTE Networks on process-studies; (d) Network of eddy-covariance flux sites (Fluxnet); (e) PAGES Pole-Equador-Pole (PEP) transects to study paleo-environmental changes.

The contributions to this Special Feature are arranged in four groups: high-latitude, mid-latitude, semi-arid tropics, and humid and sub-humid tropics.

The high-latitude research was carried out in the Alaskan Latitudinal Transect (*Jia et al*.), Boreal Forest Transect Case Study in central Canada (*Yu et al*.), and Yenisei Transect in central Siberia (*Vedrova et al.). McGuire et al*. show the power of multiple-transect analyses as biome replicates, in this particular case, for the Far East Siberia Transect, the Central Siberia Transect, the Scandinavian Transect, the Boreal Forest Transect Case Study, and the Alaska Transect.

For mid-latitudes, papers are presented on the controls of carbon and nitrogen dynamics for regions where little is known such as Patagonia (*Austin & Sala*) and Inner Mongolia (*Zhou & Wang*), and process analyses for the North American Mid-latitude Transect (*Barret et al., Murphy et al*.) with a model application (*Pan et al.). Schulze* presents an analysis of research approaches needed to study the highly fragmented landscapes of Europe and shows the importance of combining transects, experimental and observational networks with regional clusters.

As to the semi-arid tropics, *Cook et al*. unravel critical interactions between a precipitation gradient and fire dynamics in the Australian savannas and *Scholes et al*. describe the uniqueness of the Kalahari transect.

Finally, the humid and sub-humid tropics are represented by the studies of *Muridyarso et al*., who show a case of transect research application to sustainable land use in Sumatra, and *Malhi et al*., who report a new effort in establishing an efficient network and common methodologies to study forest dynamics in Amazonia.

This Special Feature was initially proposed during an IGBP Terrestrial Transects Workshop that took place in Darwin, Australia, on July 12-16, 1999. The editors thank Garry Cook for organizing that workshop.

References

Canadell, J.G., Mooney, H.A., Baldocchi, D.D., Berry, J.A., Ehleringer, J.R., Field, C.B., Gower, S.T., Hollinger, D.Y., Hunt, J.E., Jackson, R.B., Running, S.W., Shaver, G.R., Steffen, W., Trumbore, S.E., Valentini, R. & Bond, B.Y. 2000. Carbon metabolism of the terrestrial biosphere: a multi-technique approach for improved understanding. *Ecosystems* 3: 115-130.

Koch, G.W., Vitousek, P.M., Steffen, W.L. & Walker, B. 1995. Terrestrial transects for global change research. *Vegetatio* 121: 53-65.

Steffen, W.L., Walker, B.H., Ingram, J.S.I. & Koch, G.W. 1992. *Global change and terrestrial ecosystems: The operational plan*. The International Geosphere-Biosphere Programme, Report no. 21, Stockholm, SE.

Steffen, W.L., Scholes, R.J., Valentin, C., Zhang, X., Menaut, J.-C. & Schulze, E.-D. 1999. The IGBP Terrestrial Transects. In: Walker, B.H., Steffen W.L., Canadell, J.G. & Ingram, J.S.I. (eds.) *The terrestrial biosphere and global change. Implications for natural and managed ecosystems*, pp. 66-87. Cambridge University Press, London, UK.