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The sustainability principle in global agendas: implications for understanding land-use/cover change

B.L. TURNER II

Graduate School of Geography and George Perkins Marsh Institute, Clark University, Worcester, Mass. 01610, USA

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The centrality of the sustainability principle to the international agendas on environment and development raises serious research problems and opportunities. The problems are manifested in such societal objectives as 'sustainable development' and a history of human-environment relationships, suggesting that the objective constitutes a paradox. The opportunities follow from the fusion of sustainable development and global environmental change research fostered by the principle. This fusion is particularly pronounced in the study of land-use/cover change in the tropical world, a subject elevated to the forefront of the research and practitioner communities. The international agendas addressing this change, such as the IGBP-IHDP core project on Land-Use/Cover Change, promise long-term, sustained research activities that join the natural and human sciences with the research and practitioner communities. They do so, however, by requiring a scale and type of interdisciplinary and inter-perspective cooperation and coordination not typical of all human sciences, including geography. The divisive character of competing approaches and explanations of land-use/cover change illustrate this situation.

KEY WORDS: sustainable development, global change, land-use/cover change, Cassandra, Cornucopian, IPAT, social relations.

'SUSTAINABILITY' APPEARS TO BE the guiding principle for a global society entering the new millennium, superseding almost all others within the environment and development communities (IIASA, 1993; Kidd, 1992). 'Sustainable development', popularized by the Bruntland Commission (WCED, 1987), has become the most familiar concept and objective to be based upon the sustainability principle (e.g. Aniansson and Svedin, 1990; HMSO, 1994; UNCSD, 1996). What sustainable development means remains elusive, however (Lélé, 1991; Worster, 1993). The expert literature alone is filled with numerous conflicting definitions (Adams, 1990; Brady and Geets, 1994; Cruz *et al.*, 1996; Karshenas, 1994; Munasinghe and Shearer, 1995; Redclift, 1993; Torgerson, 1994; Trzyna and Osborn, 1995), within which are embedded yet more 'fuzzy' concepts, for example human carrying capacity (Allan, 1965; Brush, 1975; Cohen, 1995; House and Williams, 1975; Street, 1969). The elusive and elastic qualities of sustainable development are precisely those that resonate with a post-modern, global community. Irrespective of its inadequacies for research and practice (but see Redclift, 1993); sustainable development 'that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987: 43) is an ideal political formulation, providing the global community with the illusion of a broad, coherent consensus, within which an almost endless array of objectives may be pursued (Jacob, 1994).

Sustainable development is challenged on many grounds: as an oxymoron (O'Riordan, 1985; Paehkle, 1995; Trzyna and Osborn, 1995), a Western value from the political right (Lélé, 1991) and left (DiLorenzo, 1993), or a capitalist invention diverting attention from more pressing socio-economic issues (Jacob, 1994; Wilbanks, 1994). It may also be challenged in terms of the history of human-environment relationships (Goudie, 1994; Meyer, 1996). The defining character of that history is 'development' as increasing consumption, through escalating production, achieved by advancing technological control of nature (Ausubel and Langford, 1997; Ausubel and Sladovich, 1989; Grübler, 1994). 'Sustainable', in contrast, implies that the use of nature is in some sort of long-term balance with natural biogeochemical processes, including their flux. A nature so transformed that technological substitutes match or surpass

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nature's biogeochemistry is, by most definitions, unsustainable. In this history, development and sustainable constitute a paradox.

To produce from nature is to change nature (Warner *et al.*, 1996), and the magnitude, pace and kind of these global changes are without precedent. Many of them, be they loss in biological diversity or top soil, are global in scale or magnitude (Meyer and Turner, 1994). The rates of these changes have increased exponentially throughout this century, and remain high despite some recent reductions (Turner *et al.*, 1990). Most importantly, however, fossil fuel and synthetic technology have created a new kind of change, one in which humankind taxes the biogeochemical flows that sustain the biosphere (Turner *et al.*, 1990; Vitousek *et al.*, 1986). Nature seems poised to 'bite back' in ways that are uncertain but will surely entail considerable surprises (Duraiappah, 1993; Kates and Clark, 1996; Schneider and Turner, 1995).

The concept of global (environmental) change arises from concerns about the sustainability of an 'earth transformed' and has led to international mandates and protocols seeking to reduce the changes in question, e.g. Berlin mandate (FCCC/CP, 1995); Montreal protocol (UNEP, 1987); Agenda 21 (UNCED, 1992). It complements sustainable development by elevating issues of 'sustainable' to the biosphere itself and those of 'development' to humankind over the long term (Clark and Munn, 1986). And like sustainable development, global change has its critics. A few challenge the evidence for climate warming induced by human actions (Balling, 1992; Lindzen, 1994); others question the priority of global change interests relative to the needs and concerns of the have-not world (Agarwal and Narain, 1991; Sachs, 1993). Yet another challenge is caricatured in the Cassandra-Cornucopia debate (Ehrlich and Holdren, 1988) which continues to resurface, returning us to the sustainable development paradox (Kates, 1995; Meyer and Turner, 1997).

Cassandras worry that human impacts on the environment are approaching a condition (global change) that threatens the biogeophysical foundation of life (Daily and Ehrlich, 1992; Meadows *et al.*, 1992; UNPF, 1993). Alarm is justified in order to encourage societal consideration and responses that may alter the projected paths towards these threats (Luten, 1980; Warner *et al.*, 1996). The Cornucopian position, in contrast, draws from the history of human-environment relationships in which the great forces of technological change continue to increase nature's bounty, or substitutes for it (Simon, 1990; 1996). This history is ripe not only with environmental changes, but also with human adaptations to them (Ausubel, 1991). By extension, global change should be no exception.

Cornucopians thus 'resolve' the sustainable development and global change paradox by relegating the role of nature relative to technology and implicitly changing the meaning of sustainable to that of 'sustaining human inputs'. Cassandras reinstate and strengthen the paradox by 'raising the stakes' of the nature being changed to the basic global functioning of the biosphere – beyond human control.

Global change and sustainable development thus blur through the lens of the sustainability principle (Zimmerer, 1996) and the paradox it fosters. Local and regional problems of sustainable development are linked to global change, and global changes feedback on sustainable development. The impacts of these dynamics promise to be especially difficult for the have-not tropics where people and places are least empowered to deal with them (Adams, 1990; Posey, 1996), and where both sustainable development and global change focus on land.

Land-use/cover change in the have-not tropics

The economy of the 'have-not' tropics overwhelmingly relies on land-based resources for everything economic, from foreign exchange and debt payment, to basic subsistence. These resources are threatened by a cascading set of forces, many of which play out in complex arrangements that are well beyond the control of local land managers and are often spatially distant from them. For example, as crude as general circulation models may be, they consistently indicate that cultivation in the tropical world will suffer most from a 2°C rise in global temperatures, and benefit least from the fertilization effect of a doubling of atmospheric carbon dioxide (Parry *et al.*, 1988; Rosenzweig and Hillel, 1993; Rosenzweig and Parry, 1994). Such warming, if it happens, is driven primarily by 'greenhouse gases' released from industrial production and consumption in the mid-latitudes. Even the greenhouse gas contributions from the tropics, delivered through deforestation, for example, are traceable in part to such exogenous forces as international markets and debts (Darwin *et al.*, 1996; Brookfield *et al.*, 1995; Kummer, 1992).

Land-use/cover change in the tropics thus carries significant implications for various international conventions dealing with the abatement of global change (UN General Assembly, 1992). Many of the 'hotspots' of land-use/cover change, especially deforestation, are located in the tropics (see Ives and Messerli, 1989; Myers, 1988), contributing to the release of carbon, methane and particulates (from biomass burning) to the atmosphere, and to changes in albedo (Houghton and Skole, 1990; Meyer and Turner, 1994). Land-use/cover change, largely underway in the tropics, is also linked to changes in the global hydrological cycle through impacts on the Walker circulation (Henderson-Sellers and Gornitz, 1984). These changes operate regionally as well, as in

the case of tropospheric pollution from the rise of urban-industrial complexes in the have-not world (Ezcurra and Mazari-Hiriart, 1996), complete with feedbacks on soil toxicity and agricultural production (Chameides *et al.*, 1994).

To these impacts are added yet others that are unique to the tropics. Possessing the overwhelming majority of the world's biotic diversity (Wilson and Peter, 1992), for example, changes in tropical land cover obviously have important consequences for loss in biodiversity globally (Zimmerer, 1996). Concern also mounts about changes in disease vectors created by tropical deforestation as well as the spread of unknown pathogens released by the magnitude of human penetration into these forests (Walsh *et al.*, 1993).

Much tropical land is also embroiled in controversy over its suitability for sustained, intensive use and the degradation that may follow (Brookfield and Padoch, 1994). Various assessments of sub-Saharan Africa, for example, suggest that intensive cultivation is restricted to a few places with high quality soils – areas already stressed by occupance and use – and attempts to intensify beyond these enclaves are not likely to achieve economically or environmentally sound results (Lele and Stone, 1987). Experiences elsewhere in the tropics show greater variation in potential uses, although the majority of these question intensive uses predicated on mid-latitude practices (see Brookfield *et al.*, 1995; Hecht and Cockburn, 1989; Smith *et al.*, 1995).

It is tempting to ascribe the many examples of abandoned 'frontier' farms, environmentally degrading farming practices and cases of agricultural involution or stagnation throughout the tropics, largely to the special kind or level of environmental conditions present there. It is difficult, however, to assess the sustainability of intensive land uses divorced from the political economy in which the uses are embedded. In many cases, the user receives few economic benefits but all the environmental consequences (Blaikie and Brookfield, 1987; Solbrig and Young, 1992). An alternative interpretation suggests that where the socio-economic environment is not excessively restrictive, many examples of sustainable intensive cultivation can be found in the tropics, even under extreme land pressures and poverty (Boyce, 1987; Pingali *et al.*, 1987; Tiffen *et al.*, 1994; Turner and Ali, 1996; Turner *et al.*, 1993). There are, of course, winners and losers in these conditions, a consequence that tends to fracture the research and practitioner communities.

One way forward

International and interdisciplinary programmes and agendas identify the need to unite the sustainable development and global change communities through research on land-use/cover change (see UNCED, 1992; IAI, 1996; TEACOM, 1996). Perhaps the most mature of these efforts is the IGBP-IHDP core research project on Land-Use/Cover Change, or LUCC. The LUCC core project is planned around three research foci seeking to integrate a large range of research interests, questions and approaches towards an improved understanding of the complex patterns of the human and biophysical causes (Turner *et al.*, 1995). Causes are emphasized because understanding them is the base from which can be built theories of change, impact assessment, strategic planning, models, and projections. Recognition of spatio-temporal diversity brings the unit of analysis to sub-global and sub-continental scales, referred to as the region.

LUCC affords the opportunity to join the development community's concern with individual and household equity and empowerment with those of the environmental community on human use and its biophysical impacts. It also seeks to join the many scales of analysis employed in both communities and the many perspectives brought to bear on problem-solving, from the narrative to models and projections. The following examples of LUCC-associated projects illustrate this objective.

The Miombo project examines changes in the wooded savannas in southern Africa, linking the dynamics of household resource uses with environmental impacts and regional biophysical processes. SARCS (Southeast Asian Regional Committee for START – Global Change System Analysis, Research and Training) seeks to understand the regional variations in tropical deforestation, complete with the structural and behavioural dynamics creating the various patterns. The LUC (Land-Use Change) project of IIASA (International Institute of Applied Systems Analysis), accompanied by the National Institute for Environmental Science (Japan), is midway through a case-study-based assessment of changes in Russia, China and Japan leading to regional models of socio-economic drivers of them. Both Miombo and SARCS link their environmental change interests to development implications, and the products of LUC-IIASA are intended for use in planning as well as global change assessment.

These and the other LUCC-related efforts underway or in planning worldwide provide an opportunity that does not come frequently to the human sciences – to engage on an equal footing with the natural sciences in a large-scale and sustained research effort, built as it is around many kinds and sizes of individual projects. The emergence of LUCC and other such programmes is a recognition by the research and practitioner communities that complex and inter/inner-related issues cannot be adequately resolved by core disciplinary approaches alone and that the most difficult but most critically needed improvements in our understanding come from flows

across our core domains of study. LUCC is also an explicit statement by the global change community:

1 that global environmental change involves far more than potential climate change or loss in biotic diversity worldwide;
2 that human agency and societal structures operate synergistically in complex and various ways with nature to create this change and the responses to it; and
3 that an improved understanding of the dynamics involved, complete with their implications for sustainability, require a strategy of study and assessment far more ranging than that which has typified the history of the research community at large.

The practice of LUCC will not be easy, for it requires not only the joining of the natural, human, and remote sensing sciences, as noted in the editorial introduction to this set of papers (Batterbury *et al.*, 1997); it also asks that we cooperate beyond core perspectives. This exercise implies a mode of cooperation that strains the intellectual base on which many of these communities are constructed.

An opportunity taken?

The largest uncertainty in the LUCC programme and related efforts, therefore, may be the willingness of the human sciences, including geography, to respond adequately. The traditions of problem-solving in this community rest in small, independently-defined research, not in large, integrated efforts defined beyond the individual researcher. This second kind of research, common to the natural sciences, arouses suspicion within many human sciences, which seem to dismiss the biases in problem formulation and solution that follow by focusing heavily on their favoured scale of study.

The more important hurdle, however, is the tradition of operating within core or tribal perspectives, the aim of each being to establish explanatory hegemony in part by collapsing the intellectual foundations of the other (Turner, 1997). Batterbury *et al.* (1997) call for the study of environmental transformations in developing countries that integrates, or at least respects, the many perspectives and interests involved. This lofty and much-needed goal, however, contrasts with the history of behaviour in geography and the human sciences as well as the many competing perspectives that define postmodernity (Guba, 1900). Two examples illustrate these tensions.

The first example addresses the basic interest and approach to land-use/cover change in the have-not tropics. To simplify, the many variations are collapsed into two interests, or approaches: opportunities and behaviour, and constraints and structure. The constraints/structure approach places issues of equity, equality and empowerment at its research centre and ties land-use/cover change to them. Its practitioners usually attribute individual and group variance in these issues to some flaw in social relations – typically an exogenously derived 'ism' (e.g. imperialism, colonialism, capitalism) and its associated structures that differentially empower by class, gender, or ethnicity (Lélé, 1991; Peet and Watts, 1996; Rocheleau *et al.*, 1996; Watts, 1985; 1991). Land-use/cover change follows from the unempowered forced onto marginal lands or into land-degrading practices, and from the empowered who take over prime land for commodity production. In contrast, the opportunities/behaviour approach focuses on the operation, production and efficiency of the land-use systems. Its practitioners explain these attributes in terms of endogenous adaptations and adjustments and the decision-making dynamics in which they are embedded (Pingali *et al.*, 1987; Hayami and Ruttan, 1985). Land-use/cover change is typically seen as driven through increasing or decreasing levels of intensity. Land degradation under intensification is related to process thresholds (Turner and Ali, 1996) in which inefficient users are rooted out of the system, while in disintensification it follows from the demise of *landesque* capital and other inputs that sustained the system in transition (Blaikie and Brookfield, 1987).

The human causes or driving forces of land-use/cover change – viewed quite differently by the two core approaches – provide the second example. To simplify again, those seeking general patterns based on empirical relationships find them in the IPAT identity, while those seeking more nuanced and/or theoretical-based understanding find them in social relations (broadly defined). The IPAT 'identity' developed out of the Holdren-Ehrlich (Ehrlich and Ehrlich, 1990; Holdren, 1993) debates with Commoner (1972) and states:

$$I = P \times A \times T$$

where I is environmental impact (e.g. land-use/cover change);
P is population or base species needs;
A is affluence or *per capita* consumption;
and T is technological efficiency of production and consumption.

The power of the identity rests in the fact that P, A and T are virtually the only variables that track quantitatively with environmental changes at macro-spatial and temporal scales or within large cross-site assessments (Kasperson *et al.*, 1995; 1996; Meyer and Turner, 1992), perhaps because they serve as surrogates for resource demand.

An identity is not an explanation, but the visibility of IPAT draws attention to PAT as the cause of changes in land-use/cover and other environmental

change (Bilsborrow and Okoth-Ogendo, 1992; Dietz and Rosa, 1997; Rudel, 1989). Population, of course, receives the most attention, manifested in the many high-level, international efforts pinpointing it as a key concern for societal well-being in general, especially in the have-not world (FAO, 1984; PAI, 1996; UNPF, 1993). Affluence is increasingly identified through the have-not world's response to global change agendas (Agarwal and Narain, 1991; Kasun, 1988). Technology has not received the same level of attention, despite its role in resource procurement, consumption costs and waste.

Social relation-based explanations are grounded in societal structures, whether they are offered as post-structural narratives or structural theory. The variations in these structures foster analysis in places and regions (Blaikie and Brookfield, 1987; Leach and Mearns, 1996), the case studies of which indicate that PAT is commonly subservient to a myriad of other factors and relationships that trigger environmental change (Arizpe *et al.*, 1994). More often than not, these factors involve changes in policies or institutions affecting settlement, land use, resource extraction or waste treatment and are linked to debt payment or foreign exchange programmes, penetration of international corporations into locales with weak or corrupt enforcement of environmental/resource laws, weakly empowered segments of society with few, if any, alternatives, or powerful local producers capable of influencing the very structures in which they operate (Kasperson *et al.*, 1995; 1996).

These structures, in turn, may operate in nested orders or hierarchies and thus can be linked across scales of analysis, but they also operate in complex, coupled ways that make each case unique. The way that the factors play out is contingent on the nesting order and coupling mechanisms, as in the case of common property (Ostrom, 1990; Robbins, 1997). For these reasons, the social relations approach (excluding neo-classical economics) tends not to foster strong empirical relationships in cross-site or aggregate analyses, but provides linkages in global and local contexts.

Neither of the two approaches (opportunities/behaviour and constraints/structures) nor the two explanations (IPAT and social relations) – as well as the many variants of each – proves superior over the other for understanding land-use/cover change, because each offers robust outcomes if appropriately applied. It behoves the human sciences, therefore, to explain more fully the meanings and implications of each and identify those conditions in which either is more vigorously applied. Unfortunately, researchers tend to anchor themselves so firmly in one approach or explanation that they become inimical to or unappreciative of any others, inhibiting the integration called for by Batterbury *et al.* (1997).

Summarizing the argument

The sustainability principle has been accepted at the highest levels of decision – and policy-making. Woven into the fabric of international agendas, it blurs the distinctions between environment and development and fosters a fusion of sustainable development and global change research. This fusion, however, creates a paradox that may be resolved only by reframing the meaning of sustainable and, hence, the sustainability principle.

The paradox is especially obvious in the have-not tropics where development involves the transformation of land, complete with its ecosystem, biodiversity and biogeochemical impacts. Thus the international agendas on environment and development recognize the significance of land-use/cover change and support various research agendas so defined, the most mature of which is the IGBP-IHDP core project on LUCC. Such research is predicated on serious interdisciplinary cooperation and promises opportunities for the human sciences to engage in large, international research efforts that have long been the domain of the natural sciences. The willingness of the human sciences fully to engage such opportunities is called to question on several counts, the most important of which may be a legacy of intellectual divisiveness among competing perspectives that hinders the kind of cooperation and coordination on which the new international agendas are based.

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