

Landscape-scale research for conservation and development in the tropics: fighting persisting challenges

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Landscape approaches have been identified as a way to address conservation and development issues in biodiversity-rich tropical areas. The author conducted a literature review of 51 case studies selected by an independent analyst to evaluate how these approaches have been applied. The case studies are categorized and assessed against their objectives, scales and methods. The review highlights imbalances that favor analyses of conservation over economic outcomes and a still unmet need to provide practical solutions for analyzing the multidimensional factors affecting tropical forests at landscape scale. Applications of landscape approaches still face challenges: Simple landscape assessment tools are needed as well as a framework to allow for monitoring and comparing studies, landscape, and national initiatives. Recent research has addressed some challenges through an increased focus on learning processes and tools for adaptive landscape management.

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Introduction

The increasing concerns for nature conservation during the 20th century led to many interventions designed to protect biodiversity-rich forests in tropical countries [1,2]. However, negative trends of ongoing deforestation and biodiversity loss have continued in the tropics during the past two decades [3,4]. Deforestation rates are not decreasing in tropical forests [5] and biodiversity hotspots appear under-protected [6]. Nowadays, concerns about climate change may provide additional incentives and increasing funds to support research and action to conserve natural ecosystems. Scientists and practitioners need to reconsider lessons learnt from conservation and development (C&D) experiences in developing countries

and to renew efforts to influence landscape trajectories in more biodiversity-friendly ways.

The Integrated Conservation and Development Projects (ICDPs) of the 1980s considered the integration of local livelihoods in their interventions as a necessary condition for conservation success. Despite project efforts to collaborate with local populations, several reviews of ICDP experiences concluded that outcomes were disappointing in view of their ambitious goals [1,2,7–9]. A thorough, systematic evaluation of the success of conservation efforts [10••] is lacking, but it is now broadly accepted that purported ‘win-win’ synergies between natural forest conservation and poverty reduction have been rare or perhaps illusory [11,12]. Wells and McShane [8] have highlighted the complex realities in which ICDPs were operating and the unrealistic expectations placed on these interventions. More than being conceptually flawed, implementation of ICDPs, and rural development projects more generally, failed because of project limitations in area, time and numbers of beneficiaries, amongst other reasons. The debate about human welfare and biodiversity conservation goals remains timely and guided more by dogma than by science [13]. The emphasis has today shifted toward highlighting tradeoffs between conservation objectives and economic interests [14•], and negotiating options to minimize conflicts between them.

Local participation remains widely seen as a central condition for sustainable management of tropical landscapes: Involving local stakeholders and, where possible, encouraging them to lead the process, is more likely to produce positive conservation outcomes [15]. ‘Integration’ remains an important topic on research and conservation agendas if only because it is conceptually appealing while lacking operational instances. For example, the ecosystem approach adopted by the Convention on Biological Diversity [16] seeks ‘the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way’, thereby combining C&D concerns with that of equity. The Consultative Group for International Agricultural Research (CGIAR) has promoted Integrated Natural Resource Management (INRM), a framework of four interrelated sets of linkages: ‘(i) links between productivity enhancing and resource conserving research, (ii) spatial or landscape level linkages, (iii) temporal linkages and (iv) linkages between research and the diffusion/adoption of research results’ [17].

We use the term ‘landscape’ in relation to the landscape ecology paradigms. Troll ‘envisioned landscape ecology

as the integration between ecological and geographic disciplines, and defined it as ‘the study of the main complex causal relationships between the life communities and their environment’ which ‘are expressed regionally in a definite distribution pattern (landscape mosaic, landscape pattern)’ [18,19]. A landscape is a spatial configuration of patches of dimensions relevant for the phenomenon under consideration [20]. It is generally defined as a geographical construct that includes not only biophysical features of an area but also its cultural and institutional attributes [21,22], though some landscape ecology schools (e.g. USA) have mainly focused on ecological aspects. It has a cognitive dimension and has been described as a ‘piece of land that we perceive comprehensively around us, without looking closely at single components’ [23]. For our argument, a ‘landscape approach’ describes activities that foster sustainable natural resource management by considering spatial and socio-economic interactions of ecosystems and different stakeholders in a specific geographic area. ‘A landscape approach should:

- Build multidisciplinary teams to tackle complex, intersectoral landscape-scale problems;
- Provide a framework for negotiations between stakeholders who have different views of desirable landscape-scale outcomes;
- Identify key leverage points to change the ecosystem or landscape in desirable ways;
- Establish a flexible monitoring and evaluation system to monitor and measure impacts on the landscape to allow for changes to be made in implementation.’ [22]

Landscape approaches are appealing because of their possible role as pathways for action thanks to their focus on the links and interactions between decentralized governance systems, actors and existing natural resource management activities [24]. Conservation agencies such as the International Union for Conservation of Nature (IUCN) have formulated ways of integrating landscape perspectives into forest conservation [25,26]. The World Bank [22] is likewise promoting landscape approaches in its forest sector programmes. After a brief infancy, these new approaches have become the subject of review in the scientific literature [27,28].

The landscape approach seems an ideal framework for embracing the complexity of putting conservation and development into practice. Nevertheless, researchers and practitioners pose questions about its application and practicality. Many struggle with the fuzziness and complexity of the associated concepts and look for how to implement a landscape approach on the ground. One misunderstanding may lie in its multiple dimensions: ‘landscape’ can refer to spatial and ecological characteristics that help define conservation and development targets or it can refer to social interactions and mechan-

isms that minimize C&D tradeoffs and develop adaptive management strategies [29].

We are exploring here the state of knowledge on landscape approaches for mitigating tradeoffs between conservation and development. Our work is based on a literature review¹ of case studies related to landscape approaches and our own recent landscape-scale experiments. We examined a broad body of existing research to have sufficient cases: 51 cases of landscape-oriented research and action were collected from 45 articles and chapters, 32 published in the past 5 years, 9 in the past 10 years and 4 from previous years.

The review was conducted with two main search criteria: ‘case study’ and ‘landscape approach’, without considering the origin of the case studies. Results included 15 cases from developed countries. To avoid personal bias, the selection was undertaken by a consultant, Lisa Raitzer-Svensson, an agricultural economist. The review was based on this question: What are the main objectives and characteristics of current applied landscape-scale studies? On the basis of recommendations that have emerged from ICDP reviews, the following questions were also used to guide this paper:

1. What are the scales used in landscape-level research (and approaches)? How are they defined?
2. Does the selected landscape-scale research and case study examples help
 - (i) to balance C&D objectives?
 - (ii) to take vertical integration into account?
 - (iii) to improve stakeholder participation and support adaptive management [30]?

The case studies were first summarized, then scored from 0 to 3, according to the thematic and spatial foci of the data used and of the recommendations. The following categories were used for the scoring:

- **Biodiversity conservation and economic development**
- **Ecosystem or local scale and eco-regional or national scale**

The consultant and the author scored the articles with similar results in more than 80% of the evaluations. All diverging marks were re-evaluated before obtaining a definitive value.

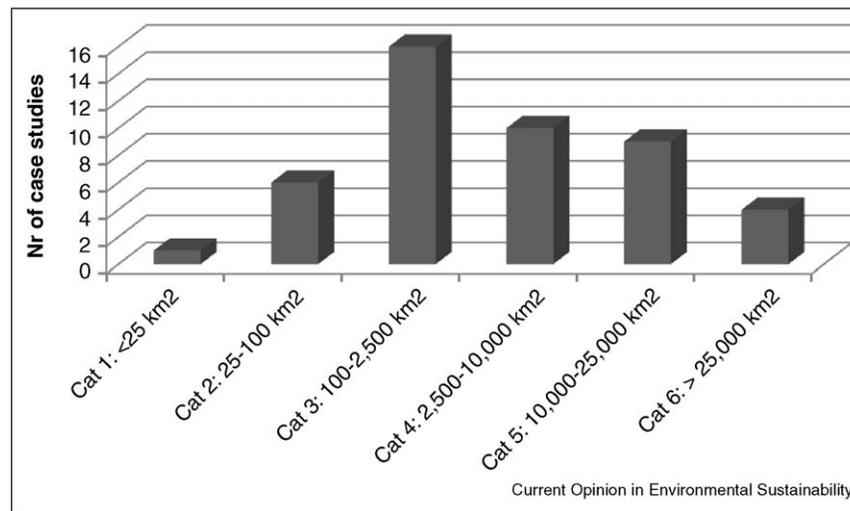
Current types and application of landscape research

Landscape areas and boundaries

The physical scale of the reviewed studies is highly variable, although most cluster at a scale of 100–2500 km², and

¹ The method description, list of references and more information are linked online in an appendix to this article.

Figure 1



Number of case studies by surface categories.

more than 50% fell in the range 100–10,000 km² (Figure 1). This variability is understandable, given the many different and site-specific research questions. It is however a direct effect of the fuzziness of some concepts and of the difficulty to assign boundaries to landscapes because of the above-mentioned issues of the cognitive components: ‘my’ landscape is different than yours (because I am bigger or live longer or have different interests). The 100 km² scale represents a lower limit for effectively integrating anthropogenic and ecosystem processes while still being connected to an administrative unit for addressing decision-making processes [30]. In the few studies involving areas smaller than 100 km², scientists observed ecological components of the landscapes. These studies resorted more to classic ecology than to landscape ecology. Most landscapes included in the larger categories, greater than 10,000 km², covered larger administrative entities (regions, provinces) or large, distinct protected areas or complexes, generally located in large biomes.

The various reasons given for delineating landscape boundaries in the reviewed studies provide an insight into the scope of the research: 18 landscapes were defined according to their protected area or reserve status; 12 corresponded to administrative units; 8 were mapped according to management units such as forests and rangelands; 3 related to watersheds; and 2 were delineated with regard to cultural aspects. Decentralized administrative boundaries (such as districts, communes and technical operation units in Cameroon [30,31]) were targeted at the outset to ensure relevance of research outputs for decentralized decision makers. Understanding the landscape spatial differentiations as well as the local governance or livelihood conditions require the use of subunits for more in-depth research: subdistricts, corridor areas or research

gradients help in analysis of social and spatial interactions [29,32].

Balance between conservation and development considerations

Most studies reviewed focused on conservation issues rather than on development ones. Though half of the landscapes studied were linked to management or administrative units, they still focused on conservation issues. More than one-fifth of the studies took no account at all of economic issues (Figure 2). In almost all cases linked to production forestry, the focus given to production was balanced with conservation considerations.

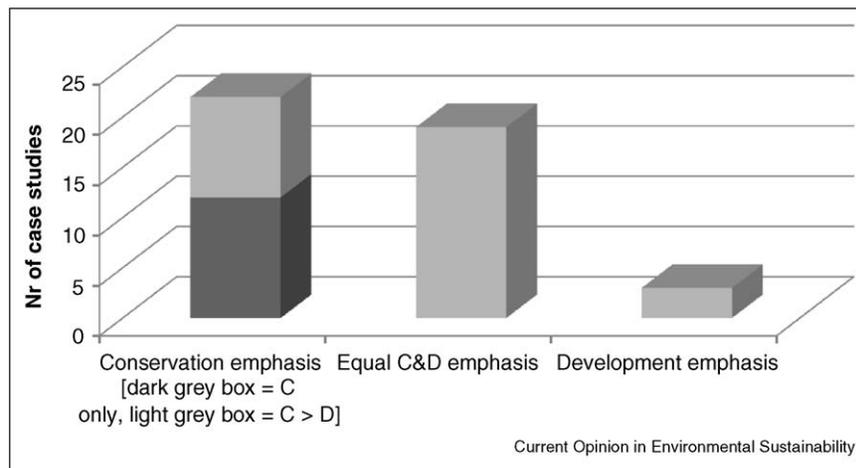
Vertical integration and influence at national level

The studies reviewed demonstrated an unbalanced emphasis on local data and recommendations; broader scales of analysis were uncommon. This might indicate a lack of attempts to link landscape-scale and local-scale research to policy issues at scales at a higher order. ‘Landscape scale’ research appears still to face scaling-up issues as scientists have not yet developed a systematic comparison framework. Messerli *et al.* [33^{*}] present a new way of defining landscape mosaics based on satellite images from the national level downward, and combine this information with population census data. Such integrated top-down approaches, combined with bottom-up studies based on sound ground-truth, should improve our ability to link landscape patterns to socio-economic realities.

Integration of various stakeholders and support to adaptive management processes

Although 8 studies did not consider the issue of stakeholder involvement at all, most articles emphasized its

Figure 2



Number of case studies according to their emphasis on conservation (C): and/or development (D).

importance. Several even focused on ways to foster dialogue and build consensus among stakeholders, and in so doing highlighted the crucial role of decentralized institutions.

Few applied experiences focused directly on adaptive management [34], but most research outputs and recommendations could serve as a knowledge base for 'seeking or muddling through to a better long-term situation' [35], using an adaptive management process. These outputs were related to tools (conservation planning, modeling and spatial monitoring) or to ways of managing C&D tradeoffs, notably land use planning issues.

Given that much science appears generally as difficult to apply [36], a surprising finding was that most of the case studies selected were designed to support decision making and practical issues. Only two of 47 evaluated cases did not describe the potential application of their findings.

What is needed to make landscape research more useful and practical?

Clearer understanding of landscape research and combination with management objectives

One objective of this review was to understand what has been undertaken under the heading of landscape approaches and research, particularly because practitioners in tropical landscapes are confronted to new research types. Landscape-related research conducted over the past decade (Table 1) is widely spread across the whole spectrum of disciplines and types of research. More research types could be added, such as meta-research on ways to translate research into practice [37,38].

This wide range of interpretations of what landscape approaches mean for researchers might reinforce the

confusion for non-specialists and practitioners. To strengthen the role the landscape concept can play in shifting from disciplinary to cross-disciplinary and from local to international research, researchers can simplify discourses and reduce the complexity of the research scope. One possibility (see Table 1) is to link the type of landscape research directly to those management levels or policy issues that it aims to influence.

Landscape assessment, planning and monitoring tools and appropriate skills

The use of the landscape concept in planning and management helps to integrate various natural and management systems, and to link various disciplines and levels. It is thus an integrating approach that ensures spatial consideration of C&D tradeoffs and works with the complexity of the socio-ecological interactions, particularly in the context of conserving biodiversity and tropical forests [39]. Figure 3 illustrates three axes on which a landscape approach can serve as an integrative support: a horizontal axis for spatial integration of various socio-economic objectives and disciplines, a vertical axis linking local to national institutions, and a temporal axis linking to past experiences and envisaging future trajectories.

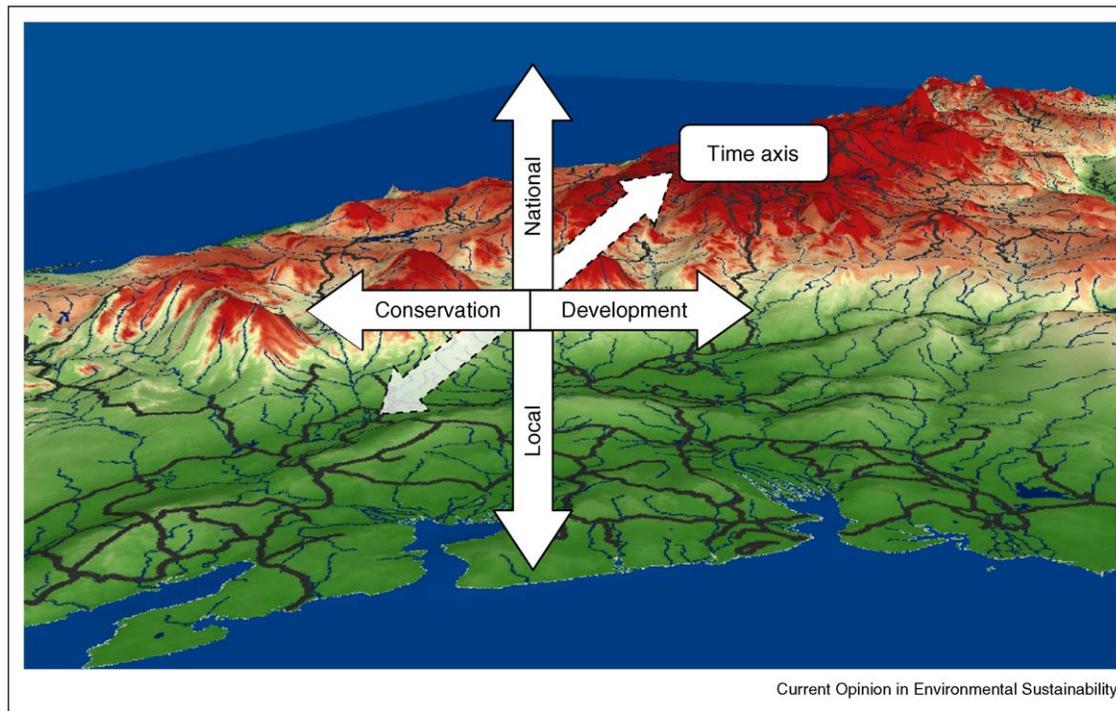
A balanced 'rapid landscape assessment'

A known risk of analysis that uses several disciplines is that the research can get lost in the complexity. Practitioners can rely on an open exploratory or reconnaissance phase to get a feel for the issues [39], but a minimal common dataset for comparable 'rapid' landscape assessments would be useful for several reasons, particularly the potential for replication and dissemination. Studies based on information required for conservation, forest and natural resource management could be used to design a landscape assessment tool [40,41]. Landscape-scale

Table 1**Categories of landscape research observed in the literature review**

	Use of the landscape concept ...				
	... in relation to paradigms of political ecology	... as a governance and political arena	... as a management unit	... as an integration level	... as a spatial (ecological) reference
Management levels	Generalization – theories	Normative level: definition of societal choices	Strategic level: <i>effective management</i> (do right things)	Operational level: <i>efficient management</i> (do things right) according to social, economic and ecological contexts	Operational level: knowledge-based management according to spatial patterns and processes
Research type	Theoretical research	Governance- and value-oriented research, linked to participation, rights and institutions	Management-oriented research (territorial planning and natural resource management processes, often transdisciplinary)	Integrative research (often interdisciplinary and related to C&D tradeoffs)	Spatially differentiated research of landscape sub-systems or components (often disciplinary)
Assessment and analysis methods	Areas of inquiry of political ecology	Remote sensing, GIS and modeling, literature review, rural appraisal, project/program evaluation, policy analysis	Interviews (local knowledge), group discussions, empowerment, secondary data analysis, vegetation surveys, hydrologic analysis, economic and energy efficiency, land tenure analysis, participatory mapping, management experiments, GIS, modeling, decision support software, workshops	Interviews, vegetation and wildlife surveys, secondary data analysis, economic valuations, rural appraisal, qualitative evaluations, retrospective analyses, modeling	Remote sensing, GIS (time series, cost-distance connectivity, landscape metrics), water quality, vegetation and wildlife surveys, habitat and ecotope mapping, statistics (PCA), modeling,
References (see Appendix)	39, (45)	1, 25, 31, 36, 38, 41, 42, 43, 45	2, 5, 6, 7, 9, 12, 14, 15, 19, 28, 29, 35, 40	3, 8, 13, 20, 24, 27, 33, 34, 37, 44	4, 10, 11, 16, 17, 18, 21, 22, 23, 26, 30

Figure 3



The landscape is a spatially explicit and integrative concept; landscape approaches take into account changes to the landscape over time.

information that would support C&D planning includes: (i) spatial C&D differentiations in order to adapt planning to socio-economic effects of accessibility and ecological connectivity [42]; (ii) social interactions within the landscape, especially local participation in INRM decision making; and (iii) risks of abrupt changes in land use, for example, those driven by external investments.

Landscape approaches are still mostly presented by conservation interests, and are thus perceived as being driven by these same interests. Adopting an evident conservation perspective at the outset may weaken the whole approach if influential economic actors and decision makers infer they are sidelined. Tools that help address economic concerns while taking account of conservation interests are clearly needed (Box 1).

From the literature review and an additional case study in Kalimantan [43], research on production forests generally combined data on conservation as well as production. Several studies have focused on linking ecosystem services to market values [for example, [44]]: economic information should be systematically considered in landscape appraisal.

A broad understanding to choose priorities and manage concerns of multiple stakeholders

After a broad and integrated landscape assessment, open to both local and external institutions, there is a need to

Box 1 Conservation and development in Malinau (by Patrice Levang, CIFOR)

Boedhihartono *et al.* [43] describe in 2007 attempts to reconcile economic development with environmental conservation in the district of Malinau, a forest area in East Kalimantan, Indonesia. Both district government and conservation organizations have subscribed to the rhetoric of pursuing development pathways that would be sustainable and would conserve the rich biodiversity of the area. Three distinct approaches to conservation have been attempted. First, spatial planning has been used to attribute land to different uses and particularly to identify and designate protected areas. Second, measures have been taken to lessen the negative environmental impact of industrial logging and to promote the preservation of biodiversity in logged forests. Last, decentralized and community-based management has been promoted on the assumption that this practice would yield better environmental and social outcomes than large-scale industrial development.

A few years later one must admit that conservation has made little contribution to development and development has proceeded with little regard for the conservation of forests. Spatial planning did not resist pressure from coal mining and plantation companies, and even long-term experimental plots are in jeopardy. The adoption of reduced impact logging techniques has been limited to a handful of big logging companies. Last but not least, local people see conservation as something that will provide them with few benefits and limits their development options. Most decisions, from the household to the central government, are driven by the desire for short-term financial gain. The international community needs to be aware that any conservation project that limits the development options of local people is deemed to failure in the absence of adequate compensations.

reduce the complexity for effective problem-solving. This can be realized by identifying the principal processes, pathways, and elements, then disaggregating the landscape complexity according to selected common concerns and issues. Several priority-setting tools exist, but it generally remains difficult to select issues that (i) concern most stakeholders, (ii) link biodiversity conservation and livelihoods and (iii) are within the competencies of the support or research team. In most cases, multidisciplinary teams are needed and collaborative approaches [45] have proved efficient for adaptive management but, again, difficult to build [46], especially if only for a short-term exercise.

Collective planning and action

At the landscape level, participation and consensus building passes from community meetings to multistakeholder forums. Advances are being made with developing and testing tools for building scenarios. These are being used to facilitate negotiations about future landscape designs as well as about monitoring landscape changes [47–49]. The use of the livelihoods and assets framework [48], while interesting for its comprehensiveness, is not entirely convincing in practice. The assets are so inter-linked that the framework can easily confuse participants. More discrete categories of indicators, such as the classic pillars of sustainability, economics, sociology and ecology [49], are likely to simplify the assessment process but that framework would need to be complemented by information management and governance aspects. Governance failures were one of the problems experienced in ICDPs and remain an important issue for implementation. Public monitoring and open assessment can help limit failures [50].

Multistakeholder negotiations are needed to reach agreement on landscape management, but how is this done officially? We lack existing multisectoral platforms and procedures. New forums could be established, but the decisions they take generally must be formally endorsed. Integrated water resources management, among others, was heavily criticized [51] because of its failure to link with administrative realities. Most existing institutions, set up to deal with a specific sector, cannot act beyond their competencies nor embrace all the interrelated issues. The way to organize negotiations presents another problem. Even if participatory tools have been developed and widely disseminated at community level, they need to be adapted or new ones developed for work with decentralized officials. Recent research on leadership concepts might help conservation scientists or advocates work better with decision makers [52*].

Incentives, partnerships and the courage to ‘learn by doing’ in the longer term

The socioeconomic dynamics and political interactions of landscapes are complex to understand and can be opaque to outsiders. If the assessment is complicated and requires

specific competencies then, once recognized, steps can be taken to incorporate them. Skills to facilitate stakeholder negotiations have to be mobilized in developing countries. Once consensus has been reached, external funding will still be needed in most cases to support long-term involvement and monitoring [30]. Until now, development aid agencies have been unwilling to be engaged in one place for too long. As an alternative to standard projects, direct payments or other compensations schemes for biodiversity services are proposed. Unfortunately, effective mechanisms are still linked to exceptional cases and the recent landscape labelling ideas are still in their infancy [53]. Biodiversity conservation might be linked to reduced emissions from deforestation and forest degradation (REDD) mechanisms if conservationists and foresters become more proactive in this debate [54]. Direct payments, conservation contracts or aid funding remain needed, and we must admit that development agencies and C&D specialists seem more focused on international negotiations than on ways to *actively* support local people to transform landscapes. This is a pity now that multidisciplinary approaches are rightly praised.

Conclusion

Landscape spatial *scales* vary from around 100 to 10,000 km² and beyond that in particular cases. Landscape governance *levels* are generally linked to decentralized land use planning entities and are important to consider because they link local village and community rules to higher policies. Until now, landscape *approaches* have amounted to little more than a combination of spatial and integrative assessment tools and a series of principles primarily based on empowerment and social learning. Promoters of the landscape approach acknowledge that many features ‘are unchanged from earlier integrated rural development, integrated conservation and development, and ecosystem approaches to solving complex rural problems’ [22]. Sayer [26] concludes, ‘since there is still little evidence of the success of such approaches, they should be used cautiously’.

For several reasons, landscape approaches may still look impractical to many practitioners in developing countries: they are complicated and at times inaccessible to those who would use them; they are still overly influenced by conservation objectives; they do not consider sufficiently the limited means and the sectoral nature of the institutions currently influencing landscape management in tropical areas. Nevertheless, considering the added value that adaptive management processes could bring to landscape planning in tropical countries, a more systematic data collection at a landscape scale, as suggested in a recent review [27], would support the establishment of baselines and the launching of monitoring standards.

This literature review distinguished four major types of research supporting applied landscape approaches:

research focusing on landscape patterns and related ecological processes, on integrative landscape assessment, on landscape management planning and finally on ways to support landscape governance. In the complex situations of developing countries, research methods (see Table 1) for adaptive management that will be the most useful are related to spatial planning, including connectivity and tenure issues, livelihood monitoring and all mechanisms that will support landscape governance, such as companion modeling in some cases and decision-support tools more generally.

Progress has been made on designing landscape planning approaches, especially from a conservation perspective. Two main issues still hamper progress. First, the need for sufficient time and trust to develop the necessary local enabling conditions. Allied to this is the difficulty of securing long-term funding. Second, the need for new conceptual and thematic competencies to help define and implement interventions in complex landscapes. Integrated assessments are limited not only by inadequate competencies but also by the lack of existing multisectoral platforms and procedures where binding decisions can be made and effective monitoring conducted. Empirical evidence that integrated landscape approaches may work is lacking, but one can question why so few pilot experiences are attempted and fewer still extended into the longer term.

Finally, scientific progress might emerge from two potentially interacting levels:

- Fundamental or theoretical research on complex socio-ecological systems, especially on cross-scale cycles as illustrated in the panarchy model [55].
- From applied experiences allowing a far more direct and continuous relationship between research and conservation and development interventions. Future interventions will need to be planned with more transparent assumptions and clearer hypotheses than in the past, and monitored accordingly. Given the complexities and uncertainties inherent in developing tropical landscapes, the risk of failure will have to be recognized and accepted by donors and other stakeholders. Scientific institutions must develop more appropriate evaluation tools that would include a focus on impact, especially at the local scale. The necessary long-term empirical research and commitment of scientists working in developing countries cannot be evaluated solely by the number of publications. Fundamentally, new and closer partnerships are needed between scientific, development and conservation institutions.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.cosust.2010.03.002.

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