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Editoral

Forests, Livelihoods, and Conservation: Broadening the Empirical Base

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Summary. — More than 10,000 years after the Agricultural Revolution started, millions of rural smallholders across the developing world may still derive as much income from foraging forests and wildlands as from cultivating crops. These steady environmental income flows come often from public forests, and are extracted by men and women alike. However, inflexible supplies from nature, the physical hardship of harvesting, and commonly low returns limit their role as safety nets and pathways out of poverty. While their harvesting does not preclude the ongoing conversion of wildlands to agriculture, privileged access to high-quality environmental resources can become a strong local conservation motive.

Key words — environmental income, smallholders, wildlands, poverty

1. INTRODUCTION

In 2005, *World Development* published a Special Issue on "Livelihoods, Forests and Conservation." Its editorial introduction concluded with a "Looking into the Future" section that called for more research on "the role of forests in socioeconomic development" and "the degree of dependence on forests by the poor." The guest editors stated a particular need for more quantified results on forest–livelihood linkages (Sunderlin *et al.*, 2005: 1397), and opined that the articles in that Special Issue and the current state of research "leave us acutely aware of the need for worldwide studies, or synthesis of case studies, in future research" (Sunderlin, 2005: 1381).

Almost a decade later, in this Special Issue we as guest editors aim to revisit the relationship between forests, livelihoods, and conservation. Together with our article contributors, we hope to fill some of the quantitative and global-level gaps that Sunderlin and colleagues identified. The contributions build on a selection of papers from the workshop "Exploring the Forest–Poverty Links: New Research Findings," held at the University of East Anglia, Norwich (United Kingdom) on June 13–14, 2011. This workshop principally discussed the first results from the Poverty and Environment Network (PEN), a collaborative effort led by the Center for International Forestry Research (CIFOR), focused on socioeconomic data collection at the household and village levels, across rural areas of developing countries (see http://www.cifor.org/pen/ and Angelsen *et al.*, 2014, this volume). In addition to the PEN global-comparative and case-study papers, the Norwich workshop also featured reports on case-study research and synthesis work from other organizations and networks, with a similar focus on the quantitative aspects of forests, environmental incomes, and livelihoods. A synthesis of the scientific findings from the workshop and their implications was presented immediately after at the policy conference "Counting on the Environment: the Contribution of Forests to Rural Livelihoods" (The Royal Society, London, United Kingdom). [1]

In this introductory article, we will start with the central issue of environmental incomes: their nature, perceptions, and quantification (Section 2). Subsequently, we synthesize the findings from the 12 main articles of this Special Issue, which comprises five global-comparative PEN papers, one PEN case study, [2] and six non-PEN studies ranging from micro-level cases to national-level analyses (Section 3). We conclude by outlining some key insights and messages,

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compare to the pre-existing literature, and discuss implications for future work (Section 4).

2. ENVIRONMENTAL INCOMES: THE PARADIGM SHIFT THAT NEVER HAPPENED

(a) *Potential welfare functions of forests and wildlands*

Traditionally, rural smallholders in developing countries have been viewed primarily as farmers, essentially cultivating crops and raising livestock for their livelihoods (e.g., Zuckerman, 1977). It thus amounted to almost a revolutionary discovery when researchers and development policy circles started to realize that off-farm incomes were becoming much more important and even outweighing farm income in many smallholder settings, such that rural households increasingly benefited from wage-employment in agriculture, mining, or service sectors and small business enterprises (Holden, Shiferaw, & Pender, 2004; Janvry & Sadoulet, 2001; Reardon, Taylor, Stamoulis, Lanjouw, & Balisacan, 2000). Correspondingly, remittances from temporarily or permanently migrated family members can further reduce the economic reliance of smallholders on farming (Barrett, Reardon, & Webb, 2001). Smallholders were thus not just plain farmers, but economic agents pursuing diversified livelihood strategies (Ellis, 2000).

Simultaneously, evidence also mounted that rural households generate high "environmental incomes," i.e., cash- or subsistence-based contributions from non-cultivated lands such as natural forests, bush, mangroves, rivers, or other wildlands. Most forest income is environmentally sourced (i.e., a "subsidy from nature" with low management intensities), but plantation forestry is by definition excluded. [3] A methodologically thorough case study in Zimbabwe (Cavendish, 2000) using quarterly surveys for household income accounting revealed high household dependence on environmental sources, and thus inspired other studies, including the PEN project which replicates this type of household income accounting across the developing world (Cavendish, 2003). Extensive references to the growing forest and environmental income literature are provided by Angelsen *et al.* (2014, this volume). In other words, the evidence so far, plagued though it is by methodological problems and inconsistencies in the underlying case studies (Vedeld, Angelsen, Sjaastad, & Berg, 2004: 62-4), has pointed to a significant "subsidy from nature" (Anderson, May, & Balick, 1991) into rural economies.

A major part of this literature pointed to the possibility that forests and wildlands are particularly important as resources to rural dwellers for avoiding falling into (deeper) poverty, not only as safety nets in response to (unforeseen) shocks such as bad harvests, family illness, etc. (e.g., McSweeney, 2004; Pattanayak & Sills, 2001), but also as seasonal gap-fillers during (foreseeable) income slack periods, such as between agricultural harvests (e.g., de Beer & McDermott, 1996; Angelsen & Wunder, 2003).

A third possible role identified for environmental resources was to provide a stepping stone out of poverty (Angelsen & Wunder, 2003). While there are examples of forest products providing the basis for asset accumulation, the consensus seems to be that this is rarely the case (e.g., Belcher, Ruiz-Pérez, & Achdiawan, 2005; Neumann & Hirsch, 2000). Many of the characteristics that make environmental resources attractive to the poor also limit their potential to accumulate assets and lift people out of poverty.

Finally, extraction of environmental resource can degrade the resource base, biodiversity, and environmental services. First, this can produce tradeoffs between current and future extractive incomes, and rural households' asset-building strategies can help understand poverty dynamics (Nielsen, Pouliot, & Kim Bakkegaard, 2012). Second, degradation can create negative externalities for society at large; even low extractive incomes could go hand in hand with disproportionate damage to threatened habitats and species (Arnold & Ruiz-Pérez, 2001). Conversely, degradation threats may justify external conditional compensations to smallholders for conserving rather than degrading environmental services, perhaps creating a new engine for forest-based livelihood contributions (e.g., Dewees *et al.*, 2010).

Consequently, if natural forest and other environmental resources from wildlands are so important to households in their everyday livelihoods, and even more essential in periods of income shortfalls, has the gradual uncovering of this "hidden harvest" (Scoones, Melnyk, & Pretty, 1992) also attracted the attention of development practitioners? Has it changed their perceptions and strategies, comparable to the paradigm shift we have seen in the wake of the off-farm income discovery?

So far, this "discovery of the wild" has not really occurred. Environmental income remains widely overlooked by policymakers in their poverty reduction strategies (Oksanen & Mersmann, 2003). National accounting systems in many countries lump forestry under agriculture in their national income calculations (FAO, 2008), while other—perhaps most—environmental income may not be counted at all. In most population-representative household surveys, such as Living Standards Measurement Surveys (LSMS), information on forestry and environmental income is often very limited, at best including only questions on fuel, fodder, or building materials. Giving limited attention to, or ignoring environmental income in such surveys may lead to the underestimation of total household incomes, by understating the value of the environment to rural households (PROFOR, 2008; Vedeld *et al.*, 2004), thus also skewing our understanding of the generation and distribution of wealth within the rural economy (Fisher, 2004).

(b) *Why the paradigm shift never happened*

If environmental income is that important, why has it so far not led to a paradigm shift in the minds of development practitioners? Below we list six tangible reasons and common perceptions that can explain why the mainstreaming of environmental incomes has been so slow a process:

(i) *Environmental extraction as a production mode is a backward relict*

The Agricultural Revolution, a process believed to have started somewhere between 10,000 and 8,000 years BC in the Neolithic Age, has continuously led to a replacement of land-extensive foraging with the intensive domestication of plants and animals, markedly increasing the food security and carrying capacity of mankind (Barker, 2006; Braidwood, 1960). In some places, historically and even today, large-scale commercial forest extractive operations (e.g., of rubber, Brazil nuts, or timber) have been developed under patronage systems of debt peonage, which generally are to be seen as socially undesirable modes of production (Browder, 1992). Hence, many policy and decision makers may equate transformations from natural extraction to specialized cropping and husbandry systems with a change from frontier resource grabbing and backwardness to progress and lasting modernity.

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(ii) *Environmental extraction offers little scope for technological progress*

Human production processes can incrementally be made more effective, aided by improved technology. The Green Revolution in agriculture is a prime example. For nature-extractive processes, the technological entry points are almost by definition severely limited. Damaging impacts from human extraction can be minimized so that over time natural regeneration of the resource is enhanced, as in the case of reduced impact logging (Putz, Sist, Fredericksen, & Dykstra, 2008). Soft management techniques can raise the productivity in near-natural extractive systems, at the extreme reaching the limits to agricultural systems.[4] Nevertheless, agriculture's technological potential for change doubtless dwarfs that of natural extractive systems. This is also why natural forests and wildlands often remain especially abundant in inaccessible areas with rugged topography and/or soil limitations, where agricultural conversion has not been worthwhile (Joppa & Pfaff, 2009; Wunder, 2001).

(iii) *Forest-rich areas offer little leverage for development policy interventions*

In continuation of the previous point, areas rich in natural forest areas typically exhibit a high poverty incidence, but due to low population numbers poverty densities typically remain low (Sunderlin *et al.*, 2008). This is an unfortunate precondition for the implementation of pro-poor policies (e.g., social sector or infrastructural investments), which tend to become overly expensive on a per-capita basis, compared to implementation in established agricultural or in urban areas. Simultaneously, poor governance preconditions often prevail particularly in forest-rich areas at the agricultural frontier, because state institutions may have only a recently established, weak presence. Land and resource tenure is often insecure and overlapping, promoting conflict and impeding investments. Policy leverage in this setting is also bound to be challenging: it would have to focus on leveling the playing field, promoting decentralization and fairness in resource access rights (Agrawal, Chhatre, & Hardin, 2008). However, complex natural resource management interventions are often not the top priority of national planners, who usually prefer policies that can be linked to more predictable, simple, and scalable models of production growth, including in agriculture and plantation forestry (Scott, 1998).

(iv) *Extractive benefits are spread over many subsistence products of mostly low unit value*

As many detailed ethno-botanical field studies using "doorstep accounting" of cash and subsistence household consumption have shown, for forest-dwelling indigenous people (Godoy *et al.*, 2002) and beyond to smallholders (Godoy & Bawa, 1993), items harvested in extractive systems often far outnumber the crop and livestock varieties produced by smallholders. In addition, many extractive products are harvested irregularly throughout the year, whereas crop harvests typically occur concentrated in time, so values are easier to recall. Individually, extractive products are often of low value, and harvested predominantly by female household members and for subsistence uses. Being consumed directly makes estimating their value challenging.[5] Hence, without any more detailed *ex ante* knowledge about which extractive products are economically most valuable, accounting for their total value can be so cumbersome that it is preferred to ignore them in national income surveys.

(v) *Few champions can be mobilized for investments in sustainable extraction models*

Keeping in mind the previous points, it is not surprising that most forest and extractive products, timber apart, have been assessed to have rather low business development potential (Neumann & Hirsch, 2000). Whereas cropping and livestock operations attract large private sector investments, and their prospects for profits generate calls for accommodating government policies, extraction models tend to have lower margins, and are thus supported primarily by civil society, seeing in them an option for benign natural uses to the joint benefit of local people and conservation. An exception to this pattern is certain scarce, high-rent extractive products, such as commercially rich timbers, and a few high-value non-timber forest products (NTFP). However, their rent-seeking potential combined with weak forest governance (see above) often induces conflict and resource-grabbing by elites that also undermine benefits to local people (Dove, 1993). Hence, natural extraction as a commercial strategy tends to be only a transitional phase (Belcher, Michon, Angelsen, Pérez, & Asbjornsen, 2005): either these products will be replaced by synthetic substitutes, or demand for them becomes so high that extractive supplies no longer suffice, so they are taken out of their natural systems for intensive agricultural cultivation—as has happened with key past rainforest products such as cocoa or rubber (Homma, 1996). Correspondingly, natural extractive products are often also subject to marked boom-and-bust cycles (Barham & Coomes, 1994), which may translate into derived cycles of deforestation followed by frustrated regional development patterns (Celentano, Sills, Sales, & Veríssimo, 2012).

(vi) *High environmental value studies represent advocacy-driven showcases*

Given the previous five perceptions, some skepticism can also be justified as to whether past economic valuation studies obtaining high extractive values on a per-household or per-hectare basis portray a realistic picture. As shown for the field of impact evaluation, the record of using hard data and vigorous methods to evaluate performance is bleak for conservation in general (Ferraro & Pattanayak, 2006) and biodiversity interventions in particular (Miteva, Pattanayak, & Ferraro, 2012). Similarly, some of the early rainforest valuation studies greatly exaggerated extractive economic potential, such as the oft-cited case study near Iquitos (Peru) published in *Nature* (Peters, Gentry, & Mendelsohn, 1989) that found *potential* annual per-hectare NTFP extraction values of US$ 700, or a net present value of US$ 6,330. Errors committed here included the underestimation of destructive harvesting techniques, post-harvest losses, marketing costs, and price fluctuations, and corresponding over-estimations of demand and of species productivity in site inventories.[6] More generally, the peri-urban nature of this site also raised questions of selection bias and to what extent extrapolations could be made. Note that several of these critical factors overlap with the methodological problems that Vedeld *et al.* (2004) identified in their review of environmental income studies. One might thus *a priori* suspect that high estimates of environmental incomes reflect assumptions with a good share of wishful thinking on behalf of the forest conservation lobby—even in those cases when sound methods have been used.

Jointly, these six stylized characteristics and perceptions can explain why extraction from natural forests and other wildlands continues to be widely seen as a productive activity that offers little prospect for poverty alleviation; at best, it may

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impede people from falling into deeper poverty. However, perceptions often do not make for the whole story, and some of them are challenged by our results below. Although not overly abundant, real-world examples can be found where forest products helped substantially in lifting people out of poverty. Conversely, in other cases anti-poor forest policies, related to, for example, resource access and product marketing impeded outcomes that could have alleviated poverty (Kaimowitz, 2003; Scherr, White, & Kaimowitz, 2004; Sunderlin *et al.*, 2005).

3. KEY RESULTS FROM THIS SPECIAL ISSUE

In presenting key results, we start with the global-comparative studies (Section 3(a)), then turn to case studies that are livelihood-, income- and poverty-focused (Section 3(b)), and close with cases oriented toward conservation and the long-run sustainability of extractive incomes (Section 3(c)).

(a) *Global-comparative studies*

The first article (Angelsen *et al.*, 2014) presents the PEN project as arguably the largest quantitative, global-comparative research project on forests and rural livelihoods to date, using standardized definitions and methods. Socioeconomic household (demographics, assets, incomes, and social capital) and village-level data (markets, institutions, natural assets, etc.) provide covariates and context. Surveys of more than 8,000 households in 333 villages, 58 sites, and 24 developing countries covered a 12-month period, using quarterly household surveys with 1–3 month income recall periods. While PEN sites were not selected randomly, we argue below that PEN is representative of smallholder-dominated tropical and sub-tropical rural landscapes with moderate-to-good access to forest resources, and all but the highest population densities (Section 4).

Overall, natural forests provide 21.1% of total household income (another 1% coming from forest plantations); 6.4% is derived from non-forest environments (fallows, bush, grasslands, etc.), making the combined environmental income 27.5%. More than a quarter of household income in the sample thus comes from natural extractive sources—close to the income share of agricultural crops for the households in the PEN sample (28.7%). This reconfirms the previous high forest income shares found in the meta-study of Vedeld *et al.* (2004),[7] although there are also some non-trivial differences in results.

In the PEN data, environmental income shares are higher for low-income households, but differences across income quintiles are less pronounced than previously observed in case studies. The poor rely more heavily on subsistence-oriented forest products such as wood fuels and wild foods, and on products extracted from natural areas other than forests. In absolute terms, environmental income is approximately five times higher in the highest income quintile, compared to the two lowest quintiles. Hence, any pressures on the sustainability of forest extraction are also disproportionally higher from better-off rural households. In explaining variations in forest incomes across the sample, the authors find agricultural and forest activities to be complementary at the household-level, but at the site-level alternative livelihood strategies appear, highlighting landscape-level trade-offs between forest conservation and agricultural development.

In the second article, Wunder, Börner, Shively, and Wyman (2014) use the global PEN data to look at safety-net and seasonal gap-filling functions of forests and wildlands. The authors test a series of hypotheses from the case study literature that generally claims an important role for forests and wildlands in alleviating income shortfalls, especially for the poorest population segments, and in particular when shortfalls are severe and shocks are covariate, i.e., affecting everybody in a village. Indeed, more forest extraction is a more likely response to covariate shocks, and somewhat higher for the income- and asset-poorest households. Especially in villages already specialized on a broad range of extractive activities, and more so in those producing timber, extractive shock responses are more likely. But this pertains to a minority of cases: on average, only 7.8% of households suffering a shock report forest extraction as their primary response (5.2% as their secondary, and 4.4% as tertiary response). Adding non-forest environmental sources only raises the primary share to 8.0%, indicating less importance here for non-forest wildlands. This finding will surprise, vis-à-vis the common wisdom of the forest safety-net literature. As a caveat, the universe of shocks in the PEN cross section did not happen to include any extreme shocks (wars, famines, and major natural disasters) that at least some of that literature had featured.

For seasonal gap-filling, the authors find that quarterly flows of forest incomes more often than not are positively correlated to both crop incomes and total non-forest incomes, thus effectively impeding them from income smoothing—a function that is more often played by wage income. In two other PEN papers of this Special Issue, multivariate regression models indicated that shock occurrence also does not raise households' propensity to clear more forest (Babigumira, Angelsen, Buis, Bauch, Sunderland, & Wunder, 2014), nor their forest incomes generally, except in response to crop failures (Angelsen *et al.*, 2014). In other words, rural households may raise their forest extraction marginally, as also amply observed in the case-study literature. Other responses, such as social networks, wage labor, sale of assets, or simply reducing consumption may nevertheless prove more important—and these were not looked into by many forest case studies.

The third PEN global-comparative article by Jagger, Luckert, Duchelle, Lund, and Sunderlin (2014) scrutinizes the relationship between forest tenure conditions and forest income. The authors pose a series of questions as to what different formal forest ownership categories (state, private, and communal), enforcement rules (the degree to which sanctions are applied), and congruence (degree of overlap between formal owners and actual users) mean for forest incomes. Across the PEN sample, the authors find that households clearly extract more income from state than from private and communal forests, in per-household as well as in per-hectare terms. In the multivariate regression analysis, controlling for other variables such as forest type and condition, forest size and population density, and strict rule enforcement comes with higher smallholder forest incomes from private forests, but correspondingly lower income from communal and state forests.

Finally, for congruence the regression results are less clear, but partially overlapping user rights in community forests and zero congruence in state forests are both positively associated with forest income; ill-enforced rules to collective forest property, and lack of clear congruence between owners and users, may actually give smallholders more flexible access to forests, thus generating higher incomes.

Sunderland *et al.* (2014) employ the global PEN data to assess the gendered aspects of forest access, use, and management. They investigate whether common assumptions and case-specific findings about differential patterns of forest use by men and women are true more generally. They find some reconfirmation, and some surprising results. Some

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product-specific gender-differentiated roles are found, but perhaps not as pronounced as expected. And, contrary to common assumptions, men contribute just as much to households' forest income as do women. Regional variations are marked, with some stereotypes borne out, such as more participation by males in the better-developed markets in the Latin American cases, and women dominating the subsistence-oriented forest product sectors in Africa. Likewise, men are more involved in hunting, wood harvesting, and minerals than women. But, again contradicting common expectations, men also dominate firewood collection in Latin America, make large contributions to firewood collection in Africa, and generally contribute a much broader range of forest activities than typically assumed.

The study also looked at gender-differentiated use of resources managed under different tenure regimes, supplementing the above findings of Jagger *et al.* (2014). They reconfirm the expectation that many forest products are harvested from state lands (in some cases, *de facto* open access), and that women collect more forest products from common property resources in Latin America and Asia, but not in Africa. Men were found to have higher participation in forest user groups, and tend to dominate forest management organizations, which leads the authors to wonder about the effectiveness of external interventions to support and encourage women's participation in such organizations. The authors thus portray a picture of a geographically and product-wise highly diversified gendered pattern of forest income generation, where men and women overall share fairly equitably in the forest-extractive action.

The last analysis of PEN data by Babigumira *et al.* (2014) aims to identify links between site context and rural household characteristics and their forest clearing decisions. They use a Sustainable Livelihoods Framework to look specifically at the question of whether asset poverty drives deforestation. The authors find that the poorest households are not the most active, and instead that households with medium to high asset holdings were more likely to clear forest (notably, many of the *relatively* wealthy households in the study are still near or below national poverty lines). The authors suggest that forest clearing is not based only on needs—it requires some minimum level of assets to engage in forest clearing. Increased market orientation and better access are also likely to stimulate forest clearance if forests are accessible and farmers have the means.

This finding concurs with much of the recent literature on markets and deforestation, and it provides a caution: policy interventions intended to address poverty through improved market access and integration may undermine, rather than support forest conservation objectives. Instead of providing competing alternative economic activities, an increase in assets and income of rural households could provide the means to increase forest clearing, once again challenging simplistic hopes for win-win solutions.

(b) *Poverty alleviation focus*

In many of the PEN cases, woodfuel made up a substantial proportion of forest income, primarily as a subsistence resource, but with some commercial trade. Schure, Levang, and Wiersum (2014) focus specifically on the contribution of commercial production and trade of woodfuel (both firewood and charcoal) in the Democratic Republic of Congo (DRC). Substantial urban demand drives a market that employs a large number of mostly poor people (over 300,000 people for the supply of Kinshasa alone), with substantial revenues that contribute up to 75% of the total income of charcoal producers supplying the Kinshasa market. In this case, two thirds of the total woodfuel production is from land clearing for agriculture, with the remaining third from standing forests: mostly degraded gallery forests around Kinshasa and primary forests around Kisangani. The research included analysis of how producers used income for woodfuel trade, finding large proportions of income are used to pay for basic needs—reflected in the local concept of charcoal production as a "rapid intervention"—but the relatively large sums also allow for some savings and investment in agriculture, livestock, and petty trade. The authors note the importance of this as a contribution to poverty reduction. The study highlights that woodfuel production can provide important and flexible benefits to producer households supplying urban markets, but with risks to forest conservation. The size, value, potential, and risks of the trade warrant attention in forestry and energy policy.

Lopez-Feldman (2014) adds to the limited body of national-level studies on environmental incomes and poverty.[8] Using the Mexican National Rural Household Survey, with a nationally representative sample, he first analyzes the determinants of household participation in resource extraction, and secondly the environmental dependence of participants. Except for the poorest household (incomes up to 25% of the national poverty line), higher incomes are accompanied by a lower likelihood to participate in resource-extractive activities. Likewise, environmental dependence diminishes clearly with higher household incomes, and also with village distance to markets. Shocks also raise the likelihood of households' participation in extraction by 13–16% points, but they do not significantly affect environmental dependence. Environmental incomes have an equalizing impact on income distribution, compared specifically to production activities and remittances, but less so than wages and public transfers. All these findings fit well with the idea of extraction constituting predominantly low-remunerative operations (see inferiority perceptions in Section 2). While methodologically environmental dependence in this national survey (average: 6.2%) may well be underestimated compared to PEN, the results dovetail with PEN findings regarding both general livelihoods (Angelsen *et al.*, 2014) and shocks (Wunder *et al.*, 2014).

Tree plantations have expanded rapidly at the global scale, in particular in countries at later stages in the forest transition, and driven by scarcity of forest products (and thereby better prices for tree-based products) or deliberate government policies and donor support. Sikor and Baggio (2014) examine the possibilities for smallholders to engage in plantations as a means for poverty alleviation. The authors present an empirical study of household tree growing in rural Vietnam, with a focus on differences in the capacities of households to gain land endowments and translate endowments into tree entitlements. Employing Heckman regression models and qualitative institutional analyses, the article finds that better-off households are more likely to possess forestland, grow trees, and invest in plantations than poor ones. Better-off households are also engaging more in tree plantations due to institutional mechanisms differentiating household access to land and finance. While the poorest segments may be restricted in their ability to get involved (e.g., low asset levels, including land), the authors argue that tree plantations are not inherently anti-poor. Instead, they call for attention to the institutional mechanisms that differentiate the endowments and entitlements accruing to different social actors. To make the poor benefit more from tree plantations, governments also need to ease the constraints they face, e.g., through expansion of micro credit services.

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(c) *Conservation and sustainability focus*

Most studies of forest income ignore the resource base, and few resource assessments concern themselves with the low-value resources that are commonly used by the poor. Meilby *et al.* (2014) address this gap with a study in community-managed forests in three sites in Nepal, investigating whether forest income is sustainable. They used biophysical data from permanent sample plots in conjunction with PEN household income data to assess forest income, extraction rates, and regrowth, and the impact of harvesting on the resource base, with a focus on woody species used for firewood and timber. Forest income contributes on average 7% to total income in the study area (range: 3–11%). Overall harvest levels were sustainable and indeed well below the annual increment in two sites (lowland and high mountain sites), while substantially exceeding the annual increment in the middle hills site. Large diameter classes and the most valuable wood species tended to be overharvested in all sites, while other species, especially NTFP species, were not. In some sites it would be possible to sustainably increase harvest levels, and forest income, substantially (up to tenfold!). The study is valuable in offering a practical approach for resource assessment, and it underlines the importance of providing basic resource management information (i.e., growth tables for locally important species). The authors were also able to compare annual extraction figures derived from the household survey to actual measurements in the harvesting areas, finding a light tendency for household under-reporting (up to 18% lower).

How does the protection status of forestland and—resources impact household incomes? Clements, Suon, An, Wilkie, and Milner-Gulland (2014) look at the impacts of two protected areas on household welfare in Cambodia. They measure welfare through both physical harvest levels and a multivariate index. Compared to households in buffer zones, those inside protected areas were worse off, because they had worse access to markets and social services. However, compared to a matched sample of households in similarly remote sites, the picture reverses: those inside are better off than those outside the parks, because of better and more secure access to land (especially for cultivating rice) and forest resources (especially resin tappers). While households outside of protected areas often have to defend their territories against land and resource grabbing by migrants or external extractors, insiders to national parkers enjoy a *resource protection effect*; continuous remoteness (e.g., no road building) may be compensated by privileged resource access. Perhaps the authors' most important contribution in relation to the emerging quantitative literature in this field (e.g., Andam, Ferraro, Sims, Healy, & Holland, 2010; Naughton-Treves, Alix-Garcia, & Chapman, 2011) is to reemphasize the importance to control for systematic location differences when we assess whether protected areas come to alleviate or enhance poverty.

Staying with quantitative assessments of the impact of conservation interventions, Bauch, Sills, and Pattanayak (2014) look at another traditional tool: the integrated conservation and development projects (ICDP). They analyze the welfare and land-use effect of the ProManejo project with community-based enterprises in the Tapajós National Forest in the Brazilian Amazon. They compare data from two household panel surveys, in 1997 (pre-ICDP) and 2006 (post-ICDP). Like Clements *et al.* (2014), they also use matching techniques to control for the potentially confounding effects (selection biases) in ICDP participation at the village and household levels. They find that the project had very few discernible impacts on assets and livelihood portfolios. Communities with project activities tended to have significantly less cattle, and also less increases in wealth than communities without. The authors could find no significant project impacts on forest conservation at community level.

Their analysis thus notably adds a solid panel data study to a tiny pool of previous quantitative analyses of ICDPs (e.g., Brooks, Franzen, Holmes, Grote, & Mulder, 2006; Leisher, Sanjayan, Blockhus, Larsen, & Kontoleon, 2013), despite the probably hundreds of such projects that have been carried out, and continue to do so under new labels. Nevertheless, their results also reinforce the view that the evidence for ICDP impacts is disappointing, on both the conservation and development sides of the equation (Wells & McShane, 2004).

Finally, the impact of conservation interventions is contextual. The PEN study by Duchelle, Zambrano, Wunder, Börner & Kainer (2014) compares two regions on each side of the Bolivia-Brazil border in Southwestern Amazonia, with similar biophysical conditions but different development levels. They sampled households inside and outside two major protected areas in Pando (Bolivia) and Acre (Brazil). Variations in forest incomes and livelihoods strategies prove to be fairly well explained jointly by the inter-country development differences and by residence inside *vs.* outside protected areas. Two research recommendations can be drawn from their article. First, the authors point to the usefulness of the forest transition framework to systematically analyze the relationship between development and forest cover at large spatial and temporal scales. The framework permits researchers to move beyond general "context matters" statements, locate sites along a forest transition curve, and test hypotheses related to their location on the curve. Second, comparative analyses of neighboring sites across national borders, with similar biophysical and possibly also ethnic and demographic characteristics, permit researchers to zoom in on the role played by socioeconomic conditions and national policies.

4. NEW PERSPECTIVES AND FUTURE DIRECTIONS

In this Special Issue, we use case studies and global comparisons to add to the empirical-quantitative knowledge about forests, livelihoods, and conservation. What new insights from this Special Issue can we point to? In Section 3 we explained why no paradigm shift in favor of the hidden harvest of environmental resources has occurred in national income accounting and development economics. Hence, the large environmental incomes and benefits we almost consistently find in the quantitative assessments of this Special Issue may genuinely surprise some observers.

Hence, how do our findings fit with the traditional image of extractivism, as sketched in Section 2(b)? Our data cannot test all six features,[9] but we make a couple of observations. First, results certainly contradict the view that "high environmental value studies [would exclusively] represent advocacy-driven showcases "(vi). Unrepresentative showcases may feature in the literature, but we show that high environmental incomes are found across a much wider spectrum of cases (see also discussion on sample representativeness below) when using sound research methods. Second, the perception that "extractive benefits are spread over many subsistence products of mostly low unit value" (iv)—mainly for women's subsistence uses—also appears dubious: some higher-value products typically stand out, being harvested equally by men and women. This assessment is supported by our empirical results from the PEN project (Angelsen *et al.*, 2014; Duchelle *et al.*, 2014), but also from other contributions to

this Special Issue (Clements *et al.*, 2014; Schure *et al.*, 2014; Sikor & Baggio, 2014), although in national-level surveys these environmental contributions may remain under-reported (Lopez-Feldman, 2014).

Overviews of the forest–livelihoods literature (Kaimowitz, 2003), and the aforementioned meta-study (Vedeld *et al.*, 2004) complement this picture. Our quantitative-comparative contributions also tie into other ongoing efforts, such as by the International Forestry Resources and Institutions (IFRI) (see below), and the forest–poverty toolkit developed jointly by the World Conservation Union (IUCN), the UN Food and Agriculture Organization (FAO), the Program for Forest (PROFOR) at the World Bank and their partners (PROFOR, 2008). So far unpublished, their pilot assessments in 24 countries, principally in Africa, also lend support to a picture portrayed in this Special Issue: rural smallholders derive high household incomes from forests and other environmental sources (Shepherd *et al.*, 2011). [10]

Consequently, 10,000+ years of agriculturization seem to only have taken us just so far in substituting the human hunter-and-gatherer activities from forests and wildlands, which in developing countries thus remain essential sources of smallholder welfare. While poverty alleviation and economic development potentials from natural extraction may remain limited, for all the good reasons listed in Section 3, the value share of extracted products in the PEN sample was overall almost as large as that of crops (Angelsen *et al.*, 2014). Market constraints and risk aversion may help us explain why. [11] As a main result emerging from this Special Issue, a large share of the economy of rural smallholders with access to forests and wildlands still builds on foraging.

A first non-trivial implication of this central finding is that households with access to a rich pool of natural resources can be materially much better off than what their often modest income from other sectors (agriculture, wages) alone would tell us. This is in addition to the non-material local welfare benefits forests also frequently provide. [12] The World Bank-supported Living Standards Measurement Studies (LSMS) find high diversification and increasing off-farm income with higher incomes, but generally do not distinguish forest or environmental household incomes. [13] Simply ignoring this large "hidden harvest" might arguably do little harm, from the progressive viewpoint of extractivism's limited leverage for economic growth. But it remains dangerous from the defensive stance that losing access to extractive resources through ill-conceived development interventions or regulatory reforms could spell disaster for local people. Correspondingly, detailed country-specific results from PEN and other case studies in this Special Issue could in principle be used to design upscaled country-specific survey components that can capture the lion's share of environmental incomes by making the right shortcuts, i.e., focus on the locally most important products.

Second, when rich extractive resources are located inside protected/sustainable-use areas that give local residents exclusive or preferential access, this can make an even more important welfare difference, making more than up for any local use restrictions that the protection status may put on their shoulders (Clements *et al.*, 2014). In other words, the natural riches of these areas may not only be protected *from*, but also *for* local people. Obviously, rents from protected resources could over time also attract migrants and/or slow out-migration, and thus lead to increased population pressures in and around protected areas through "magnet effects" (Wittemyer, Elsen, Bean, Burton, & Brashares, 2008).

Third, economic extraction values will seldom spread evenly over the entire ethno-botanic spectrum of local uses: typically one or a few products make a larger, concentrated income difference. Correspondingly, to be in the know about these product values may be essential for focusing both poverty alleviation and conservation interventions. People's livelihoods are thus also seldom sustained proportionally by biodiversity in all its multiple facets, but typically more so by strategic components of it. Obviously, those components might also change their strategic status over time with different boom-and-bust cycles in extractive commodities. Notably, while in some cases (such as Brazil nuts in Eastern Bolivia and Western Brazil) non-timber forest products make astonishingly large livelihood contributions (Duchelle *et al.*, 2014), more often did timber and wood products have a high income share. Especially woodfuel is an important provider of primarily subsistence incomes, and secondly cash. As foreshadowed a decade ago by case studies from another Special Issue (Shively, 2004) and a global stocktaking of the literature (Arnold, Köhlin, Persson, & Shepherd, 2003), charcoal sales to expanding cities are a powerful livelihoods incentive in forested areas—making rural asset-poor producers better off (Ainembabazi, Shively, & Angelsen, 2013; Khundi, Jagger, Sserunkuuma, & Shively, 2011) and providing "stepping stones" for reinvestment of profits into other sectors (Schure *et al.*, 2014; Stoian, 2005).

Are forest and environmental products especially valuable to the poorest and most vulnerable? It has been asserted in the literature that "the asset-less poor" living in less-favored areas (i.e., marginal production zones for agriculture) are often particularly dependent on the natural environments that surround them (Banerjee & Duflo, 2007). Resource quality and access to key markets would become key triggers for leveraging the use of common-property and open-access resources—but often at the cost of over-exploitation (Barbier, 2010). How does this picture fit with our findings?

Generally, our results confirm that asset and income poverty go hand in hand with greater environmental dependence, as measured by the share of environmental income in total household income. But, the differences in environmental dependence across different income quintiles are not glaring. Some caveats are also in place. First, the better-off rural smallholders typically extract much larger *absolute* quantities for both auto-consumption and sales (Angelsen *et al.*, 2014). [14] Second, extractive incomes from natural forest are invariably more equally distributed than other incomes combined (Angelsen *et al.*, 2014; Lopez-Feldman, 2014); this contrasts interestingly to the Vietnamese plantation forestry case, concluding that better-off households are more likely to dedicate land and capital to grow trees (Sikor & Baggio, 2014). Third, while women dominate the extraction of some products, men bring in just as large extractive incomes overall, but in a diversified gendered pattern (Sunderland *et al.*, 2014).

What does this forest income distribution mean for forest loss and degradation? Even when resource users are extremely poor, sustainability of forest extraction need not be compromised, as shown for the Nepali case (Meilby *et al.*, 2014)—while in the DRC case, smallholder extraction was clearly intertwined with forest degradation and conversion processes (Schure *et al.*, 2014). In turn, forest clearing and conversion occur across the full welfare and asset spectrum, but a certain minimum asset threshold proves to increase its likelihood significantly (Babigumira *et al.*, 2014).

Hence, based on our results in this Special Issue, it would be hard to blame the poorest households for deforestation and

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forest degradation. Conversely, conservation strategies that make people better off (e.g., through unconditional cash transfers) would *per se* seldom alleviate pre-existing resource pressures. It might actually worsen them, by easing constraints on activities with larger environmental impacts. In turn, ICDP strategies invest in pro-conservation local business strategies, but the results by Bauch *et al.* (2014) underline that the lasting impacts on both livelihoods and conservation may be negligible. While strictly protected areas may cap local forest-product extraction, sustainable use areas may actually enhance it (Clements *et al.*, 2014). Strategies to boost off-farm income, allowing people to diversity out of low-remunerative environmentally degrading activities, may often still remain another viable policy option (Shively, 2004).

While "the supermarket of the wild" (Cavendish, 2000) is better stocked than we could expect from Section 3, surprisingly the corresponding "insurance company of the wild" sells less policies among rural smallholders than portrayed in the forest safety-net literature (Wunder *et al.*, 2014). What do those two observations combined tell us about the nature of environmental incomes? Probably many extractive products face non-trivial supply limitations of their own so that, while summing up to a high share of household consumption, their harvesting cannot just be multiplied in times of special needs or seasonal gaps. Similar structural supply rigidities have been observed vis-à-vis their failure to accommodate long-term trends of accelerating demand (Homma, 1996).

What tenure and access conditions enable forests to best sustain livelihoods? Interestingly, global-comparative findings from IFRI have underlined the role of both forest ownership and governance (Chhatre & Agrawal, 2009; Persha, Agrawal, & Chhatre, 2011). Drawing on 80 forest commons in 10 countries, they show that community forestry and other arrangements with high local rule-making autonomy, together with larger forest size, are more likely to produce scenarios with both high subsistence livelihood benefits and forest conservation. The PEN results—different from IFRI in terms of sample, targeted livelihood benefits, and tenure concepts—alert to the importance of state forests. Furthermore, ill-enforced rules, and lack of congruence between owners (i.e., the state) and users (i.e., local people) may give smallholders better access to extract higher forest incomes (Jagger *et al.*, 2014). This may serve as a word of caution to those unequivocally advocating tenure reforms toward clear congruence and high enforcement: the pre-existing complex and "muddled" institutional arrangements may sometimes prove to actually favor smallholders.

Given that the research sites in this Special Issue were not randomly sampled, how can we be sure the results are not biased toward high forest income cases, i.e., bias (vi) in Section 2? What are these results genuinely representative of? First, some of our case studies looking at the impacts of interventions (Bauch *et al.*, 2014; Clements *et al.*, 2014) or broader development policies (Duchelle *et al.*, 2014) carefully employ matching techniques and other contextual controls of potential site selection biases. Second, while PEN aimed at representing all major forested regions in the tropics and subtropics, biases in the global PEN sample vis-a-vis the rural tropics were also empirically tested for: forest cover and population density were compared to province- and village-level controls (Angelsen *et al.*, 2014: Annex). The PEN study areas match the full forest-cover range of controls, but somewhat overweight high forest-cover cases. Likewise, PEN does not cover cases with very high rural population density. Finally, it also excludes corporate forest frontiers dominated by largeholders. Hence, we can say that PEN is representative of smallholder-dominated tropical and sub-tropical rural landscapes with moderate-to-good access to forest resources, and all but very high population densities. This implies that results should be trustworthy for the bulk of rural developing country scenarios, though they could differ for some of the under-represented special cases. [15]

Finally, in interpreting our results some temporal caveats related to economic cycles might also be justified. Constituting a cross-sectional one-year snapshot from the first decade of this millennium, preceded by a half-century of unprecedented global economic growth, the PEN results also would not allow us to retrospectively determine the previous historical trajectory of rural smallholders' forest incomes, nor judge what could be their future direction, for instance, in case a protracted crisis in the global economy was to develop. As the forest transition literature tells us, the societal dynamics of how forests are being used under variable economic context conditions are likely to differ substantially (Rudel, 1998).

What do our results mean for current climate change mitigation efforts through Reduced Emissions from Deforestation and forest Degradation (REDD+)? Our high forest income figures per household could indicate that conservation opportunity costs are lower than previously thought, when these represent higher *sustainable* extractive incomes with low carbon impacts—the value of which is often set to zero in REDD+ economic analyses (e.g., Gregersen, El Lakany, Karsenty, & White, 2010). But opportunity costs would conversely increase to the extent these higher incomes come from *forest-degrading* extraction (e.g., of timber, firewood, and charcoal) that increase emissions. When most forest incomes come from state forests with ill-enforced access rules (Jagger *et al.*, 2014), this may also complicate enforcement of REDD+ induced access restrictions. On the other hand, if deforestation and forest degradation are primarily due to large-scale external actors, REDD+ projects could provide win-win outcomes for local people provided sustainable local uses remain permitted. In other words, the impacts of our extractive income results on the different actors and cost dimensions of REDD+ would be context specific, but we demonstrate that some non-trivial forest income flows could be at stake.

Similarly, the PEN household income results can also be useful for understanding the scope of adaptation to climate change. First, the detailed assessment of household incomes give us a benchmark for what income flows from crops, livestock, and the environment are at stake in various regions with differential exposure to climate risks. Second, data on households' stated responses to different shock types and degrees will also allow for projections of responses to climate-induced fluctuations and shocks in different natural resource-based sectors.

In terms of needs for future research, the spatially specific patterns of forest-extractive incomes (which forest areas matter for what products?), their sensitivity to reduced forest size, and spatial overlay with ecosystem services, could thus become important fields of investigation. For instance, we could imagine that firewood incomes remain relatively robust to area variations, while bushmeat may decline when forest habitat shrinks below critical thresholds. Second, moving beyond the PEN-type annual income snapshot to comparable temporal points and panel data opens up various possibilities. This could reveal the degree of volatility inherent to forest incomes, as demonstrated in a single case of PEN panel data in Malawi (Chilongo & Angelsen, 2013), the impacts over

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time of certain livelihood-related interventions (Bauch *et al.*, 2014), and the broader role that forest and extractive incomes play for diversification, asset accumulation, and poverty dynamics.

NOTES

1. For the Norwich workshop, see more details at (http://www.cifor.org/pen/news-events/london-conference/science-workshop.html); for the London conference, see http://www.cifor.org/pen/news-events/london-conference.html.

2. A couple of dozens of other PEN case studies have been published elsewhere in the peer-reviewed literature (see Angelsen *et al.*, 2014).

3. Forest environmental income (i.e., excluding income from forest plantations) and non-forest environmental income combined make up total environmental income, i.e., the sum of incomes (cash or in kind) obtained from the harvesting of resources provided through natural processes not requiring intensive management (Angelsen *et al.*, 2014).

4. One example from the Amazon is the increasingly intensive management of extractive assai palms (*Euterpe oleracea*, Palmae) for highly demanded fruit pulp, which eventually in some places has led to quasi mono-species stands, and also eventually opened the door for cultivated systems (Homma, Nogueira, de Menezes, de Carvalho, Nicoli, & de Matos, 2006).

5. See the various chapters in Angelsen, Larsen, Lund, Smith-Hall, and Wunder (2011) for an in-depth discussion of environmental accounting methods.

6. Critiques of the approach followed, e.g., Pinedo-Vasquez, Zarin, and Jipp (1992) or Coomes and Barham (1997). See Sheil and Wunder (2002) for a summary. More recently, in the oil palm debate it has been held that conversion benefits may exceed those from standing forests, even when realistic carbon compensation payments were counted in (Butler, Koh, & Ghazoul, 2009).

7. Vedeld *et al.* (2004) found a forest income of on average 22%, i.e., one percentage point more than in the PEN data. However, non-forest environmental incomes were not separated out, so that the combined extractive incomes in PEN are significantly larger. Agricultural income (crop and livestock combined) were 37% in Vedeld *et al.* (2004: 27); in PEN these were slightly larger (41.5%) (Angelsen *et al.*, 2014: Table 1).

8. For instance, Wunder (1999) analyzed resource extraction data from Brazil's national agricultural census.

9. Several of these characteristics and perceptions from Section 2(b) are of a structural nature (technological change, modes of production, investments, and policy interventions), which it would require long-term data to illuminate.

10. See also http://cmsdata.iucn.org/downloads/gill_ny_flyercomplete_4ds.pdf [accessed on August 11, 2013]. Most of their case averages seem to show household forest incomes in the 25–40% range.

11. On the one hand, constraints in the supply of rural labor or credit continuously limit the adoption of agricultural innovations, even when these are more profitable. On the other hand, risk-averse agents will tend to adopt, but only partially, new technologies, when risks between innovative and traditional activities are not perfectly correlated (Fafchamps, 1999).

12. Forests often provide locally captured environmental services (e.g., clean drinking water), cultural and spiritual services, as well as health benefits from medicinal plants and animals that may not be fully reflected in their locally prices.

13. For instance, Davis *et al.* (2010) report LSMS results from 14 countries, but fail to mention forest and environmental incomes as a source.

14. In economic theory's terminology, we can say that the forest product categories tend to be the so-called *necessary goods* (for a 1% rise in income, their consumption rises with more than zero and less than 1%), but for most products this elasticity remains positive along the full income spectrum, and thus not becoming *inferior goods*.

15. For instance, the PEN finding that planted forests only make up 5% of total forest income may thus not hold, for instance, in a South Asian scenario that is highly populated, scarce in natural forest, and abundant in reforestable degraded farmlands.

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