Methodology Workshop on 'Environmental services & land use change'
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Asking the Right Questions: Policy Analysis and Environmental Services at Different Scales

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Abstract

Plausible (albeit dire) scenarios for the future in Southeast Asia include increasing conflict over land and water resources and degradation of hydrological, ecological, and other environmental services, which could undermine the stability of national economies, urban centres, and national food security. But do we really know enough about these complex relationships to build a consensus for action? How big are the effects of land use change (for better or worse) on stability of production systems at the local, regional, and national level? How well do these forest-derived land uses substitute for natural forests from the perspective of local people and national objectives? What scientific evidence is available to answer these questions? Are scientists even asking the right questions? From a policy perspective, at least three sets of questions are crucial:

(1) Who cares? How are people affected? Are the effects big?
(2) So what? Would action serve one or more public policy objectives?
(3) What can be done? Will it work?

After pausing to consider why intervention often is both necessary and difficult regarding environmental services, in the main part of the paper these 3 basic sets of policy questions are applied to each of three 'meso-level' environmental concerns: smoke, biodiversity loss, and degradation of watershed functions. In the last sections, the paper turns to another set of questions: assuming measurement of environmental impacts is possible, is it useful? The answer offered is twofold. First, impact measurement can help clarify whether policy action is desirable. Second, impact measurement also can reveal insights about incentives faced by different groups, thereby guiding design of interventions that may have some hope for successful implementation. Finally, we discuss how data needs and uses may change with evolution of understanding of a policy problem.

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First draft – not for quotation – comments welcome

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1. What is at stake?

The summary report of the World Commission on Forests and Sustainable Development (WCFSD) speculates that deforestation '... could change the very character of the planet and of the human enterprise within a few years...' (Krishnaswamy and Hanson, 1999, p. 6). The press release announcing the WCFSD report included the following statement from George Woodwell of the Woods Hole Research Center: '... Forests have a role in supplying the world with timber and fiber. ... But while those products can be partly substituted, the forests' ecological services for a functioning world cannot' (Lalley and Magnino 1999). These statements reflect relatively recent concern with global environmental issues (climate change, mass extinctions), but they also build on a longstanding literature tying the condition of soil, water, and forest resources to social and economic stability at the regional and national scale (e.g., Carter and Dale 1974 [earlier example?]).

Such concerns have particular force now in Southeast Asia since the monetary and financial crisis has boosted incentives for forest conversion and intensification of natural resource exploitation, possibly contributing to long-term natural resource management problems

Southeast Asian scenarios

The possibility that land use change and natural resource degradation could disrupt the economic and social basis of Southeast Asian nations seems plausible enough. For many countries in the region, irrigated rice production in the lowlands is the foundation of national food security. High population densities in rural areas and (until the recent interruption) rapid growth in urban industry and services each contributed environmental pressures.

There are several areas of potential conflict between the welfare of households in SE Asia's uplands – particularly their pursuit of profitable land use options – and their neighbors downstream (or downwind). Among these perhaps the most pertinent question for the people of SE Asia is whether pursuit of profitable land uses undermines key environmental services – translating, for example, into more frequent and more damaging floods, water shortages, and outbreaks of invasive pests. The recurrent transboundary smoke problem in Southeast Asia is linked to El Niño, but also is driven by land use change promoted as part of development strategy and resulting conflicts over land. Without interventions to strengthen or create mechanisms for conflict management, the future may bring intensification of social conflicts over natural resources—particularly water.

While some have argued that 'artificial' distinctions between global environmental interests and regional, national, and local concerns impede action (UNDP et al. 1994, p. 5), the tradeoffs among objectives spanning these scales that should not be ignored. Pursuing global interests in conservation of endangered species and unique ecosystems involves a high-opportunity cost for local people because of land scarcity in SE Asia. Under these circumstances, it is clear that the feasibility of key conservation objectives rests on the ability to secure the boundaries of so-called 'protected' areas. Again, this requires capacities for conflict management, including a mechanism for compensating local people for foregone opportunities. If it is not feasible to realign incentives for local communities, it is inevitable that conservation areas will continue to shrink – ultimately to the point that they no longer function. There may be more scope for finding common ground to couple local development initiatives with global interests in carbon sequestration since, if the possibility of global climate change is realized, its local manifestation may accentuate the frequency and scale of floods, droughts, fires, and pest outbreaks (Jepma and Munasinghe 1998, p. 49.)

2. Natural capital and environmental services: some BIG questions

'Natural capital' is economists' jargon for the stocks of natural resources, including soil, water, air, vegetation, wildlife, and other organisms, that supply environmental services (Constanza et al. 1997; Izac 1997). Table 1 lists some of the wide range of environmental services at different scales that may be affected by land use change. Although these 'environmental services' often have been treated as synonymous with 'forest functions,' we prefer the former term because even if forest-derived land uses are not perfect substitutes for natural forests, they still provide some level of these services.

The global ASB research programme already has made contributions to clarification of tradeoffs between welfare of poor rural households and global environmental services (for Indonesia, see Tomich et al. 1998, 1999). However, the hydrological, ecological and other environmental services at the local and national level are a significant gap in this analysis in terms of their impact on local people but also regarding potential complementarity with global environmental objectives. For Southeast Asia, prime candidates for research to fill this 'missing middle' include smoke ('transboundary haze'), the functional roles of biodiversity, and watershed functions.

The WCFSD report and the statements by Woodwell and by Newcomb mentioned above are but a few examples of myriad well-intentioned messages aimed at policymakers and the public regarding land use change and environmental services. But do we really know enough to build a consensus for action at the local and national level? How big are the effects of land use change (for better or worse) on stability of production systems at these scales? Although it appears that there are no perfect substitutes for natural forests regarding global environmental issues, some derived land uses may provide some of these services (Tomich et al., 1999). How well do these forest-derived land uses substitute for forests from the perspective of local people and national objectives? To what extent does expansion of shifting cultivation and other smallholder land use systems pose a threat to the 'natural capital' of Southeast Asia? What scientific evidence is available to answer these questions? Are scientists even asking the right questions?

From a policy analyst's perspective, three questions are crucial:

1. **'Who cares?'** How are people affected by degradation of natural capital? Who loses? Does anybody win? Are the negative (or positive) effects big enough to capture the attention of local people or of policymakers? If not, nothing is likely to happen. However, because of the possibility of conflicting interests, it is naïve to expect that research alone will lead to better public policy.

2. **'So what?'** Policy research aims to enhance options for meeting specific policy objectives, including growth with poverty alleviation, food security, and environmental stability. (Tree planting, reforestation, and soil conservation are means to ends; they are not policy objectives themselves.)

3. **'What can be done? (Will it work?)'** Policy research must consider specific policy instruments, the means of affecting policy objectives in the 'real world.' Examples of policy instruments relevant to land use change include exchange rates and interest rates; price, trade, and marketing policies; laws and regulations affecting access to and transfer of land and other assets; and public expenditures for infrastructure, research, and extension.

Note on environmental change and public health

In principal, Table 1 also could include a number of environmental services (and disservices) directly affecting human health, which of course are crucial to human welfare. Land use change per se (see Roelet et al. 1998) and all of the major themes explored in the balance of this paper -- smoke, biodiversity, watersheds – have major public health implications. The literature on pesticide runoff alone is substantial (e.g. Rola and Pingali 1993). Many of these concerns are the topic of a recent review of environmental change and human health (WRI et al., 1998). Moreover, it is possible to treat human health as a separate dimension of overall sustainability – as long as human health is reintegrated into the analysis of tradeoffs with production and other environmental effects at some point (Crissman et al. 1998). Although we will mention them briefly below, human public health concerns are omitted from most of the rest of this paper.

3. Social costs and scaling in space and time

Policy intervention so far has had at most a weak influence on transboundary smoke problems, biodiversity conservation, and watershed management. Banning burning for land clearing has not worked, at least in Indonesia. Conservation areas for the protection of biodiversity continue to shrink. And it is difficult to demonstrate results after years of watershed management projects. In this section, we consider why intervention is both desirable and difficult regarding environmental services. Approaches taken so far mainly are variations on land use planning, which seeks to regulate decisions of millions of people dispersed across the landscape. Land use planning can lead to nice colors on maps in planners' offices but little impact on the ground since it does not involve workable 'policy levers' that *really* can influence the rate and pattern of land use change.

Why don't individuals take care of environmental problems themselves? Most economists' answers to this question can be subsumed under three broad categories: policy distortions, market imperfections, and market failures. In each case, market incentives that influence people's land use decisions fail to include the full *social costs* (or benefits) of their choices. *Policy distortions* are government mistakes – at least from the point of view of the public interest, if not from the perspective of the private interests of policymakers and bureaucrats. But even if there were no misguided policies, there still would be plenty of work for policy analysts because markets for many (but not all) environmental services either are imperfect or fail completely.

Mayan myopia? A parable of scale, imperfect information, and irreversibility.

Market imperfections include the combined effects of uncertainty and irreversibility; regional growth linkages and spillovers; and economies of scale.[1] These classes of market imperfections operating together can create situations where, once an unforeseen threshold is passed, for all practical purposes, there is no going back. A report in the International Herald Tribune aptly illustrates how these concepts are linked to our topic. After describing how explorers cleared the Yucatan rainforest to reveal a magnificent Mayan temple, a news story about this major archeological find in Central America concluded that '... scientists have theorized that the logging required for the stucco construction may have depleted forests and compounded ecological changes, perhaps undermining agriculture and forcing the Mayans to migrate...' (International Herald Tribune 23 April 1999, p. 2). Despite the implausible interpretation by the unnamed US scientists, the article illustrates how uncertainty and irreversibility have a reinforcing effect—presumably the Mayas would not have built the

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[1] They also include high transactions costs, which are discussed further below, and factor market imperfections, such as insecure tenure and lack of access to banking services.

temple in this way if they had understood the consequences. It also illustrates the importance of time scales. Few things are absolutely irreversible; the rainforests returned … but too late for the Mayas. This story – call it a parable -- also raises questions about spatial scale and threshold effects: How big is the temple? How big was the forest and how much was logged? Metaphorically, this story contains the same basic dynamics as the WCFSD report cited above. But is this ecosystems really behave? If there are such catastrophic thresholds for land use change, can we anticipate them with any certainty?

Externalities, institutions, and scale

Market failures, which include *externalities* and *public goods*, are cases where no market price exists. Effects of externalities and public goods may be felt locally, regionally, or globally; in fact they correspond to many of the environmental services listed in Table 1. The term 'externality' refers to the effect of activities by one economic agent on another that is not reflected in market prices. Externalities may have positive and/or negative effects. Many of the meso-level environmental services listed in Table 1 [add examples from Table 1] are externalities.

'Public goods' are a specific form of externality. The defining characteristics of public goods are (1) their use by one person does not prevent full benefits being enjoyed by others and (2) it often is difficult to exclude users, hence it may be excessively costly to charge them. The global environmental services in Table 1 – climatic stability and avoidance of extinctions – are global public goods. Many of the impacts of land use change on pests and diseases of crops and livestock also are public goods (or bads) at the local, community, or national level.

Existence of externalities is not a sufficient justification for policy intervention, however, since individuals may be able to negotiate a solution even if markets fail to provide one (Coase, 1960; Zilberman and Marra, 1993). Whether or not such solutions are implemented depends on the value of the externality compared to the transaction costs – costs of organizing, negotiating, monitoring, and enforcing agreements – involved in a negotiated solution among the interested parties. Generally, these transaction costs increase with the number of people involved, their dispersion in space, and differences in timing due to lags between causes and effects. So local environmental externalities concentrated in a small area and involving a few people (who probably know each other and may even be relatives) and for which there are clear and immediate cause and effect relationships often will not be a policy problem. For example, well-established communities in Indonesia's Outer Islands often have their own well-developed techniques for managing burning and timber felling in order to avoid accidental damage to neighbors' property; and widely-recognized compensation rules already exist when accidents do happen (H. de Foresta, C.P.A. Bennett, and F. Gatzweiler, pers comm). Conversely, transactions costs are likely to be high for global public goods, including climatic stability and avoiding extinctions, whose effects are complex and dispersed globally and in which six billion humans share an interest. The focus of this paper is meso-level environmental externalities – smoke, landscape level functions of biodiversity, and watershed functions -- which involve groups and spatial or time scales that are too big for individuals to resolve but that fall within the jurisdiction of a single (or a few) government entities.

4. Managing smoke: key questions

Slashing and burning is the preferred method of land clearing in the tropics—for smallholders and large companies alike—because it is cheap, at least from a private perspective, and easy. In addition, fire eliminates field debris, reduces problems with weeds and other pests and diseases, makes nutrients available in the form of ash and loosens the soil to make planting easier. In some ways it is preferable environmentally compared to some other land-clearing methods. For example, bulldozers and other heavy machinery cause soil compaction and erosion.

Smoke is a textbook case of divergence between private benefits (cheap, effective land clearing) and social costs (lost opportunities for commerce and tourism from disruption of transport and obliteration of beautiful views, damage to human health (especially asthma and bronchitis), increased absenteeism and reduced worker productivity). In fact, smoke features prominently in Coase's (1960) seminal treatment of externalities. Forest, land, and coal seam fires associated with drought and human activity are not new in Southeast Asia, but smoke problems seem worse than ever before. From their historical review, Brookfield et al. (1995, p. 178) concluded that '... the impact of drought and fire over the past 10 years has been much more devastating than at any time in at least the previous 100 years, and probably much longer.'

What is the problem? Who cares about burning and smoke?

Who benefits most from free use of burning for land clearing, large-scale plantations or smallholders? Which of – or under what circumstances do -- these groups contribute the most to smoke problems? How do these costs compare with the direct benefits of burning for land clearing? What are the consequences of land clearing without the use of fire? In addition to use of fire as a tool for land clearing, fire also can be a weapon in social conflict (Tomich et al., 1998b). But does arson play a significant role in the smoke problem? Vayda (1998) argues that the incidence of accidental fires may be much higher that is conventionally believed. For a complex situation where firm conclusions are difficult even with detailed case studies (Potter and Lee, 1998), is there any hope of being able to attribute shares of smoke between purposive burning (for land clearing or arson) and accidents? The answers matter a great deal for the design of interventions – training programmes may be appropriate if most smoke comes from accidental fires, but would be irrelevant or even counterproductive if most fires are set deliverately – but is it feasible to measure these phenomena at a scale relevant for policy formulation?

Who bears the greatest costs of smoke from burning for land clearing? Local people in the neighborhood?[2] … people in the province or state? … the nation as a whole? … people in other countries? The widely-cited 1998 study by the Economy and Environment Program for SE Asia (EEPSEA) and World Wide Fund for Nature (WWF) estimated that of over $4.4 billion in damage from Indonesian fires and smoke in 1997, almost $3.8 billion (85%) was borne by Indonesia itself (Table 2). (Imputed value of carbon release was by far the biggest cost external to Indonesia.) And although the situation in Singapore and Kuala Lumpur received most of the media attention, the EEPSEA/WWF estimates indicate that Indonesian citizens suffered the most short-term health effects by far ($924 million out of a total estimate of just over $940 million; about 98%). If this is the case, is this really a regional problem?

What can be done about burning? What are the options for action to reduce the smoke problem?

What policy options and policy instruments exist to manage the recurring regional problem of smoke from land clearing? Are there opportunities for action to improve management of smoke through policy reform or institutional strengthening? What are the main lessons from the experience of different countries in designing and implementing strategies to manage smoke? With the return of smoke to the skylines of Singapore and Kuala Lumpur in mid-1999, and with fresh memories of the smoke problems of 1997/98, ASEAN environmental

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[2] In addition to the social costs of smoke, simulations by Menz et al. (1997) indicate that risk of fire spreading from neighbors' plots could be a significant disincentive to smallholder tree planting on *Imperata* grasslands.

ministers have once again called for immediate implementation of a 'zero-burning' policy (The Star, 17 April 1999). *Is it possible to go beyond apparently futile efforts to ban burning to identify more workable options for managing burning to reduce smoke problems?*

Are there any win-win opportunities? If there are conflicting interests, should/will the victims of smoke compensate people who give up burning? Or should the polluters pay? Is either approach feasible administratively or politically?

Who could implement these options? Who (or which institution) has the greatest influence over smoke and/or burning for land clearing? How could they influence it? What is a workable unit for management of smoke? ASEAN or other international organizations? The nation? Whole islands? Regions? Specific landscapes? Fields? What role do local ("informal") institutions play in managing burning and smoke?

What are the priorities for further research on burning and smoke?

What data would be useful in designing and implementing a strategy to manage burning in order to address the smoke problem? What is the role of remote sensing in managing smoke? Aside from remote sensing and better understanding of institutional functions at various levels, what other types of data or research would be useful to policymakers?

Is more or better information the answer? Is there a need for refinement of the influential EEPSEA/WWF (1998) estimates? If more and better data were available, how could they be used? Given the inaction to date, under what circumstances would more or better data be used?

5. Functions of biodiversity in the landscape: key questions

Much discussion of biodiversity conservation focuses on **global** existence values – in other words, preventing extinctions. Much less attention has been given to **local** functional values of biodiversity (belowground as well as above). This workshop seeks to put aside, for the moment, legitimate global concerns with extinctions, in order to focus on local, functional roles of biodiversity in landscapes where people seek their livelihoods.

Who should care at the local and national level? Who loses from biodiversity loss at the local level? How? Are there winners too?

Among the three themes of this workshop, the role of biodiversity at the landscape level is by far the most difficult to grapple with conceptually because, while there is a consensus of concern, there is no clear consensus about the basic functions of biodiversity at this scale. The Policy-makers' Guide of the Global Biodiversity Strategy (WRI et al., 1992, p. v) states that 'The conservation of biodiversity is fundamental to the success of the development process.' Perrings et al. (1997b, p. 308) are a bit more specific:

> What is becoming clear ... is that the sustainability of economic development implies ecological stabilization: the maintenance of the productive potential of ecosystems supplying essential ecological services either by the containment of stress levels or by the promotion of ecosystem resilience through biodiversity conservation. [3]

But what does this mean in practice ... over what spatial and temporal scale should we be concerned? On this, Gowdy (1997, p. 26) points to a dilemma for policy analysts:

> Although our present socioeconomic system cannot continue to expand indefinitely by destroying biodiversity, it is quite possible that economic growth can continue for decades or perhaps even centuries. ... If biodiversity loss and all other forms of environmental degradation will not appreciably affect economic activity in the immediate or even medium-term future, why should we bother to protect it?

The Mayan parable mentioned above suggests a possible answer: are some ecosystems headed on a path toward collapse, which, on a human time scale, is essentially irreversible?

Are there threshold effects of biodiversity loss on stability of production such that land use change that could be sustainable for a limited number of actors on a limited area

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[3] Perrings et al (1997b, p. 307) elaborate as follows: 'Loss of resilience implies a narrowing of the range of environmental conditions in which the system concerned can maintain its productive potential. ... Since all of the general circulation models (of climate change) predict and increase in the range of environmental conditions within which economic and

would be an ecological catastrophe if everyone did it? From studies in Malaysia, Thailand, and India, Boyle et al. (1997) concluded that for many forest species, 'threshold values of intensity of disturbance exist, beyond which there is a rapid loss of genetic diversity.' They include collection of non-timber forest products by settled communities among the 'disturbances' that 'can have serious disruptive effects' on genetic diversity. The question remains, however, about how this loss of diversity affects stability of production systems. And, if the probability of catastrophe is small, but not trivial—as may be the case for biodiversity functions at the landscape scale, then Perrings et al. (1997b, p. 303) point to an additional methodological challenge: conventional decision models do not work well for this class of problems.

Perrings (1998) has argued that '... the main external cost of biodiversity loss lies in the reduced resilience of agroecosystems in the face of environmental and market shocks.' (Also see Pagiola and Kellenberg 1997, p. 11). The main evidence on these functions comes from studies of North American grasslands, which showed biodiversity plays a role in resilience to drought (Tilman and Downing 1994; Gowdy 1997). *From a local perspective, how important are stabilizing functions of biodiversity compared to its other ecological goods and services?* For example, are the effects of biodiversity on production stability big or small compared with:

- opportunities for direct use and marketing of forest products by local people, either under normal conditions or during difficult times.
- effects of biodiversity conservation on prevalence of human pests (tigers, elephants) and diseases (malaria).
- less tangible aesthetic and spiritual roles of biodiversity for local people, which also may be developed as a basis for ecotourism and other new economic activities.

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ecological systems will have to function in the future, the loss of resilience in key ecosystems must be a matter for concern.'

Methods for valuation of commodities are well developed, whether the goods are marketed or not, except in cases of new (or emerging) markets (Vosti and Witcover 199X). So are methods for estimating amenity values (Lopez et al. 1994; Bockstael 1996), although some of these methods are difficult to apply in the absence of well-functioning land markets with large numbers of transactions. There are, however, alternative methods that have been used successfully in Southeast Asia (Mingsarn Kaosa-ard et al. 1995). It remains to be seen, however, whether it will be feasible to replicate these studies sufficiently for patterns to emerge. Moreover, how relevant will these estimates be with the passage of time and with economic and social change? Does the relative importance of these different ecological services to local people shift with rising incomes or with market integration? Is there any way to predict how these local values may shift as a result of new economic opportunities?

Should national policy makers worry about loss of these ecological functions in the same way they seem concerned about loss of watershed functions? From a national perspective, how important are the stabilizing functions of biodiversity compared to other pressing national concerns? How about all ecological functions taken together? Do we have any idea of these magnitudes? Can they be valued and compared with degradation of watershed functions, transboundary smoke, or other environmental concerns that do capture policymakers' attention from time to time? Are there concerns about biodiversity loss at the national level that are distinct from local concerns? How can diverse societies identify these functional roles of biodiversity and assess tradeoffs with other public policy objectives? How would these functional values of biodiversity to a nation compare to the compensation that people in the rest of the world would be willing to pay to preserve natural habitats to prevent extinctions?

So what? How does biodiversity affect the level and stability of production? How big are these effects?

What are the functions of biodiversity in the stability of production systems at the plot level? In contrast to well-recognized watershed functions—enumerated in a separate workshop theme (see part 6 below)—the ecological functions of biodiversity in the stability of local production systems have not been articulated clearly. For example, suppose for a moment that a perennial monoculture plantation provides watershed services that are indistinguishable from natural forest. What, if anything, would be lost (or gained) on-site from conversion of natural forest to monoculture plantation in terms of stability of the production system? One tangible example is the increased risk of pest and diseases. Chinese officials are reconsidering monoculture plantations in watershed protection forests because of infestations of pine nematodes and other pests (The Economist, 9 January 1999, p. 75).

Perhaps an even more important question is what effect (if any) would conversion from natural forest to a monoculture plantation have on the level and stability of production off-site on land adjacent to the monoculture plantation? Would neighbors face fewer production options because of loss of wild seed sources? ... new difficulties in managing fallows or soil nutrients? ... would they suffer more (or fewer) outbreaks of pests and diseases of crops and livestock? ...or would familiar pests and diseases be replaced by exotics? In short, should the neighbors worry? If so, about what? What is the evidence on these effects? Has anyone tried to measure them? More generally, how much/what types of biodiversity is needed to maintain productivity and stability?

Is it possible to produce a short list of key ecological functions of biodiversity regarding the stability of production systems at the plot level? ... encompassing interactions across plots within a landscape--land uses and their combinations in different patterns or 'landscape mosaics'?

What can be done? Do we even have the methods and data that we need?

To what extent is it feasible to go beyond plot-level measures of richness and to scale-up to the landscape level? Or, alternatively, is it better to begin with landscapes as the unit of analysis? And what is the appropriate unit for analysis at the landscape level? How big must a landscape unit be meaningful for local communities? ... for policymakers? *What are the appropriate scales – in space and in time – for assessing the effects of biodiversity loss on stability of production systems? Is it necessary to measure everything?* (Let's hope not!) Can insights from better understanding of the functional roles of biodiversity help guide priorities for measurement? *Are there important functions of biodiversity at the local or national level that are unquantifiable* (Norton 1988; Ehrenfeld 1988)? If so, how can these be incorporated in the debate?

6. Watershed functions: key questions

National concern for natural forest conservation and reforestation often focuses on the degradation of watershed functions, which typically is understood as some combination of:

- on-site declines in land productivity as a result of soil erosion,
- off-site concerns about water supply (quantity) including annual water yield, peak (storm) flow, dry season base flow, and groundwater recharge or depletion,
- off-site concerns about water quality, including siltation of reservoirs and environmental damage from runoff of pesticides, fertilizers, or animal wastes.

Who cares? Who should worry about loss of watershed functions? Why? Do we have the methods and data to answer these questions?

When is soil erosion a problem for farmers? Can the on-site impact of erosion on productivity be measured at the plot level? Can these on-site effects be estimated for bigger units? ... for landscapes? ... for states, provinces, or nations? What is an appropriate time scale for such estimates? Are these effects big? If so, under what circumstances? Ratan Lal

(1998, p. 158), one of the most respected researchers in the field, has concluded that 'agronomic effects of erosion on crop yield have not been adequately assessed. ... A major cause of controversy and confusion about the agronomic impact of erosion is due to weak, incomplete and unreliable data on soil erosion and its impact on productivity.' Based on careful econometric analysis of data from soil samples taken intermittently since the early part of the 20th century in Indonesia and since the late 1930s in China, Peter Lindert (1998) concluded that the analysis of 'erosion failed to show that it was a key source, or an accelerating source, of soil degradation in Indonesia over this half century ... Perhaps research on soil degradation should concentrate less on erosion and more on other human-induced processes, such as fertilizer, water control, and nutrient depletion' (p. 209) and 'we now know that in the most erosion-prone areas, particularly in the loess plateau and the arid fringes of China's northwest, the cultivated areas have been expanding, not declining, over the half century ending around 1990. The deserts and gullies have not advanced onto farmlands as much as the farmlands have advanced on the edges of the deserts and gullies' (p. 251). By suggesting either that the data are not there or that the problem is not there, these assessments fly in the face of popular conventional wisdom (e.g., Ekholm, 1976) as well as some respected expert opinion [example?].

When is soil transfer a problem (or an opportunity) for people downstream? Can the off-site impact on productivity of soil transfer (erosion net of sedimentation) be estimated at the landscape level? ... for states, provinces, or nations? What is an appropriate time scale for such estimates? What do available estimates tell us about effects of soil transfer on productivity for larger spatial units? Are these values big or small? ... under what circumstances? Mountain valleys and the great alluvial plains, which are the foundation of food security in Southeast Asia, are products of erosion. On net, does erosion from steep slopes and deposition in the lowlands increase or decrease aggregate production? If erosion were to halt completely, what would be the effect on lowland productivity? How do the net effects on aggregate productivity compare with other effects of soil transfer, siltation of reservoirs for example? Again, Lal (1998, p. 152) suggests that much remains to be done:

> ... the magnitude of soil erosion for principal soils and ecoregions is also not known. The available information on the magnitude or severity of soil erosion, voluminous and often replete with rhetoric is confusing, qualitative, incomplete, and unreliable. ... The information on soil erosion is also erratic because of lack of scaling procedures. It is difficult to aggregate the data from point or field scale to landscape, watershed, ecoregional and global scales.

Which among (a) on-site effects of soil erosion on productivity, (b) off-site effects of soil transfer on productivity, (c) other off-site effects of soil transfer, (d) flooding, (e) water shortages, and (f) water pollution from land use are of greatest concern in terms of the stability of production at various scales (communities, provinces, nations)? Can this question be answered? *Which among the foregoing six concerns counts as the biggest worry for policymakers at the local, provincial, or national level: erosion, sedimentation, flooding, or seasonal water shortages?* Kramer et al. (1998, p. 2) observe that 'most analyses of watershed services have focused on soil erosion effects. Studies of other watershed services, such as streamflow stabilization, water quality and quantity effects (particularly in the case of tropical settings) have seldom been done.' It follows, then, that there is little scientific basis for answering the first of this pair of questions. But just as with the assault on conventional wisdom regarding soil erosion, fundamental questions about the hydrological functions of forests and derived land uses are being raised. Recent comprehensive studies have concluded that deforestation has little impact on flooding (Chomitz and Kumari 1996; Calder 1998) and that forests (whether natural and plantation) 'use more water than most agricultural crops or grassland' (Bruijnzeel, 1990, p. 179). Chomitz and Kumari (1996) sum things up nicely: '... the levels of the [hydrological] benefits are poorly understood, likely to be context-specific, and may often be smaller than popularly supposed.' These uncertainties about basic relationships between land use and water supply are cause for concern in light of evidence that rapid growth in water demand for domestic and industrial uses may over time emerge as a threat to growth in food production (Pinstrup-Andersen and Pandya-Lorch, 1998, p. 6; Rosegrant et al., 1997). For Southeast Asia, Mark Rosegrant and his co-authors (1997, p. 7) predict that '… a doubling of domestic water withdrawals and a 290 percent increase in industrial demand will boost the combined share of these sectors in total water demand from 25 percent in 1995 to 47 percent in 2020.'

So what? Does land use change matter?

Do landscapes – land uses and their combinations in different patterns or 'landscape mosaics' -- matter for soil transfer? Are there significant differences in soil transfer among landscapes? How does the sedimentation arising from various landscapes compare with other sources of sedimentation, road construction for example? Do methods exist to quantify erosion from natural processes, agriculture, and other activities (such as road construction) and to assess the impacts (positive as well as negative) of resulting sedimentation at the landscape, provincial, or national scale? *Do landscapes differ significantly in their impact on water supply functions?* How do landscapes matter for total water supply (annual yield)? … for risk and severity of flooding? … for risk and severity of water shortages? *Is there a relationship between watershed functions and loss of landscape biodiversity?* Are these separate topics, or does it make sense to treat them as a single, composite issue?

What can be done?

What are the options for influencing land use change? If there are "big" concerns at various scales, what are the policy and institutional options for addressing them? …at what scale? As already mentioned, land use planning but has had little impact on the ground. What policies and institutional options really can influence the rate and pattern of land use change? How do we know any of this will work?

Who are the winners and the losers? If there are conflicting interests across groups, is it possible to strengthen or create mechanisms for conflict management—between neighboring communities; upstream and downstream populations; local, national, or perhaps even global concerns? Is it possible to create and manage mechanisms for compensating people for foregone opportunities? Consider the case of the Mae Taeng watershed in Northern Thailand, where water yields had declined for two decades: although it was not possible to definitively identify the complex causal factors underlying this trend, it was clear that competition for water between upstream, agricultural uses and downstream, urban uses was increasing (Vincent et al. 1995). The research team observed that 'it may be cheaper ... to allow farmers from the Irrigation Project area to sell their water to users in the city' but 'buying water from farmers would require an institutional revolution in Thailand...' (Vincent et al. 1995, pp. vi-vii). To date, this market-based approach has not been tried.

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Table 1.

Environmental goods & services at different scales

Goods & services	Global	Regional Trans-boundary	National	Local I: Inter-community	Local II: Intra-community
	Macro scale	**Meso scale**			**Micro scale**
Commod-ities					
Amenities & protective functions	Climate stability Exis-tence of species	Aesthetics Air quality (smoke) Biodiversity functions: pollination; seed sources, biological controls; production stability Water quality: filtering sediments and pollutants Water quantity: buffering flooding and base flow			Nutrient cycling Micro-climate effect of trees
Moral values					

Notes: typology of goods and services is based on Norton (1988).

Table 2. Fire and Haze Related Damage

Type of Loss	Lost to Indonesia	Lost to other Countries	TOTAL
Timber	493.7	-	493.7
Agriculture	470.4	-	470.0
Direct forest	705.0	-	705.0
Indirect forest benefits	1077.1	-	1077.1
Capturable biodiversity	30.0	-	30.0
Fire fighting costs	11.7	13.4	25.1
Carbon release	-	272.1	272.1
Short term health	924.0	16.8	940.8
Tourism	70.4	135.8	256.2
Other	17.6	181.5	199.1
TOTAL FIRE & HAZE	3799.9	669.6	4469.5

Source: EEPSEA (1993-1998), p.13