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The effects of scales, flows and filters on property rights and collective action in watershed management

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Abstract

Research and policy on property rights, collective action and watershed management requires good understanding of ecological and socio-political processes at different social-spatial scales. On-farm soil erosion is a plot or farm-level problem that can be mitigated through more secure property rights for individual farmers, while the sedimentation of streams and deterioration of water quality are larger-scale problems that may require more effective collective action and/or more secure property rights at the village or catchment scale. Differences in social-political contexts across nations and regions also shape property rights and collective action institutions. For example, circumstances in the Lake Victoria basin in East Africa require particular attention to collective action and property rights problems in specific "hot spot" areas where insecure tenure leads to overuse or under-investment. Circumstances in the uplands of Southeast Asia require analysis of the opportunities for negotiating more secure rights for farmers in exchange for stronger collective action by farmer groups for maintaining essential watershed functions.

Keywords: Scale; Lateral flows; Filters; Collective action; Watershed management; Property rights; Southeast Asia; East Africa; Externalities

1. Introduction

Many analysts see two obvious property rights problems inherent in watershed management. First, farmers in upland areas will fail to invest in soil conservation measures when they have insecure property rights. An obvious answer: governments should strengthen individual rights to those lands and support land markets. Second, farmers in upland areas do not take account of the

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off-farm impacts of their investments and land use patterns. Another obvious answer: governments should create private property rights and markets for environmental goods and services.

Most analysts would admit that these are likely to be only partial solutions to the watershed management problems in developing countries. The high transaction costs involved in establishing property rights or arranging efficient exchanges implies possible roles for collective action among groups within a particular catchment. And there may be a public interest in the way that the watershed is managed that is not served by either the private market or collective action solutions. The public sector may thus play important roles, often in concert with local community groups.

The issues of property rights, collective action and public sector interventions are made more complex when one considers that the common wisdom on catchment hydrology, erosion, and soil movement is based on several fallacies. The cause of many of these fallacies is a lack of understanding of key ecological processes affecting the movement of water, soil and pollution loads.

In this paper, we identify and discuss a number of key issues for property rights and collective action in watershed management that are particularly related to the issues of scale, flows and filters. Our approach is to integrate insights from ecological and socio-economic theory, evidence from the international literature, and our own first-hand experiences from work in Southeast Asia and East Africa. Section 2 focuses on the ecological underpinnings of watershed management, developing the concepts of scales, lateral flows and externalities. Section 3 presents some information on the problems of watershed management and research on watershed management in Southeast Asia and East Africa conducted by the international centre for research in agroforestry (ICRAF). In Sections 4 and 5, we use that base of practical and theoretical information in discussions of property rights and collective action in watershed management. Section 6 then discusses the roles of government, non-governmental and research organizations in watershed management.

2. Insights from the landscape ecology of watershed management

2.1. Watershed and catchment management

In this paper, we follow Tiffen and Gichuki (2000) in distinguishing between the terms ''catchment'' and ''watershed''. A catchment is ''the area of land from which rainwater can drain, as surface runoff, via a specific stream or river system to a common outlet point which may be a dam, irrigation system or municipal/urban water supply off take point, or where the stream/river discharges into a larger river, lake or the sea'' (DENR, 1998, p. 29). On the other hand, a watershed is a ''whaleback land unit'' that forms the upper area of one or more catchments, with hydrologic linkages to lower parts of the catchments (Tiffin & Gichuki, 2000).

The term ''watershed management'' is usually used to refer to both the management of both watersheds and catchments. In practice, it is clear that some policies and programmes are focused on the protection of the upland watershed areas that form the headwaters of streams and rivers, while other policies and programmes are focused on the management of the land and water throughout catchment areas. The term ''watershed management'' has often been the basis for

top-down management approaches by outside agencies, particularly in South Asia and Southeast Asia. Policies and programmes in northern Thailand, Indonesia and the Philippines are primarily concerned with the maintenance of tree and forest cover on upper watershed areas in order to maintain the quality and quantity of water in rivers emanating from the uplands. The presumption is that trees reduce sediment runoff and increase water infiltration, leading to higher dry season base flow and less sediment in lakes and rivers. High dry season base flow and infiltration are given particularly high value in rice-based societies with large concentrations of people living in flood plains.

On the other hand, catchment management is concerned with the use, allocation and ownership of units of landscape that are comprised of complex formations of soils, landforms, vegetation and land uses and the flows of water that link them together (Lal, 2000, p. 4). In recent years there has been a marked increase in the focus on catchments as units of land management in both developed and developing countries (Rhoades, 2000). The main issues motivating catchment management usually include: (1) on-site land productivity and the welfare of the people who rely on that land; (2) annual water yield flowing into reservoirs used for electricity generation, irrigation, and municipal uses; (3) peak (storm) flow of water and the implications for floods in lowland areas; (4) dry-season base flow, especially for people, animals or industries that draw water directly from streams; (5) appearance and safety of water in lowland areas; and (6) sedimentation of lowlands, reservoirs and lakes (Van Noordwijk, van Roode, McCallie, & Lusiana, 1998, p. 224). On the basis of an extensive review of the literature, Aylward (2000) concludes that soil erosion caused by agricultural production causes substantial off-site damages in the United States and similar areas around the world, but that the evidence is less conclusive on the importance of off-site damages of soil erosion in the tropical regions.

2.2. Fallacies of watershed and catchment management

Over the years, a number of presumptions have become entrenched in the policy making process. Many of those presumptions are fallacies. One common fallacy is the magnitude of soil loss due to erosion. Plot or farm-level studies of erosion are often "scaled up" to the landscape level through simple multiplication of per plot measures by the area in such plots. Viewed from the landscape scale, however, it becomes clear that soil that moves from one place in the landscape is often deposited at another place in the landscape. The key issues therefore are not related to the total amount of soil that moves, but the quantity that moves across boundaries, and the value of that soil in source and sink areas (Nagel, this volume; Van Noordwijk et al., 1998). Soil that moves from a hillside to an eutrophic lake would change from an asset to a liability. On the other hand, soil that moves from a hillside to a rice paddy may increase in value.

A second common fallacy is that agriculture is the dominant source of soil erosion in agricultural landscapes. In fact, minority land uses like footpaths and roads are often the main sources of erosion and sediment. For example, in some parts of Kenya it was been estimated that the level of erosion was 16 t/ha/yr for grazed land, 13 t/ha/yr from terraced land, and 250 t/ha/yr from roads (Reid, 1982; in Tiffin & Gichuki, 2000, p. 314). Nagel et al. (this volume) used the Cesium-137 method to estimate that only 17% of the sediment moving into reservoirs in the Nizao watershed, Dominican Republic, could be attributed to surface agricultural erosion since 1963.

A third common fallacy is that there is a short time lag between the detachment of soil in one location and its movement through the catchment or water system. There now is ample evidence that there often are very long lags—decades in many cases—between soil erosion and the deposition of that soil in major rivers or lakes. Agricultural landscapes are comprised of sediment sources, sediment and nutrient filters, and stores of past sediment. Lateral flows between these different parts of the landscape often occur very slowly. Nagel (this volume) shows that changes in agricultural land use in the Nizao catchment would have very little if any immediate impact on reservoir sedimentation.

A fourth common fallacy is that seasonal water shortages are all due to the removal of forests and trees in upland areas. Forests and trees are seen as natural sponges—soaking up excess water during storms, then slowly releasing it to the downstream areas. It is assumed that this increases overall stream flow, increases dry-season flow, and reduces the likelihood of floods. The weight of the evidence now shows that trees use more water than other types of vegetation, so that deforestation is usually associated with substantial increases in total water yield. Dry-season base flow may increase soon after deforestation and later decrease if the deforested soils degrade. Deforestation increases storm flow, as previously thought, but perhaps for different reasons than commonly perceived. Forest soils generally have high infiltration rates, not only because of the trees in the forest, but because of their rough surfaces and porous structure. Other land use types such as grasslands may have infiltration rates comparable to those in forests, while tree plantations may have lower infiltration rates (Van Noordwijk, Poulsen, & Ericksen, 2001). Interventions such as community woodlots may not, therefore, be an appropriate way to respond to problems associated with deforestation from a watershed management perspective.

A fifth common fallacy is that catchments are appropriate units for natural resource management (Forest Management Bureau, 1998, p. 4). From a hydrologic perspective, it is obvious that most important interactions between people and their environment occur within catchments. On the other hand, rivers and streams often form the boundaries, rather than the centre lines, of social and administrative units. Rivers and streams have several advantages as boundaries—they are easily observable, relatively fixed in space and difficult to transverse. There may be tradeoffs, therefore, between the convenience of using existing social and administrative boundaries and the logic of re-alignment along hydrologic boundaries (Johnson, Ravnborg, Westermann, & Probst, 2001).

2.3. Two approaches to scale

We may recognize two different approaches to scale: scale as hierarchy or scale as magnitude. The hierarchy approach of ecology portrays a phenomenon as a series of hierarchical relationships. The system of interest (level 0) is a component of some higher level (level +1). Level 0 itself can be reduced into a number of components (level –1). ''Scaling up'' in this approach is concerned with a shift in emphasis from a lower level (0) to a higher level (+1), while ''scaling down is concerned with a shift in emphasis from a higher level (+1) to a lower level (0) (King, 1991). Some of the principles of hierarchy theory are as follows:

(1) Different types of hierarchy are appropriate for understanding and addressing different problems of watershed management. For example, plot level studies may be appropriate for

understanding how different land uses affect the erodibility of different soils, while landscape-level studies are necessary for understanding how different landscape mosaics affect the sedimentation of streams.

(2) In general, it is not possible to transpose principles developed at one hierarchical level to higher or lower levels. For example, it is not possible to use data on stream sedimentation to draw conclusions about the severity of on-farm erosion in particular parts of the catchment area. If we are concerned with watershed management problems manifest at different hierarchical scales, then we need to design research and solutions that integrate across those scales (Scheier & Brown, this volume).

(3) Higher-level scales impose constraints on lower-level scales. For example, national-level laws constrain the jurisdiction and autonomy of local-level policy makers, while local-level policies have very little impact on the formulation of national laws.

(4) Higher level processes can be used to predict the outcome of lower-level processes, but it is often more difficult to predict higher-level outcomes on the basis of information about lower levels (King, 1991). For example, it is difficult to predict stream sedimentation on the basis of plot-level erosion.

Hierarchical scales for catchment management can be defined in several different criteria. One criterion is the Strahler stream order classification (Strahler, 1957). First-order streams originate from an accumulation of overland flow in a catchment area, second-order streams are formed by the intersection of two first-order streams or by the intersection of a second-order stream and a first-order stream, and third-order streams are formed by the intersection of two second-order streams or by the intersection of a third-order stream with any lower order stream. A second criterion is social-cultural grouping, with groups ranging, for example, from households, sub-clans, clans and ethnic groups. A third criterion is political—administrative boundaries and groupings, with the smallest unit being a plot and the largest being a group of nations. There may be some correspondence between the different hierarchical scales, but there will invariably be some important differences. Administrative boundaries may have some correspondence with socio-cultural boundaries, although socio-cultural units will tend to be less spatially defined and less homogenous in size than administrative units. This will be particularly true for ethnic groups who are relatively mobile, such as fishers, pastoralists and migrant workers. And neither administrative nor social-cultural boundaries generally overlap with the catchments of first- second- or third-order streams. On the contrary, rivers often form the boundaries of administrative units and socio-cultural groups often occupy distinct portions of catchment areas.

Important questions therefore are: (1) what possibilities are there to reconcile catchment and administrative boundaries? (2) what aspects of watershed management should be addressed according to which hierarchies and at what scales within those hierarchies? The remainder of this paper provides some answers to the first of these questions, while the paper by Scheier and Brown (this volume) provides some answers to the second question.

The second approach to the concept of scale focuses on the size or magnitude of a phenomenon. For catchment management, obvious biophysical units of measure are the hectares of land in the catchment or the number of kilometers in the stream network. Standard socio-economic factors that are measured in terms of their magnitude are persons and households in a population. "Scaling up" and "scaling down" in this approach describe changes in average unit value if the

magnitude of the phenomenon or size of the population changes. Migration is a phenomenon whose average unit value clearly changes with magnitude. At the magnitude of a single house, the proportion of persons who migrate sometime in their lifetimes is very close to one; at the magnitude of the planet earth, the proportion is zero.

Van Noordwijk et al. (2000) summarize the externalities that are created by lateral flows in catchments. Some of those externalities are manifest within relatively short distances, e.g. 0.1–1 km while others are manifest across hundreds of kilometers (see Table 1).

2.4. *Lateral flows, externalities and filters*

Economists often articulate the problems of catchment management in terms of the concept of externality. In general terms, an externality is produced when one economic agent A (e.g. person, firm, household) acts in such a way that another economic agent B bears a cost or receives a benefit that A does not consider when A makes his or her choices. The effect of upstream water users on downstream water consumers is a textbook case of an externality.

There is a strong link between the economic concept of externality and the ecological concept of lateral flows. Lateral flows may consist of mass flows of soil, water or air, of specific substances carried in such flows, or of movement of organisms.

In a catchment context, lateral flows exist whether or not there are people in the system, but without people lateral flows do not generate externalities. Externalities occur when three conditions are met: (1) there are lateral flows across a landscape; (2) there are people in the system who can deliberately or incidentally change the lateral flows; and (3) there are people in the system who are directly or indirectly affected by those changes in lateral flows.

Table 1
Externalities created by lateral flows of soil and water

Lateral flows	Examples	How far (km)?	+ or − externality	Ways to stop
Soil	Land-slides	0.1–1		
	Water-born sediment	10–100	− Physical destruction	Forested strips as filter
	Water-born sediment	10–100	− Siltation of reservoirs, ±fertilization	Riparian strips
Water	Floods	10–100	− Drowning & destruction	Riparian strips & floodplains
	Dry-season river flow	10–100	+ Off-season water supply	Reservoirs
	Total river water yield	10–1000	+ Storage water supply	Groundwater use
	Groundwater recharge	10–1000	+ Offsite water supply	Landscape surface roughness & infiltration sites
	Salt	1–10	− Salinization	Salt absorbing vegetation
	Nutrients	1–100	∓ Eutrophication	Absorptive filter
	Other pollutants	10–1000	− Pollution	Biological filter

Modified from: Van Noordwijk et al. (2000).

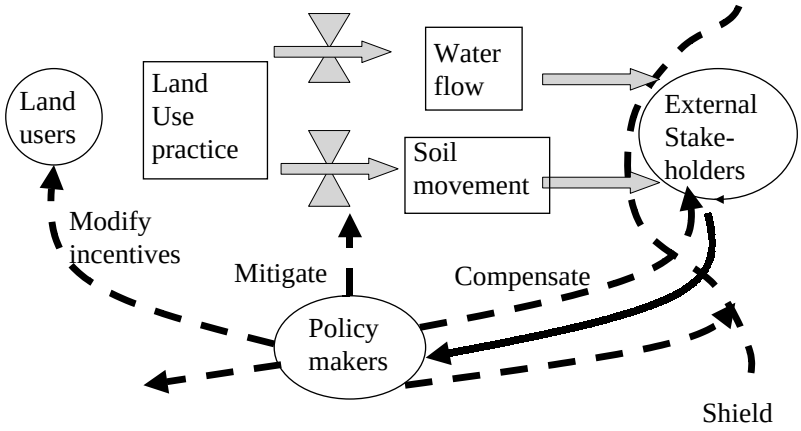

Fig. 1. Responding to externalities.

Closely related to the concept of lateral flow is the concept of filters. A filter is an element of a landscape that intercepts or modifies a lateral flow. Filters can decouple flows of dissolved particles from a mass flow of water, or act on flows of air or even organisms. Filters have profound effects on the way that people cope with externalities and the "scaling up" and "scaling down" of catchment management. There are filters in the landscape at all scales, from field edges, to rice paddies, to river vegetative strips to wetlands.

Fig. 1 illustrates the ways that policy makers can respond to the externalities created by lateral flows. Five types of responses are illustrated: (1) modify incentives for land users whose land use practices affect either lateral flows or filters; (2) mitigate the effects of lateral flows by enhancing filters in the landscape; (3) shield off external stakeholders from the effects of the lateral flows; (4) compensate those receiving negative externalities, possibly with funds raised as taxes from those who generate those externalities; or (5) ignore the situation. Ignore may be the optimum response if the transaction costs of any response exceed the benefits of responding.

3. Catchment management research in Southeast Asia and East Africa

The ICRAF has undertaken research on watershed and catchment management since the mid-1990s. In many ways we consider the watershed scale as the "missing middle" for research on land use and agroforestry. ICRAFs research previously focused at the plot and farm-level interactions between trees, water and soil. Under the systemwide alternatives to Slash and Burn Programme, ICRAF and its partners have gained an understanding of the relationships between land use and environmental services of global interest, particularly carbon sequestration and biological diversity. However, it has become increasingly obvious that much of the debate and conflict over land use in the tropics revolves around the effects of land use on environmental services that are important beyond individual farms, but not at the global level. Watershed protection is the most important of these services (Van Noodwijk et al., 2000).

There are many contrasts between catchment and watershed management in Southeast Asia and Africa. In most Southeast Asian countries, watershed protection has been the overt objective

of a great deal of government policy dealing with management of upland areas. Other government objectives—for example, biodiversity preservation and extraction of tax income—are often subsumed under the rubric of watershed management. Most watersheds in Southeast Asia are exorheic, that is, the rivers empty directly into the ocean without interception by lakes. The island countries of SE Asia contribute an exceptionally large proportion of the total amount of sediment that ends up in the world's oceans compared to their limited land areas (El-Swaify, 2000).

In contrast, many of the catchments in East Africa are endorheic, that is, they empty into lakes or reservoirs. For example, twelve of the larger rivers (i.e. stream networks of thousands of kilometers and catchments of thousands of square kilometers) originating in Burundi, Rwanda, Tanzania, Kenya and Uganda empty into Lake Victoria. Only a small proportion of the sediment from those rivers ultimately finds its way down through the Nile River system to the Mediterranean Sea.

ICRAF conducts multi-disciplinary research in three catchments Southeast Asia: the Mae Chaem catchment in northern Thailand, Sumber Jaya catchment in Sumatra, Indonesia, and the Manupali catchment in Mindanao, the Philippines. The Mae Chaem catchment covers about 4200 km^2 and is located 100 km west of Chiang Mai. The Mae Chaem is the upper-most tributary of the Chao Phraya River, the source of irrigation water for Thailand's main rice growing areas and over 20 million of its inhabitants. The area has a history of shifting cultivation and opium production. There is a diverse range of conditions within the watershed involving ethnicity, road access and property rights. Eighty percent of the area is classified as forest (ICRAF, 1998).

The Sumber Jaya catchment is located in the center of the Province of Lampung, on the island of Sumatra in Indonesia. It is an upland area of about 400 km^2 surrounding the Bukit Rigis mountain that forms the headwaters of the Tuland Bawang River, one of the major rivers in Lampung. Migrant farmers from elsewhere in Lampung and Java have moved into the area in the last 50 yr, primarily to grow coffee in upland areas.

The Manupali catchment in Bukidnon, Philippines is a similar upland area surrounding the Kitanglad Range National Park in the southern island of Mindanao. The area is inhabited by indigenous Talaandig people and Filipino settlers from other parts of Mindanao and the Visayan islands. Tenant farmers and land owners grow a variety of crops on the steep hillslopes.

In East Africa, ICRAFs research focuses on the basin of Lake Victoria, the second largest fresh water lake in the world. Lake Victoria supports livelihoods of hundreds of thousands of fishers and traders directly, with 30 million people living in the 168,000 km^2 lake basin. Lake Victoria is also an important global resource, with hundreds of fish species and one of the highest rates of speciation ever recorded. Lake Victoria now experiences a triad of problems—increasing loads of nutrients and other pollutants, colonization by water hyacinth and related water weeds, and destructive and unhealthy practices of fishing that have led to a ban on exports to the European Union.

3.1. Property rights in the Southeast Asian catchments

Property rights are contested in all three of the Southeast Asian sites. For example, 70% of the land area of Indonesia is now classified as State Forest, with the millions of people who live in those areas considered to be illegal squatters (Fay, de Foresta, & Sirait, 1998). State forests are frequently given out as forest concessions and tree plantations, ignoring the previous uses of that

land. Social conflict over the use of those lands is high. One manifestation of that conflict was the Indonesian fires of 1997 and 1998. Rural residents used fire as a weapon to damage firms with logging concessions, while plantation owners used fire to displace local people (Fay et al., 1998).

Most of the area included in the Sumber Jaya catchment in Indonesia was declared to be State Forest land in the 1970s. Since the late 1980s there has been almost continual conflict between the state forest department and the local population, with several large-scale evictions attempted. In the Manupali catchment in the Philippines, property rights are also insecure and uncertain. In the upper watershed areas there are overlapping claims between the forest department, the ancestoral communities, and the migrant farm communities. In the lower watershed areas, much of the land is owned by absentee landlords and farmed by long-term tenants. These tenancy contracts provide a disincentive to land investment because landlords do not want tenants to obtain stronger land rights. A similar situation prevails in the upper hillside portions of the Mae Chaem catchment in Thailand. The mountain ethnic groups (Karen and Hmong), who form the majority of the population inhabitat areas that are also classified as protected watershed forest. The Royal Forest Department is the recognized custodians of the area, while the mountain ethnic groups are not formally recognized as having any property rights. There is a long history of conflict between the Royal Forest Department and the mountain ethnic groups. In each of these catchments, ICRAF researchers work with a variety of partners to develop solutions that meet the needs of local people for tenure security, while also meeting the objectives of the forest departments for forest resource development and protection of forest functions.

3.2. Collective action in Southeast Asian watersheds

Experiences from Indonesia, the Philippines and Thailand suggest that there are strong links between property rights and collective action. Consider the case of Indonesia. Since the fall of the Suharto regime in May 1998, there has been an increase in the ability and aptitude of local populations to voice their demands for changes in the property rights regime and to resist the coercion of the Ministry of Forestry and Plantations and the commercial interests who have been granted forest concessions (Fay et al., 1998). The Ministry officials have in turn started to take the concerns of local people more seriously and has indicated some willingness to grant management rights to local people in exchange for having local residents abide by agreed management plans. The recent trend toward decentralization in Indonesia has further strengthened this trend toward more cooperative solutions to land use conflicts.

In Mindanao, the Philippines, ICRAF has been actively engaged in the formation and operation of local organizations for improved land management (Mercado & Garrity, 2000). These groups are called Landcare groups, after the successful movement for land management with the same name in Australia. At present there are over 300 village-based landcare groups in northern, central and southern Mindanao. In the Manupali catchment in central Mindanao there are some 60 landcare groups formed at the sub-village or neighborhood level to address local agricultural and environmental problems. Initially formed to share knowledge about the use of conservation farming practices such as natural vegetative contour buffer strips, these groups are increasingly addressing a range of land degradation and agricultural sustainability issues. Their watershed-protection activities have included the monitoring of water quality in local streams, re-vegetation of riparian areas to protect streams from contamination by soil erosion and manure/

sewage, and local legislation to promote soil conservation and biodiversity protection. Landcare groups formed at the sub-village level and village-level groups are members of registered municipal landcare associations. Landcare associations have become active partners with their respective municipal governments in developing and implementing local natural resource management plans.

3.3. Property rights in the Lake Victoria Basin

There is considerable variation in property rights across the 168,000 km^2 of the Lake Victoria Basin. The Kenyan portion of the lake basin includes protected state forest, large commercial tea estates, smallholder farming areas occupied by up to 1200 persons/km^2, irrigated rice and sugarcane, and more sparsely populated smallholder farms. Property rights to agricultural land are generally quite transparent, almost all agricultural land under private ownership with registered title deeds. Forests are more problematic, with the Ministry of Environment and Natural Resources, Kenyan Wildlife Service and county governments having responsibilities for the management of different types of forests. ICRAF research conducted in the Kenyan Lake Victoria Basin has identified three property rights problems: (1) over-exploitation, poor management and under-investment in the riverbank areas that are *de jure* state property and *de facto* open access; (2) hillside areas that are used for collective grazing or wood collection but are held under individual title; and (3) degraded hillsides and converted wetlands that are leased to outsiders on short term contracts.

There are three main types of land use in the Tanzanian portion of the Lake Victoria Basin: (1) extensive agriculture; (2) extensive and mobile livestock production; and (3) multiple-use wetlands. Customary property rights systems prevail in most of Tanzania, with rights most individualized in areas farmed most intensively. Pastoral property rights systems support mobility across large areas. The most conflict over property rights occurs in the wetland areas where many competing land use practices overlap and often compete.

The majority of the agricultural land that drains into Lake Victoria is held under customary tenure, with patrilineal rules of inheritance (Place & Otsuka, 2000), while a small percentage of the area is held under the *mailo* system of tenure. The mailo system has its origins in the early colonial period when large tracts of land in the Buganda region of central Uganda were given to notables and elites. Much of this land has in turn been rented to tenants in exchange for fees and rents. Today, most of mailo land is farmed by long-term tenants.

3.4. Collective action in the Lake Victoria Basin

There are different challenges and opportunities for collective action in Uganda, Tanzania and Kenya. The governments of Uganda and Tanzania have already devolved significant authority to local government units. This puts governments in closer touch with local resource management problems and possibly improves their ability to implement land management programs such as landcare that bring together local policy makers, farmers, and technical agencies. In the Kabale area of Uganda, for example, researchers, local policy makers and NGOs have formed a research-policy forum for natural resource management.

To date, however, the greatest successes with collective action for land management in East Africa have been achieved in Kenya. Since 1988, the Kenyan Ministry of Agriculture and Rural Development has applied a focal area approach to soil and water conservation with support from Sida. Each year conservation officers identified one or two focal areas in each administrative division of the country. Focal areas are usually about 200–300 ha in area, with populations of about 200–300 households. Focal areas were also called "catchments" although in practice the boundaries of the areas are determined more by social and administrative criteria than by hydrologic criteria.

Once a focal area has been selected, participatory rural appraisal techniques are used to identify land management problems in the area and priorities for solution of soil and water conservation problems. Focal area committees are elected to work with the conservation officers. A land management plan is developed for the focal area as a whole and for each farm. During the rest of the year, the Focal area committee and conservation officers worked to develop land management plans for each farm. At the end of the year the conservation officers move to a new catchment and frontline extension staff are responsible for follow-up with the farmers.

At its peak, the focal area approach to land management reached 100,000 new farms each year, prompting adoption of different conservation techniques by 20–70% of farmers in each catchment. In 2001, the focal area approach was adopted by the Ministry of Agriculture and Rural Development as the main extension approach used in Kenya. The new programme is called the National Agriculture and Livestock and Extension Programme (NALEP).

At the same time as this national program has succeeded in alleviating land management problems on hundreds of thousands of individual farms in Kenya, the overall landscape and key water bodies have been deteriorating. Since July 1999, the ICRAF has been working with the Kenyan Ministry of Agriculture and Rural Development on a joint research project to: (1) identify areas prone to particularly severe and rapid degradation, (2) evaluate technical interventions and institutional options for reducing sedimentation of the Lake Victoria water system while improving the welfare of people living in the Lake Basin, and (3) quantify the actual and potential impacts of promising land management interventions on human welfare and the environment. The Ministry of Agriculture and Rural Development and ICRAF are now experimenting with natural resource planning at the catchment scale and the formation of coordination committees and task forces to facilitate greater cooperation in the management of priority catchments.

4. Property rights and the management of watershed resources

4.1. Plot and farm-level property rights

As indicated in the introduction, there is a common conception that ill-defined property rights at the plot and farm levels are a major cause of erosion and sedimentation. The logic is that if farmers do not have secure rights in their land, they will not have the incentive to care for that land or make long-term investments in its improvement. The way to solve this problem is to support the development of private property rights and land markets (Tiffin & Gichuki, 2000, p. 310).

Public action in support of more secure collective or private property rights may indeed be appropriate in some circumstances. One such circumstance is where other important actors—government, forest plantations, and wealthy absentee landlords—monopolize land rights in competition with smallholder farmers. For example in Southeast Asia, smallholder farmers compete with forest companies, commercial farmers, absentee landlords and the state for land rights in upland watershed areas.

In most of Africa, land is still governed by customary institutions that provide smallholder farmers with relatively secure and long-term property rights. Indeed, in many parts of Africa, farmers are able to gain more secure and permanent rights by investing in the land. This provides contradictory incentives vis-à-vis watershed management. On one hand, land clearing is an investment that can inhibit watershed protection. On the other hand, investment in soil conservation and trees can enhance watershed protection. Overall, however, the soil degradation observed across much of Africa is likely caused by many factors in addition to insecurity of land tenure (Place & Swallow, 2000).

4.2. Property rights and the management of upland watershed areas

The concept that the state needs to take control of upland watershed areas is based on an assumption that farmers' individual land use practices will be in direct conflict with the social objectives of watershed protection. On that basis, governments, particularly those in Southeast Asia, have declared vast tracts of land to be state land. There are several problems with this approach for the management of upland areas. The first problem is that the approach is based on some of the fallacies discussed above. For example, it is assumed that forest is the only land use consistent with watershed protection and that tree planting is the best way to restore watershed protection to a degraded hillside. The second problem is that the state agencies made responsible for managing land are often motivated by objectives other than watershed protection. Some of these objectives may be consistent with the public interest, such the conservation of biodiversity, while other objectives are contradictory to the public interest. The allocation of state forest is often used for political patronage, extraction of rents, and retention of political power. The third problem is that the millions of farmers who live on state forest land remain on the land, but at risk of eviction. This lack of tenure security discourages land husbandry and investment. Finally, conflicts between smallholder farmers and the state may be manifest in destructive land use practices, for example, using fire as a weapon in a land-use conflict (Tomich et al., 1998).

Property rights to upper catchment areas are also overlapping and contested, particularly in Southeast Asia. In the Manupali catchment area of the Philippines, for example, there are overlapping rights by the national Department of Environment and Natural Resources, the indigenous Talaandig people who have an ancestral claim to a large part of the public lands, and migrant settlers who are homesteading on these lands. There are also overlapping jurisdictions among government entities. The boundaries of the municipalities surrounding the Kitangad Range Natural Park overlap entirely with the public state forests. Thus, three types of management plans must be reconciled for the land conflicts to be resolved: the Park and buffer zone management plan, the ancestral domain claim and management plan, and the natural resource management plan of each of the surrounding municipalities. Appropriate land tenure instruments will need to be agreed upon by all these parties to ultimately resolve the confusion.

4.3. Property rights and erosion hot spots

Within a landscape, it is usually possible to identify specific areas—hot spots—that are responsible for a disproportionate share of the erosion and sedimentation problems. In the Nyando River Basin in Kenya, for example, the main erosion hotspots appear to be forest margins, roads, footpaths, hillside areas, gullies at the base of escarpments, and river banks. There is considerable variation in property rights across these areas. Forests are contested resources in Kenya, with pressure for conversion into farmland exerted by smallholder farmers and large-scale commercial producers. Roadways are usually considered to be state property, with the Ministry of Transport given responsibility for construction and maintenance of roadways. Footpaths are common use areas, located on either individual or village land. Usually there is little conscious planning of the design of footpaths.

Even in the high potential areas of Kenya where almost all land is assigned individual ownership, most eroded hillsides and gullies are de facto open access because the owners do not have the means or interest to make the investments necessary to rehabilitate the land. There are cases of successful gully reclamation by individual farm households, but these are the exception rather than the rule.

The spatial configuration of land use and property rights can have important implications for the management of hillside areas. For example, in the Kabale area of Uganda, farmers tend to own plots that are scattered about the hillsides of an area. Although plot scattering may have advantages for risk minimization, the transaction costs associated with farming such widely scattered plots may be one reason for under-investment and low productivity of land in those areas. Where there are narrow plots running up and down hillsides, lines of trees planted to mark boundaries between farms do not serve as filters.

4.4. Property rights to filters

As indicated above, lateral flows of sediment and nutrients are often most dependent upon the presence and location of filters. Fig. 1 shows that installation or enhancement of filters can be a cost-effective way for policy makers to respond to lateral flows and externalities. It is common, therefore, for policy makers to declare state ownership of natural filters, for example, wetlands and riverine areas. The problem is that without strong state management institutions, state property often deteriorates into de facto open access. Once those areas are degraded, there is no incentive for private re-investment.

Natural wetlands are often used by different groups of people for different purposes. Sustained use of natural wetlands usually requires a management system that builds upon customary management regimes, while recognizing public interest in wetlands. What is needed to make such management regimes functional is an excellent base of information about the tradeoffs involved in alternative uses and management of wetlands. Research that integrates ecology, economics and institutions is needed to provide that base of information.

Advances in appropriate technology and ecological engineering are yielding new options for installation of filters. The simplest type of filter is the natural vegetative strips adopted in the Philippines. Forest wetlands with cyprus trees are now being routinely constructed for filtering waste for urban and industrial sources of pollution in the United States. Some of those

approaches are being tested in the Lake Victoria Basin. Again, some type of co-management regime may be appropriate for the management of those new types of filters.

5. Collective action and the management of catchments

There are several ways in which public agencies, resource users, and those affected by lateral flows of sediment, water and pollution could work together to solve the problems of watershed and catchment management. One way, discussed in the introduction, would require the state to create property rights to watershed services and a market for the exchange of units of those services. Such approaches may have promise in a few developing countries where markets are very well developed. In most countries in the developing world, however, the transaction costs that would need to be incurred to implement such solutions are prohibitive. Collective action—people working together toward some common goal—is a potential solution. In this section, we draw upon the literature and our experiences from the Philippines and Kenya to propose some principles to guide the search for effective collective action.

5.1. Farmer first

Collective action for catchment management is likely to be successful when it appeals to the self-motivation of farmers to improve their fields and the welfare of their families (Shaxson, 2000). Successes observed in both Kenya and the Philippines emanate from the benefits that individual farmers obtain from investments on their individual fields and farms. The three primary motivations for individual farmers to adopt soil and water conservation practices are reduced risk, increased possibility for cash crop production, and avoidance of punishment (Tiffin & Gichuki, 2000). Tiffen and Gichuki (2000, p. 316) explain that the success in the Machakos area of Kenya of "More People Less Erosion" occurred in part because the Machakos farmers were able to transform their investments in land conservation into cash earnings from the sale of coffee.

5.2. People manage watersheds

The conventional wisdom is that planning for watershed management should be done on the basis of hydrologic boundaries. There is good logic underlying this assumption—the flows that are of greatest concern are encompassed by catchment boundaries. But the practical challenges of mobilizing local social and political support across political boundaries are a major limitation to this approach. It is thus increasingly acknowledged that the practical approach may be to make general plans on a catchment basis, but to mobilize action within the smallest political units and only gradually work back up to the coordination of these actions across the catchment as a whole (Johnson et al., 2001). The landcare experience in Australia and the Philippines, and the experience of the Catchment Committees in Kenya, lend support to the approach of building from the village up. To date there has been much experience in stimulating collective action at the village level, but successful cases of scaling this up to the watershed level are still fairly rare.

5.3. Small is still beautiful

The bulk of the experience with catchment management shows that the "small is beautiful" (Schumacher, 1973) hypothesis holds true in watershed management. In the Philippines, people have been most interested in forming landcare groups at the sub-village level, with groups of <40 members (Mercado, Patindol, & Garrity, 2000). In Kenya, the catchment approach has worked best where focal areas are small, where they fall within a single local government area (sub-location), and where the members know each other as neighbours (Tiffin & Gichuki, 2000, p. 306).

Lateral flows create some of the rationale for organizations that form to internalize externalities. e.g. negotiation between upstream and downstream groups. However, these interactions are often over-emphasized. For one thing, a focus on lateral flows may ignore the possibility that the installation or strengthening of a landscape filter or barrier may be the best way to reduce an externality. Secondly, groups may be more strongly linked through economic networks than through lateral flows. If there are not strong lateral flows, or if lateral flows can be effectively mitigated without super-village groups, then it may not be worthwhile to form organizations to facilitate interactions between small groups.

5.4. The larger the scale, the greater the need for external mediation

If indeed there are significant benefits to be gained from collective action at larger social scales, then there may be an important role for some credible external agency. For example, the Philippine Strategy for Improved Watershed Management (DENR, 1998) involves building up from village landcare groups with the facilitation provided by provincial and national government agencies.

6. Roles for external organizations

This concluding section of the paper will focus on the role of external research and development agencies in light of the discussion of property rights and collective action presented above.

6.1. Roles of non-governmental organizations in watershed and catchment management

The experience so far is that donor agencies want non-governmental organizations involved in watershed management projects because they are seen to be more participatory and more willing to listen to farmers' concerns than government agencies. Certainly there are many success stories that have involved non-governmental organizations, as indicated by the articles by Shah and Raju (this volume) and Kerr and Chung (2001). However, Rhoades (2000) points out that NGOs also have their own agendas that may or may not be consistent with farmers' needs. ICRAFs experiences from Indonesia suggest that NGOs may see themselves as the guardians of farmer interests or guardians of the forest. This may hamper their ability to appreciate legitimate public interests in watershed management. In addition, NGOs often "adopt" communities, and may begin to assume the role of gatekeeper to the community. This may have the intended effect of helping to shield the community from other outside organizations or entities that are perceived

to be detrimental, while also blocking useful contacts between communities and the outside world.

6.2. The state as problem and solution

ICRAF experiences from Southeast Asia and East Africa suggest that the state is often part of the problem of watershed management. In Southeast Asia, the state often contributes to the adoption of unsustainable farming and land clearing practices by undermining the property rights of local farmers. In Kenya, there is great concern at the moment about government plans to re-classify large areas of forest as agricultural land (The Economist, March 31–April 6, 2001, pp. 40–42).

In Kenya and the Philippines, we also have substantial evidence that the state can also be an important part of the solution. The state can play a variety of roles at different scales. At the village level the state can help to facilitate the development and effectiveness of local organizations. In the case of landcare in the Philippines the state assists by mobilizing, training, and directing extension officers to assist group facilitation (Garrity et al., 2002). At the municipal level the state can provide significant assistance through policy and financial support to group activities and strengthening. At the national level a favorable policy environment may be a crucial element for local organizations to be effective.

6.3. Information brokers

Information and knowledge are often the most limiting factors in catchment management (El-Swaify, 2000). The landcare concept is that information brokers (e.g. research organizations, universities) can assist in providing all stakeholders with a good base of information for making decisions that affect their lives, their farm enterprises, and the community. Better information and skills may also be important to assist negotiation to manage or solve conflicts among stakeholders with competing interests (Garrity et al., 2002; Johnson et al., 2001). Research organizations can play key roles in providing both information and training.

6.4. Prioritizing public investment in catchment management

One of the possible roles of research organization is to provide governmental and non-governmental organizations with information that can be used to determine priorities for the use of public funds in catchment management. There are two overall approaches to priority setting:

(a) General prioritization of funds according to the objectives of human welfare and environmental conservation. In those areas, the state can provide a very low-cost method for groups to form, then direct support to those communities that are self-motivated and already willing to invest substantial resources of time and effort of their own.
(b) Prioritization of areas with large land management problems that can be ameliorated by some change in land use or installation of a filter. This is the approach that ICRAF and the Ministry of Agriculture and Rural Development are taking in Kenya.

The approaches may also be combined. For example, after selecting the localities where major land management problems are most critical, the flow of support to communities in the area may be directed on the basis of the relative quality and motivation of the local organizations in different communities.

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