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THEMATIC ESSAY

Soil Conservation in a Watershed: Institutional Alternatives

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Abstract: The private, collective and public nature of soil quality in a watershed provides three different institutional alternatives for watershed management: individual, collective and government action. This study reviews the success and failure of these alternatives in different parts of the world. Individual action by a farmer is driven by the net present value of farm profit and the resale value of the agricultural land. However, individual action for soil conservation remains sub-optimal due to the presence of negative externality and the short-run income loss to the farmer. Many government and development agencies have designed several mechanisms such as collective and government actions to internalise the externality. However, not all these alternative initiatives have been successful in ensuring successful management of soil quality in a watershed.

1. INTRODUCTION

Soil quality in a watershed has the characteristics of a private, collective and public good. Farmers have the property right to farmland and responsibility for farm soil quality. But soil erosion due to inefficient farm practices can affect soil quality of the neighbouring farms, especially the downstream farms in a watershed, thus causing a negative externality. Cooperative action among the farmers is therefore required to contain this externality for a collective good or the common property of a group of people. There are many stakeholders of a typical watershed: farmers, the government, and the general public. The government may have property rights over the upland forest land and grasslands. The general public has property rights over the watershed too. And it is this property right over the watershed that ensures several things: water supply for the use of households and industry, safety

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from floods, carbon sequestration from forest and grassland etc. They are the public good services provided by a watershed.

Collective goods are those available for collective supply and collective use of a group of people. In a watershed, upstream forests, grazing lands and soil quality can be characterized as collective goods. In literature, upstream forests, grazing lands and soil quality of a watershed are characterized as common property resources. Collective goods share characteristics of both public and private goods because they are divisible and rival in consumption (like private goods) while also being non-excludable (like public goods).[1] Because they are non-excludable, the externalities associated with the supply and use of these resources create the familiar free rider problem. Much scholarly work has focused on explaining how collective action by the stakeholders can deal with this problem for the efficient management of these resources.[2]

Samuelson (1954) defines public goods as goods available for joint consumption, with non-excludability and indivisibility properties, where, as in the watershed context, the supplier of the good may be one while the beneficiaries are many. In the present instance, forest and soil conservation in the uplands (by government and/or farmers) could benefit many in the downstream due to its role in controlling floods and providing fresh water. This means that upstream and downstream hydrological relationships obtain among the users of the watershed. Hence, an efficiently managed watershed provides private, collective and public good service to the people.

Due to the public and collective good nature of a watershed, the market for many watershed services are either missing (for e.g., hydrological services, carbon sequestration, etc.) or are less than efficient as the price of food, wood, hydro power, etc. may not fully reflect the social cost. Under these circumstances, the optimal provision and use of collective goods by farmers to achieve the larger interests of the society such as hydrological services, carbon sequestration, etc. may not be possible. However, there exist several mechanisms to internalise the negative externality and to provide incentives for on-farm investment in soil conservation in the watershed. They are: "(1) moral suasion; (2) regulatory limits and economic penalties; (3) taxes on negative externalities; (4) tradable environmental allowances (permits for negative externalities); (5) investment subsidies; (6) indirect incentives; (7) mergers; (8) payments for environmental services; (9) changing and/or

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[1] Cornes and Sandlers (1984; 1996)

[2] Some of them are Olson (2009), Ostrom (2000), Wade (1987), Chopra *et al.* (1990) and Baland and Plateau (1996).

strengthening property rights and liability systems; and (10) facilitating negotiation and conflict resolution" (Kerr *et al.* 2007).

Overall, the institutional alternatives for the efficient use of soil quality in a watershed and the effective implementation of mechanisms to internalise the externality require, in practice, a combination of individual, collective or group, and government actions. This paper reviews some empirical studies dealing with these three institutional alternatives for soil conservation in a watershed. Section 2 discusses on-farm soil conservation and individual action. Section 3 deals with inefficient farm practices and collective action for containing the externality of soil erosion. Section 4 presents a discussion on forest conservation and government action. Lastly, Section 5 provides concluding comments.

2. ON-FARM SOIL CONSERVATION AND INDIVIDUAL ACTIONS

Inefficient agricultural practices could lead to soil erosion, which reduces farm productivity while significantly inflating the input cost. Concerns regarding the actual/potential decline in yield and the higher cost of production lead individual farmers to adopt conservation measures to reduce topsoil loss. Farmers are the owners of farmland on the basis of property rights. They make investment decisions regarding soil conservation considering the costs and benefits involved. In addition to the net private benefits from conservation measures, the resale and rental value of the land also influence an individual farmer's decision to invest in soil conservation.

Lutz *et al.* (1994) provide evidence that the net positive benefit from agriculture may offer an incentive to the farmers to invest in soil conservation. In a study of several countries in Latin America, Lutz *et al.* (1994) empirically established investment in soil conservation by a farmer is driven by the market prices of both inputs and outputs. A study by Miranowski (1984) evaluates the impact of productivity loss on land management decisions in a watershed in Iowa, USA, and yields similar results. The author established that the expected rise in crop price in future (which would mean a higher expected future profit) may also encourage farmers to adopt more intensive soil conservation measures. McConnel (1983) established theoretically that the increasing soil loss over time was part of rational farm management choices and not due to a farmer's ignorance about the future. However, the possibility of soil loss could lead to a decline in the resale value of land in future. The expected loss in future can force a farmer to invest in soil conservation.

The studies of McConnel (1983), Lutz *et al.* (1994) and Miranowski (1984), however, ignored problems related to negative externality of soil erosion. The paths of private and social rate of optimal soil erosion could diverge in the presence of significant negative externality (Miranowski 1984) like change in hydrological cycle, increase in cost of water purification for water supply etc. In addition to externality, the eroded land slowly reduces the capability of the individual farmer to invest in soil and water conservation measures to halt the degradation of land due to the continuous fall in revenue and/or rise of cost in agriculture. Therefore, without proper monetary incentives, it is difficult for farmers to invest in degraded land (Barbier 1990). Moreover, some soil conservation techniques not only lower the yield of the crop in the short run but also raise the cost of production immediately. This short-run penalty on profit may also discourage the farmer to adopt on-farm soil conservation.

In response to lack of adequate incentives for farmers to invest in soil conservation, the U.S. federal government has started providing technical assistance to farmers while sharing the cost of soil conservation measures (Walker and Young 1984) – this is one way of providing investment subsidies for soil conservation. For instance, in the Palouse region of the USA, the federal government has increased its expenditure in order to encourage on-farm soil conserving tillage system in order to manage crop residue. However, despite the progress in yield enhancing technology in the study area, the potential gain in crop yield was not realised due to the existing erosive farming system, i.e., the absence of tillage (Walker and Young 1984). A similar kind of initiative was undertaken in Australia. In New South Wales, for instance, a farm planning scheme provides technical (i.e., recommendations on specific soil conservation measures) and financial assistance (i.e., a long-term loan at cheaper rates of interest to farmers) for on-farm soil conservation measures.[3] These and such assistances could be described as an amalgamation of moral suasion and indirect incentives to overcome the externality of soil erosion. In their study, King and Sinden (1988) revealed that soil conservation measures fetched a higher price and a higher rental value of land.

The findings of Walker and Young (1984) and King and Sinden (1988) have established that investment subsidies, moral suasion and indirect incentives by governments in developed countries can provide farmers the incentive to undertake soil conservation measures. However, there have been many instances of such measures falling short of the expectations in countries of the developing world. In developing countries, development agencies,

[3] See, King and Sinden (1988).

governments and donors have spent substantial amounts of money to encourage farmers to adopt on-farm soil conservation measures. These measures have been diverse in nature and very much region-specific. They have combined indigenous, mechanical (e.g., stone bunding and terracing) and agronomic (e.g., agroforestry, minimum tillage, etc.) practices. Of these, the mechanical measures were funded by the government or donors. In the case of Nicaragua and the Dominican Republic, for instance, an investment subsidy and indirect incentive succeeded in incentivising farmers to adopt soil conservation for a limited period of time in a Soil Conservation Project implemented during the 1980s. It was however observed that farmers were not only abandoning soil conservation but physically removing conservation measures once the subsidy period was over (Lutz *et al.* 1994).

Apart from the cost sharing strategy of soil conservation measures in the developing countries, governments have also tried to influence (i.e., regulate) output prices. For instance, Pagiola (1996) examined the role of the pricing policy on the return to terracing in the semi-arid region of Kenya by using experimental data where the Kenyan government had artificially raised the price of maize (the main staple food in the land degraded area) to incentivise farmer to adopt soil conservation. The empirical findings suggested that the increase in maize price had increased the net present value of the crop in steep slopes but had decreased it in shallow slopes. Therefore, the impact of the pricing policy adopted by the government on returns was not independent of the biophysical characteristics faced by the farmers.

In addition, the problems with regard to implementation of on-farm soil conservation by an individual farmer are more prevalent in a developing country than in a developed country due to insecure property rights, wide spatial dispersion of agricultural activity and, consequently, the weak enforcement powers of the government (Pagolia 1996), free riding behaviour of farmers due to lack of incentives, and lack of awareness and inadequate financial capability of farmers with regard to the importance of cooperative institutions (Khisa *et al.* 2007; Van Rijn *et al.* 2012).[4] However, though important, these conditions are not in themselves sufficient as conditions to prompt the adoption of soil conservation (Shiferaw *et al.* 2009). Since soil conservation benefits are partly private and partly public goods, as mentioned before, collective action could result in efficient on-farm soil conservation decisions by farmers.

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[4] The decision regarding conservation is also influenced by socio-economic factors, farm characteristics, market-access variables, social learning, and social networks (Teklewood *et al.* 2014; Wossen *et al.* 2015). However, these factors are not the focus of discussion in this paper.

3. INEFFICIENT FARM PRACTICES AND COLLECTIVE ACTION FOR CONTAINING THE EXTERNALITY OF SOIL EROSION

The soil quality of farmlands is a collective good as the soil quality of a farm carries consequences for the quality of land in neighbourhood farms. It is especially so in the context of soil erosion in upstream farms, which could affect soil quality in downstream farms in a watershed. This upstream and downstream linkage creates interdependence among users of the resource. But, in a free market situation, getting farmers to adopt soil conservation technology voluntarily in order to achieve the goal of required adoption and diffusion of the technology is not easy. Soil conservation requires collective provision and use of soil quality in a watershed, especially in a micro watershed. Given this externality of soil erosion, soil quality has to be conserved as a collective good.

The studies of Wade (1987), Chopra *et al.* (1990), Ostrom (2004), and Baland and Plateau (1996) have suggested principles for successful collective action for managing collective goods like soil quality in the context of externality. They are presented as operating principles for or limits to collective action. The institutional characteristics for successful collective action include: (i) the characteristics of user groups, (ii) the presence of institutions for discussion of common problems, (iii) the presence of rules for sharing the costs and benefits of collective action, (iv) the existence of sanctions and punishments for not adhering to rules of cooperation, (v) the presence of mechanisms to resolve conflicts, and (vi) the recognition of the user group's property rights to the resource by government. Some examples of successful cooperation for managing collective goods in the Indian context can be found in Wade (1987) and Chopra *et al.* (1990), among other studies.

The possibility of successfully managing topsoil loss through collective action also depends on the demographic composition of the group since the demographic composition and organisational structure of the group may influence the outcome of collective action for soil conservation. For instance, a heterogeneous group in terms of ethnicity and social class may reduce cooperation. Even the size of the group (large or small) and inequality among group members may create problems regarding coordination within the group (Shiferaw *et al.* 2009). However, problems that hinder the emergence of collective action due to heterogeneity among group members can be minimized, if not eliminated, by the strict enforcement of rules for collective action and the fostering of reciprocity among group members (White and Runge 1994).

As far as soil conservation is concerned, collective action could entail a certain network externality that would act as the driving force behind farmers' efforts to adopt soil conservation. According to Meinzen-Dick *et al.* (2002), farmers take action to ensure soil conservation not only because of their dependence on agriculture for their livelihood but also due to growing pressure from peer groups or other farmers from the locality. In many micro watershed projects in India, NGOs too have persuaded farmers to voluntarily adopt soil conservation measures and/or voluntarily contribute to community labour for soil conservation efforts (Kerr *et al.* 2007). Willy and Holm-Muller (2013), who studied whether collective action can act as a driving force behind farmers' adoption of soil conservation measures in rural Kenya, reported that, in their study area, there were a number of collective action initiatives, including physical and/or financial, to manage natural resources. The findings of the study suggested that collective action by the farmers resulted in the efficient management of soil conservation. A study by Nyangena (2008) in the context of watershed conservation programme in rural Kenya confirmed these findings.

Collective action does not always mean physical and/or financial support by individuals within a group as, in some cases, it can go beyond these supports. For instance, in the land care approach adopted in the Philippines in the mid-1990s, the group, after formation, identified the local level problems about natural resource degradation. They then took upon themselves the responsibility of disseminating information and mobilizing action by and financial support from the community to improve the condition of land, water and vegetation. Cramb (2005), who evaluated the impact of the land care programme on the individual adoption of soil conservation (natural vegetative strips and contour hedgerows) in the Philippines, found that participants in the land care group had a positive and significant impact on the adoption of soil conservation measures.

The above example suggests that collective action in soil conservation underscores the power of moral suasion as a tool to overcome negative externalities. However, instances of collective action have been reported where mechanisms other than moral suasion have been used to overcome externalities. In India, the provision for imposing a penalty for illegal grazing, in the form of a fine by the local government, exists in many areas in order to ensure better land management under community forestry. In 87 villages of the Indian dryland state of Rajasthan, a tax has been introduced to discourage overgrazing as well as a fee for grazing in order to conserve top soil under World Bank's Integrated Watershed Development Programme (Kerr *et al.* 2007). In addition to these mechanisms, a form of the merger is practised in the watershed of Sukhomajri village in India, where villagers share water, forest and pasture products among themselves irrespective of the ownership (i.e., status and area) of land. Here, groundwater is treated as a common property of the watershed rather than the private property of the owner of the land. This kind of collective sharing of the benefit provides incentive to the dwellers to conserve land (Chopra *et al.*, 1990).

Given that the soil quality of a watershed is collective good, governments and/or development agencies encourage collective action through institutional mechanisms for better management of watershed development programme. For instance, in semi-arid region in India (parts of Maharashtra, Karnataka and Andhra Pradesh) users' groups were put in place by implementing agencies to set rules and their monitoring: grazing and deforestation in upper reaches of treatment area, cultivation of water intensive crops in lower reaches of treatment area and community labour to build soil and water conservation measures in treatment area. Some examples of such projects were: MYRADA, Aga Khan Rural Support Programme and several major bilateral watershed programmes with European countries.[5] Number of studies evaluated the environmental and socio-economic outcomes of these watershed projects. Findings of Kerr (2002) and Reddy *et al.* (2004) suggested that various watershed development programmes under study were able to preserve natural resources with modest improvement in some of the livelihood indicators. In another watershed intervention, villagers collaborated in constructing ponds and trenches, planting trees and plugging gullies, etc., to improve agricultural outcomes. These interventions took place on both private and public land in Madhya Pradesh, another Indian state in the semi-arid region. Hope (2007) in his study established that the treated villages experienced a reduction in water collection time in the dry season. However, the treated villages experienced no significant gain in the return to farming.

In addition to the above, there are other case studies which show that collective action is moderately successful in preserving soil and water vis-à-vis the provision of tangible economic benefit. For instance, Shiferaw *et al.* (2009) studied the contribution of collective action in a watershed of semi-arid region of India to community investment in natural resources (wells, check-dams, ponds, etc.) and household welfare and poverty reduction (livestock, food security, seasonal and permanent migration, etc.). This study considered two strands of variables: a) enabling institutions and b) participation and organisational performances, in order to measure collective action. A number of variables, like the existence of rules to ensure

[5] See, Kerr (2007) and Kerr (2002) for details.

co-operation and the fraction of members who respect the various rules, were used to measure the enabling institutions. To capture participation and organisational performance, the study used the fraction of members participating in user group meetings and the percentage of well-managed user groups. It established a strong correlation between collective action and increase in community investment in natural resources while reporting a statistically insignificant association between changes in natural resource conditions and farm outcomes.

As mentioned before, the success of collective action in managing natural resources is dependent upon various factors like group size, distribution of benefits, etc. In addition, the probability of success through collective action depends on exclusively defined property rights (Reddy *et al.* 2007). In many tropical countries, forest land is owned by government. Collective action cannot work efficiently in forest areas where private property right is absent or is not well-defined. Besides, in many developing countries there are varying property rights to land even within watersheds. Often, private property is in the form of farmland owned by farmers in the downstream and forest land upstream is owned by government. Farmers adopt number of on-farm soil conservation measures individually or collectively, as we saw before, but forest areas face the threat of deforestation, seen in many countries, including tropical countries, although the forest cover upstream provides some very important ecosystem services, among them the provision of hydrological services and soil conservation as well as the maintenance of soil nutrients downstream and biodiversity. Forest, therefore, is an important component of a watershed (Pattanayak 2004) and government intervention is required for its conservation since neither market mechanisms nor collective action can optimally ensure that it renders the services identified above.

4. FOREST CONSERVATION AND GOVERNMENT ACTION

Governments directly try to internalise the externalities of watershed management by investment, regulation, ban, penalty, subsidy and innovative incentives like payment for ecosystem services. Governments of many countries in East and South Asia (e.g., Thailand, Taiwan, China, Malaysia and India) have imposed a logging ban (Label & Daniel 2009; Lu *et al.* 2001) as well as restrictions on grazing (Kerr *et al.* 2007) in upland forest in order to mitigate downstream impact.

A number of empirical studies that have investigated the effects of upland forest conservation through government intervention have provided evidence of significant benefits to stakeholders who are located downstream of a watershed. In Malaysia, for instance, Vincent *et al.* (2015) have shown that the conservation of virgin (undisturbed) and logged tropical forest located in the mountainous terrain of the country reduced the cost of water treatment in the coastal plains that were converted to non-forest land. In another such government initiative, Pattanayak and Kramer (2001) and Pattanayak and Butry (2005) found that regeneration of forest cover in the upstream watershed provided drought mitigation service to downstream farmers in Indonesia.

In contrast, many studies have revealed that regulations imposed by the government can be inefficient due to typical command and control type problems. Veloz *et al.* (1985), for instance, analysed soil conservation benefits in the context of a hydroelectric dam in the mountain watershed of the Dominican Republic, where the government had laid down guidelines for land use patterns in the four slope classes of the watershed: a) Class A (3% to 20% slope) – mulching and contour ploughing along with traditional agriculture, b) Class B (21% to 35% slope), and Class C (36% to 50% slope) – agro forestry in place of cropland and renovation of rangeland respectively, c) Class D (more than 50% slope) – afforestation in existing crop and rangeland. The findings revealed that except for farmers in slope class A, those in other slope classes earned negative private net present value.

To internalise the externality of the farmer in the upland, governments in many countries also provide incentives such as compensation in monetary form to farmers of a region to change the existing land use pattern on their land. For instance, in the Midwest US changes in land use from upland forest and wetlands to farm and pastures has increased the intensity of flooding, deteriorated water quality, and threatened biodiversity. Given that the restoration of land has the potential to benefit the community at large, the US senate passed the Wetland Reserve Programme Bill in 2002. Under this bill, the government offers farmers compensation for restoring forest and wetland on private land (Zedler 2003).

To address the failure of the market to deal with the externality of upstream stakeholders affecting downstream stakeholders, governments in many countries have started facilitating mechanisms to pay for ecosystem services for the purpose of managing natural resources. The payment for ecosystem services can be seen as a Coasian contract (Pattanayak *et al.* 2010), where the government is directly or indirectly involved in money transfers to upland farmers conditional on the conservation of forest and biodiversity. The difference between payment for ecosystem service by design and other approaches to checking externality such as regulatory limits, economic penalties, taxes and tradable permits is that the former is based on the 'beneficiary pays principle' while the latter are based on the 'polluter pays principle'(Engel 2016). Under the payment for ecosystem services principle, a farmer in a particular area receives payment for a fixed tenure contract. The US and European Union are the pioneers in adopting the practice of payment for ecosystem services. In the US, the government pays USD 1.7 billion per year to farmers, which is conditional upon maintaining forest cover on a portion of farmland and evidence of measures for sustainable agricultural practices including soil conservation. Countries of the European Union also spend USD 7.2 billion per annum as payments to farmers to maintain forest cover and to derive the benefits of ecosystem services (Armsworth *et al.* 2012).

In the context of developing countries, payment for ecosystem services is important due to certain reasons. First and foremost, mountains in developing countries contain huge portions of tropical forest, which plays a major role in providing environmental benefits. Secondly, both governments as well as the majority of the people are resource poor. Hence, any scheme related to payment for environmental services can be seen as win-win situation which would reduce poverty while preserving the forest (Pattanayak *et al.* 2010). Examples of facilitation by the government for payment for ecosystem services can be seen in Latin America, where the longest running programme for payment of ecosystem services, the Pagos por Sercios Ambientales, in Costa Rica was initiated by the Costa Rican government in 1997 (Arrigada *et al.* 2012). In Asia, too, there are examples of payment for ecosystem services for the purpose of protecting and maintaining the vegetative cover. In China, for instance, the main objective of the Sloping Land Conservation Program was to reduce soil erosion through afforestation in the 12 million hectares of the upper reaches (Pattanayak *et al.* 2010). In Southeast Asia, many governments have facilitated the Rewarding Upland Poor for Environmental Services (RUPEES) project, which is a payment mechanism to the upland poor to adopt land conservation (Kerr *et al.* 2007).

However, the findings of several studies (Ferraro 2008; Winscher *et al.* 2008) suggest that the rate of success of payment for ecosystem services to preserve and restore forest is limited. The first precondition for the effectiveness of payment for ecosystem services is a well-defined property right which, as discussed before, is not always found in developing countries. The efficacy of the scheme also depends upon the administrative targeting of the beneficiary, the degree of compliance and administrative monitoring, and the enforcement capability of the implementing agency (Arrigada *et al.* 2012; Engel 2016).

5. CONCLUSION

This study reviewed the institutional alternatives for soil conservation in a watershed. Soil quality in a watershed has the characteristics of a private, collective and public good. The three institutional alternatives to protect a watershed are: on-farm individual, collective and government action. Since these actions are not mutually exclusive, a distinct categorisation of institutional alternatives and comparing their role in soil watershed management is difficult. Nevertheless, this study reviews a number of empirical studies on watershed management, especially in the context of soil conservation, and provides evidence on the roles of individual, collective and government action.

As the studies reviewed show, farmers invest in soil conservation if they realise that soil erosion will reduce their agricultural profit and the resale and rental value of farmland. However, due to the presence of externality and insufficient financial capability, on-farm investment in soil conservation remains sub-optimal. This has led governments and development agencies to implement several mechanisms such as penalties, taxes, direct and indirect subsidies. Nonetheless, evidence of success of these measures to encourage on-farm investment by farmers is very limited, especially in developing countries.

It is also well-established that soil quality in a watershed is a collective good. Consequently, various development agencies have tried to develop intuitional mechanisms for successful collective action to manage soil quality in a watershed. But the success of the collective action depends on an effectively determined set of rules; mechanisms to monitor farmers and to tackle defectors through regulatory limits and penalties; and the ability to cope with conflict and to provide solutions to disputes over property rights. Available empirical evidence suggests that the outcome of the collective action to maintain soil quality and to provide tangible benefits to stakeholders of watersheds remains moderately successful.

It is quite clear that government intervention is also required to protect watersheds on account of market failure. It is also a fact that the upland areas of watersheds in tropical countries are covered with forests which are mainly under government control. Governments have taken many initiatives to protect forest cover such as ban on logging and grazing, regulation of land use patterns, and subsidies and conditional cash transfers to farmers for protecting forest cover. Like the other two institutional arrangements, evidence of the success of government action in maintaining forest cover to protect watershed is also mixed.

The review of literature on individual, collective and the government action on soil conservation come up with key policy implication. It is necessary to get over the schematic perspective that stakeholders can/cannot preserve watershed and recognise their inclination and capacity to bear the burden of watershed conservation across site, and over time. Therefore, recognising the elements which subscribe to constructive watershed management by stakeholders can provide valuable input in identifying where watershed development programme can be implemented easily, and where extra effort of development agencies is required.

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