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THE WATERSHED APPROACH TO SUSTAINABILITY ON THE COMMON POOL RESOURCES : LESSONS OF INDIA'S EXPERIENCE

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Resources : Lessons of India's Experience

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ABSTRACT

Sustainability of renewable natural resources in general and common pool resources in particular has now become one of the major concerns of natural resource policy makers, planners, scholars, managers, and environmentalists all over the world. This paper defines sustainability as the ability of a natural resource system to produce socially optimum level of output in perpetuity with no detrimental effects on the physical environment and future generations. Sustainability is commended as an explicit goal of natural CPR development and management and the conditions for sustainability are derived mathematically using the concept of optimal stationary policy. The agro-ecological characterization and the watershed approaches to sustainability are briefly described and, drawing upon India's experience, it is shown that the watershed approach could attain sustainability on renewable natural CPRs and that the approach is practicable.

1. INTRODUCTION

Sustainability of renewable natural common pool resources (CPRs) has now become one of the major concerns of natural resource policy makers, planners, scholars and managers in both developed and developing countries of the world. The usual dictionary meaning of sustainability is "keeping an effort

going continuously, the ability to endure or last out and keep from falling". In the context of renewable natural resources, I use the term to imply the ability of a natural resource system to produce socially optimum level of output which is necessary to meet in perpetuity the needs and aspirations of the people dependent on the system with no detrimental effects on the physical environment and with no imposition of significantly greater risks on future generations. Sustainability in this sense is a dynamic concept that reflects changing levels of output corresponding with changing human needs over time. Although the CPRs include such diverse things as common pastures or grazing lands, community forests, lakes, rivers, streams, ground water basins, fish ponds, airsheds etc., they all face one common problem and that is how to coordinate the actions of individual users to attain an optimal rate of production or consumption for the whole community (Oakerson, 1986 : 13). If a community of users is unable to control the use of its CPRs under the changing circumstances, destructive competition or conflict among the users is bound to follow. This eventually results in depletion or degradation of the CPRs. Hardin (1968 : 84-96) characterises this eventuality as "the tragedy of the commons". The occurrence of "the tragedy of the commons" implies loss of sustainability which means loss of welfare of those who depend on the CPRs in question for their livelihood. Both developed and developing countries of the world are beset with "the tragedy of the commons" and are in search of practicable strategies to resolve the problem.

In this paper, drawing upon the India's experience, I make an attempt to show how the watershed approach could attain sustainability on the renewable natural CPRs of land, water, and forests.

2. SUSTAINABILITY AS A GOAL IN CPR MANAGEMENT

Sustainability is now being increasingly accepted globally as an explicit goal in natural CPR development and management. Sustainability as a goal is superior to the goal of maximum sustainable yield (MSY) which had been till recently the major goal of management of many renewable natural resources like forests, fishery etc. This is so because sustainability implies the optimal level of output which is not, except by fluke, the MSY (Dasgupta, 1982 : 125). Secondly, unlike sustainability, the MSY principle does not consider ecological and other intangible effects of resource exploitation nor does it take into account the changing human needs over time.

A distinction should be made between sustainability and productivity. While greater productivity will be required to achieve sustainability goals, that productivity must be achieved in such a manner as not to jeopardize the ability of a natural resource system to meet future needs. In other words, it is possible to achieve productivity goals through unsustainable short-term approaches (York, Jr., 1988 : 19-20).

Sustainability has long been an important precept in natural resource management. Plato, for instance, accurately and graphically described direct and indirect effects of deforestation of the mountains of Attica on the region's soil and water resources and the economy of Athens (Oram, 1988 : 14). The concept was used by Carlowitz in forestry in Germany as early as 1713 and today the principle of sustention is regarded as obligatory in forest management in the Federal Republic of Germany (Wiebecke and Peters, 1984 : 109). In almost all societies in olden days, there were conventions, and taboos that helped the people in using and managing their renewable natural resources so as to maintain their sustainability (Swaminathan, 1986 : V).

3. CONDITIONS FOR SUSTAINABILITY

Dasgupta (1982 : 120-133) attempts a formulation and characterization of optimal stationary policies for renewable natural resources. Following him, we denote by B(Y) the flow of social benefits enjoyed by people when the use/appropriation/harvest rate is Y. In general, the rate at which the regenerative or renewable resource rejuvenates or restores itself in time period, t, is a function, interalia, of the stock level at that time period, St. Let H (St) be the rate of natural rejuvenation in the absence of human intervention. Then, the following equation represents an ecological balance in a stable environment:

$$dSt/dt = H\ (St) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

If H (St) = 0, the resource is exhaustible like fossil fuels. But if H (St) = A where A is a positive constant, the resource s renewable and renews itself at the constant rate of A per unit time. In many situations, the natural replenishment rate is a constant percentage of the stock level, i.e., H (St) = A St where A, a positive constant, is the percentage rate of growth.

Now let Yt (> 0) denote the harvest/appropriation rate at time, t. Then, the dynamical equation representing the stock becomes :

$$d\,St/dt = H\,(St) - Yt \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Since Yt can be regulated, the dynamical system (2) is a controlled one. If Yt = H (St), then d St/dt = 0. This implies that the stock does not change due to harvesting or appropriation. This is the case where the rate of harvest equals the net replenishment rate. If Yt = H (St) for all t > 0, then we say that Y is a stationary harvest/appropriation policy—'stationary' because the harvest is constant over time. From Figure 1, it is clear that if S. $< S < \bar{S}$, then a stationary harvest policy can be followed; not otherwise. Of the various possible levels of stationary harvest, H ($\hat{S}$) is the maximum and is called the maximum sustainable yield (M S Y), which has for long been considered a desirable target but in fact it almost never is (Dasgupta, 1982 : 125).

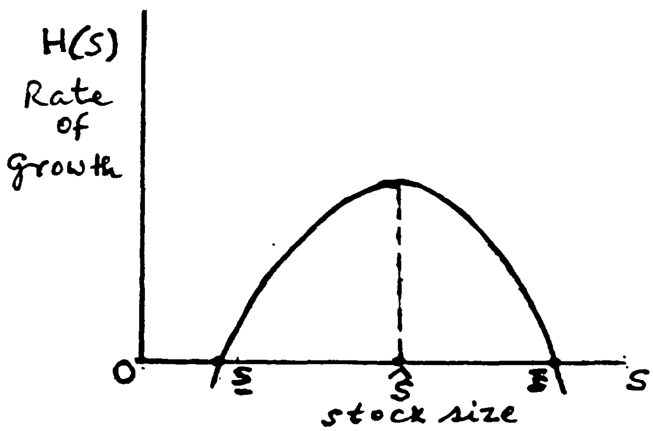

Figure 1 : A stock-growth relation in renewable natural resource systems

Assuming that social benefit, $B(Y)$, is a concave function reflecting non-increasing marginal social benefits, that social rate of discount is a positive constant, r, and that $C(S, Y)$ is the social cost of harvesting Y when S is the stock, we define the net social benefit at time, t, as follows:

$$N(S_t, Y_t) = B(y_t) - C(S_t, Y_t) \ldots\ldots\ldots\ldots\ldots (3)$$

$N(S_t, Y_t)$ is the flow of net social benefit at time, t, and $e^{-rt} N(S_t, Y_t)$ is the present discounted value of this flow. By adding all present discounted values, we get the following objective function :

$$\int_0 e^{-rt} N(S_t, Y_t)\, dt \ldots\ldots\ldots\ldots\ldots (4)$$

We know from equation (1) that $dH(S)/dS$ is the marginal productivity of stock which we denote by $H'(S)$. Then, $r-H'(S)$ can be regarded as the net social rate of discount that ought to be used in discounting marginal benefits from exploiting the resource in question. The current marginal net social benefit is $N_y(S, Y) = B_y(Y) - C_y(S, Y)$. The marginal cost of increasing current harvest marginally at each future date is : $-\partial C(S, Y)/\partial S \equiv C_s(S, Y)$. Discounted at $r-H'(S)$, the present value of this flow of marginal cost is : $-C_s(S, Y)/[r-H'(S)]$. For a stationary policy to be judged optimal, the marginal cost must equal the marginal benefit from increasing current harvest marginally, i.e.,

$$N_y(S, Y) = B_y(Y) - C_y(S, Y) = -C_s(S, Y)/[r-H'(S)] \ldots (5)$$

Since we are studying a stationary policy, the system must satisfy the following equal on:

$$H(S) = Y \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

An optimal stationary policy roust satisfy equations (5) and (6). For the sake of ease in exposition, we assume that equations (5) and (6) have a unique solution which we label as (S^*, Y^*). For a wide range of plausible cases, optimal stationary policies are really long-run goals. For the immediate future, the right policy would be to allow the existing stock, which may not be optimal, except by fluke, to adjust until it attains the long-run target. Dasgupta (1982 : 141-47) suggests that this should be done by proceeding as rapidly as possible to a stock size worth maintaining and then staying there forever.

An optimal stationary policy which specifies an optimal level of stock, S^*, and an optimal rate of harvest, Y^*, has an underlying production function relating labour and capital inputs, natural resource stock, and technology to production of natural resource commodities. A typical natural resource commodity production function may be represented as follows (Howe, 1979 : 17-19).

$$Yo(t) = f\,[L_1(t), K_1(t), S(t), t] \ldots\ldots \quad (7)$$

Where $Yo(t)$ is the natural resource commodity or the harvest/output of the natural resource at time, t, $L_1(t)$ and $K_1(t)$ are the labour and capital inputs respectively used in production of Yo, $S(t)$ is natural resource stock and t indicates technology. We know that the output of resource commodity could be increased by technological improvements or by augmenting the stock, or by intensifying labour and capital inputs. A change in technology may shift the production function upward and thereby may change the optimal stationary policy, ceteris paribus. Thus, we may visualise a unique optimal stationary policy associated with every unique resource commodity production function. It is based on this relationship that technocrats assert that the optimal levels of harvest and stock need not be stationary or constant over time; they could be changed in response to human needs and aspirations. In other words, natural resource systems could be manipulated and managed to produce socially optimum output over time on a sustainable basis.

4. APPROACHES TO SUSTAINABILITY

There is no consensus among the scholars and practitioners in the area of CPR management about the definition of sustainability and the best method of attaining it (Oram, 1988 : 14). In particular, issues of short-term versus long-term exploitation and growth versus equity are controversial. Some ecologists and resource economists advocate a no-growth or steady-state approach to sustainability arguing that continued growth will eventually lead to resource depletion on a catastrophic scale. The concept of steady-state is not meant to be taken literally. in a world having a definite life span, an infinite time horizon is merely a long hand for a long time horizon. Furthermore, a steady-state does not imply that the rest of the economy is at a stationary state. Most technocrats, however, take a pro-growth stance and assert that science and technology will continue to maintain the growth of productivity in future. According to them, drawing upon the principles of ecology and population dynamics, it is possible to design systems of CPR use and management that can attain optimal yield levels and maintain them indefinitely. There are two approaches that have been used to attain sustainability on the commons, namely, the agro-ecological characterization approach and the watershed approach. Both are quite similar in many respects.

4.1 The Agro-ecological Characterization Approach

Inter-disciplinary research in ecology, climatology, geography, ecophysiology, soil science, plant sciences, animal sciences, environmental economics, and other resource-related disciplines is needed to generate new information and technologies necessary for sustainability. At present there is no universally acceptable conceptual framework to integrate these different disciplines so they could interact effectively and contribute to the goal of sustainability. Agro-ecological characterization provides a practicable framework for effective integration of various disciplines (Oram, 1988 : 17 & 30). Early global and regional attempts at agroecological zoning have shown that this approach can be valuable to agricultural planners. In essence, proper agroecological characterization depends on the collection, organisation,, and analysis of climate, soil and land topography data and their influences on species' distribution, plant growth, and agricultural yield. Despite significant advances made in the methodology of agro-ecological zoning, application of this approach to effective management of natural resources is beset with a number of problems such as controversy over tools and techniques, lack of a unified approach across different disciplines, data inadequacies, and lack of trained staff (Oram, 1988 : 33-34). In India, this approach is proposed to be adopted on a pilot project basis during the Eighth Five Year Plan period. For this purpose, the country has been divided into 15 agroclimatic zones and 74 sub-zones.

4.2 The Watershed Approach

This approach is conceptually very similar to the agroecological characterization approach. A watershed may be defined as a natural drainage area of a river, a tank, or a lake. In the watershed approach, a watershed is used as a unit for planning and management of land, water, and other resources of the watershed. The approach is holistic, and multidisciplinary and is a practicable approximation of the system approach. It enables the planners and managers to consider together various physical, biological, socio-cultural, economic and institutional factors operating within a watershed and its surrounding environment and formulate a comprehensive and integrated watershed development plan to achieve specific private and social objectives. In a watershed, natural and human resources are all inter-dependent and interact with one another. This means that nothing short of a system approach can realise full potential synergistic benefits from the use of a watershed's resources. The watershed approach is also justified on the ground that it internalises various externalities involved in the use of land and water resources in a watershed and thereby narrows the hiatus between individual and social interests. In view of all these considerations, the watershed seems to be an ideal unit for resource use planning and management.

It is only when the watershed approach is used that the different views and perspectives of ecologists, economists, technocrats and people could be reconciled and conditions of optimality fulfilled. A typical watershed development project consists of the following activities:

1. Assessing watershed dwellers' felt needs, priorities, resources, and constraints through a benchmark survey.
2. Survey, measurement, and mapping of watersheds' natural resources, and assessment of their status and productivity.
3. Planning for restoration/development, conservation and optimum utilization of watershed's resources using the latest available technologies for the purpose and keeping in view the watershed dwellers' needs and preferences.
4. Provision of basic supporting infra-structure and creation of necessary institutions.
5. Human resource development through education, training and motivation.
6. Community management of CPRs including collective action for resolving common problems.

Now, I shall briefly present the lessons of the India's experience with watershed approach.

5. LESSONS OF INDIA'S EXPERIENCE

In India, the watershed approach was first adopted on a significant scale in 1974 when the Government of India (GOI) enforced its implementation under a Centrally-sponsored "Scheme of Soil Conservation in the Catchments of River Valley Projects". At present, ie scheme is in operation in 27 catchments in the country. In 1982, GOI, under the auspices of the Indian Council of Agricultural Research (ICAR), sanctioned 46 model watershed projects to be implemented in the dry land areas of the country. These projects are now being implemented by the State governments through their Agriculture Departments and technical back up is provided by the All India Coordinated Research Project for Dryland Agriculture (AICRPDA), the Central Research Institute for Dryland Agriculture (CRIDA), and the Central Soil and Water Conservation Research and Training Institute. The CRIDA and AICRPDA scientists are responsible for monitoring of 30 of these model watershed projects. Another Centrally-sponsored scheme of Integrated Watershed Management in the Catchments of Flood-Prone Rivers was taken up during the Sixth Plan period. It now covers 200 watersheds in 8 catchments in the Indo-Gangetic basin.

In July 1986, the Union Ministry of Agriculture and Rural Development launched the National Watershed Development Programme (NWDP) for rain-fed agriculture as a Centrally-sponsored scheme. It is currently in operation in 16 states in the country covering 99 districts. Besides the Centrally-sponsored ones, there are many other watershed development programmes currently underway in the country that are funded by the State Government and/or external aid agencies. Among the externally-funded projects are included the four World Bank-funded dryland watershed development projects one each in the states of Andhra Pradesh, Karnataka, Madhya Pradesh, and Maharashtra. In the Eighth Five Year Plan of India, a high priority has been given to the watershed development programmes.

No comprehensive documentation of the India's experience with her various watershed development projects is available at one place. However, recently three major attempts have been made in India to pool and document such experiences. First, the Society for Promotion of Wastelands Development (SPWD), a non-governmental organization (NGO), sponsored with financial assistance from the Ford Foundation three background papers and ten case studies of watershed development projects in different agro-climatic zones of the country. The background papers and the case study reports were presented and discussed in a National Workshop on Small Scale Watershed Development on October 30 to November 1, 1988. The Workshop proceedings and the papers are available from SPWD (SPWD, undated). The Workshop was attended by 63 participants from various governmental and non-governmental organizations, and research institutes. Nine out of the ten case studies presented in the Workshop had attempted to evaluate the impact of the projects studied. All the nine case studies revealed that the watershed approach had a substantial positive impact on crop production, milk production, fodder production, availability of ground and surface water, soil erosion and sedimentation, employment etc. The participants were unanimous in recommending that the watershed should be taken as a unit for natural resource use planning and management and that for implementation and monitoring purposes the watershed could be divided into small administrative and/or socio-economic units. The participants also highlighted the need for enlisting people's participation in watershed development and management programmes and identified good leadership, flexibility in project design, equity in distribution of programme benefits and in cost sharing, substantial private net benefits from participation, and support of a non-political non-governmental organization as pre-requisites for people's participation.

Second, the Indian Society of Agricultural Economics had chosen watershed development as one of the topics for discussion at its Golden Jubilee Conference held in Bombay on December 4-7, 1989. Thirteen papers were contributed on various aspects of watershed development. Their summaries are contained in the Conference Number (July - September, 1989) of the Indian Journal of Agricultural Economics. All the papers contributed show that the watershed approach had a substantial positive impact on resource productivity in the project areas.

Third, the Indian Water Resources Society (IWRS) organised a National Symposium on Watershed Development and Management in Kanpur on February 2-4, 1990. Over 40 papers were prepared for the Symposium by scholars and practitioners from various governmental and non-governmental organizations and research institutes. The papers covered all aspects-technical, socio-economic, environmental, and organizational- of watershed development and management. The papers are available from IWRS (IWRS, 1990). The papers show that a lot of work has been done in India on various aspects of watershed development and management, that the watershed approach has yielded positive results, and that India now has the necessary technical know-how to mount a watershed development programme at the national level.

There is enough evidence now available from many successful watershed development projects and on-farm experiments done in India to establish that it is technically feasible to design and attain sustainability endogenously on natural resources of a typical watershed in the rain-fed dry regions of the country receiving 800 mm or less of average annual rainfall. Sustainability has been achieved through watershed-based comprehensive and integrated planning focused on optimal development, conservation, and utilization of land, water, trees, and other resources and biomass recycling with the ultimate objective of producing enough biomass to meet the food, fibre, fodder, fuelwood, manure and other basic necessities of the watershed community in perpetuity. The work done by Datye and Paranjpe (1990) and Datye et. al (1989) shows that it is possible to attain sustainability with as small as 1.5 - 4.0 hectares of land per family of five members. In most dry farming regions of India, the size of total private and common pool land available per family is around 4 ha which is sufficient to generate enough biomass for the family to be self-reliant in perpetuity. Besides promising sustainability, the watershed approach also ensures equity in distribution of benefits from the CPRs of watershed. This is so because the benefits from CPRs are distributed in proportion to the labour contributed by each family and labour is more uniformly or evenly distributed among poor rural communities than land or any other asset.

The major elements of the watershed approach that help attain sustainability are as follows:

1. Restoration of degraded land resources through appropriate soil conservation and land reclamation measures.

2. Harvesting, storage, conservation, and optimal utilization of rainwater.

3. Use of land according to its physical suitability. This typically means that steep slopes and fragile lands in upper reaches of watersheds are used for growing trees, shrubs, grasses and other permanent vegetation to produce enough biomass for the watershed community to meet their needs of fuelwood, fodder, organic manure etc., relatively flat lands are used for production of food crops and cash crops, and the lands in lower roaches of watersheds are used for storage of rainwater which is used for supplemental/protective irrigation in dry season. Use of the improved technologies available in the country is essential for all these purposes.

4. Preparation of resource budgets and balancing of the budgets by recycling of renewable resources like biomass, solar energy, water, atmospheric nitrogen and other plant nutrients.

5. Control of pests and diseases by biological methods.

6. Processing of timber, minor forest produce and other biomass to add value to them and to generate employment opportunities for watershed dwellers.

7. Manpower planning and development of human resources through education, training, motivation and provision of information about new technologies and government policies, and programmes.

8. Determining optimal carrying capacity of watersheds in terms of human and animal populations at the existing and prospective levels of technology and adjusting the existing population accordingly. This aspect needs to be integrated vertically and horizontally with planning in other watersheds.

9. Organising watershed community along economic activities and motivating them to mobilize their resources, to manage their CPRs collectively, and to establish systems for equitable distribution of benefits from the CPRs including water, fuelwood, fodder etc. and to maintain the developed CPRs in good productive condition.

6. CONCLUSIONS AND IMPLICATIONS

India now has the technical know-how, and, more important, the means to prevent the processes that lead to degradation of natural CPRs. What is lacking is the political will to apply the available technical knowledge, and a national policy and an appropriate organization structure to plan, coordinate, implement, monitor, and evaluate watershed development programmes on the national scale.

Given the interdependences among various natural and human resources and hence the existence of externalities in their use and management, the watershed approach that is a close approximation of the system approach is the most appropriate one for planning and management of natural CPRs. The watershed could be used as a unit for planning and management of natural and human resources but for implementation and monitoring purposes smaller administrative and/or socio-economic units could be used. The principles of balanced resource budgeting and biomass recycling underlying the watershed approach ensure that the conditions for sustainability are fulfilled.

There is need for *a* cross-cultural, cross-sectoral and transdisciplinary approach to sustainability. In essence, it requires that all major actors and players in the development process, namely, policy-makers, hydrologists, soil scientists, agronomists, horticulturists, foresters, environmentalists, resource economists, sociologists and so on come out of their pigeon-holes and jointly devise watershed development and management strategies that are technically feasible, economically viable, organizationally feasible, and socially and politically acceptable.

People's involvement is essential for success of watershed development projects. To enlist people's participation, good local leadership, flexibility in project design and operational procedures, equity in distribution of project benefits and cost sharing, support of a non-governmental and non-political organization and proper education and training of people are all essential. Furthermore, people would not generally participate in a project unless the expected private benefits from participation are markedly higher than the expected costs of participation.

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