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Watershed management, torrent and avalanche control, land rehabilitation and erosion control

Strategies for strengthening watershed management in tropical mountain areas

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SUMMARY

Watershed management is described in system terms, together with the typical problems arising both with the watershed itself and downstream, as a premise for justifying planning and management seen as a valid strategy for land use planning. The findings of a critical analysis of the causes of watershed degradation in tropical mountain areas are also presented.

Watershed management is a matter of responding to a whole series challenges and paradigms, among them that of sustainable development. Practical applications in designing "ecological villages" within the planning and management of a watershed are illustrated.

The limitations of watershed management, together with it accompanying difficulties, explain why it has had less impact than hoped. A series of action approaches designed to strengthen the management process complete the discussion.

1. WATERSHEDS IN TROPICAL MOUNTAIN AREAS

Watersheds are units of territory within which a hydrological subsystem produces water; and at the same time it is an economic and social subsystem that is at work under the impulse of man, capital, labour and technology. Watersheds produce goods and services – from crop and animal husbandry, from forestry, and from leisure activities for which the demand comes chiefly from the people of the area. Marketing such goods and services generates income and contributes to the development process.

Even so, this same productive process generates a series of undesirable side-effects, among them erosion, a decline in agricultural productivity, run-off pollution, and a reduction in biodiversity and in water availability (Hufschmidt 1986).

Undesirable effects can be kept to a tolerably low level provided resource use and production technology conform to ecological and sustainable development principles.

Where the local population or society at large disregard these principles of sustained development such undesirable side-effects tend to increase to the point where the system becomes degraded, to the detriment of the area's production and of the people themselves. Productive capacity gradually diminishes and the local population becomes impoverished in the process, stultifying any possibilities for development and giving rise to health risks for people who depend for their water on these mountain watersheds.

Mountain watersheds constitute major territorial units because they are the home of most of the population. They have a very pleasant year-round climate, and intermountain valleys are highly fertile for certain crops; the population there are hardworking and are attached to their land, and have their

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own cultural, historical and economic values. The tourist potential is considerable. Above all, watersheds constitute strategic sources of water that is needed for regional development beyond the watershed itself. A system view of the watershed and its management with the social implications taken into account has been dealt with in an interesting paper delivered at this Congress (Settawan 1996).

At the same time, watersheds have other characteristics deriving from their physical environment. There are hillsides and springs in the higher-lying slopes; and highly erosive rainfall can occur, when rock and the banks of torrents and streams are easily made to disintegrate; the soils are markedly subject to erosion and mass slumping may take place in the rainy season.

Again, the slopes in the middle and upper reaches are the scene of active deforestation (with the loss of biodiversity, in both plant and animal life), and unsound cropping practices (and an accelerating incidence of disease among crops). Land ownership titles are of only a temporary kind – where they exist at all. One finds excessive taking of wild fauna, water pollution from an excessive use of agricultural chemicals, and drawdown in springs. Conflicts arise among newcomers wishing to settle because there is not enough water to go round. Another feature is the decline in population numbers and the flight from the land. Sometimes illegal mining aggravates the problem of pollution in major rivers and streams.

In many cases, too, one finds a complete lack of basic services – education, medical assistance, or technical assistance in agriculture and forestry. Housing is currently inadequate; land titles are provisional or non-existent; the population is not organized for marketing, and roads are in a poor condition. Taken together, all these things point to the absence of the State. To be sure, there are a host of enactments – superlegal, legal, state and municipal – ostensibly designed to prevent degradation but whose effect usually leaves much to be desired.

These shortcomings and mistaken ways of going about things become aggravated over time, what with the population growing at a very high rate and doubling every l5 to 20 years and adding to water and food needs. A vicious circle, therefore, of upper watershed degradation depressing development prospects downstream and in turn at the regional level. This upper watershed degradation creates shortages for water supply systems thereby limiting the options for regional development simply because water points run dry.

To the problems described must be added that of deterioration in the quality of water feeding the supply systems as result of excessive chemical use in agriculture, with the deleterious effects that this may have for human health.

Wide-ranging research has identified the causes of watershed deterioration in Latin America. The studies in question come under three main heads (Sheng1988), namely:

(a) studies on the natural environment and dealing with the fragility of young mountain watersheds;
(b) conditions affecting people's lives – such as population explosion, struggle for survival and loss of self-esteem as the individual becomes poorer; and
(c) the "style" of government and of development, characterized by highly fragmented approaches side by side with inter-institutional rivalry, not to mention instances of paternalism and "jobs for the boys" – all standing in the way of coordinated action. Insufficient importance is accorded to technical assistance and agro-ecological extension activities. This is because funds are rarely forthcoming, since what there is goes to paying off the external debt, or because of mismanagement and waste or of embezzlement of public money. Furthermore, at times technical packages are imported without reference to their suitability or otherwise for local use.

2. PLANNING AND MANAGEMENT OF MOUNTAIN WATERSHEDS IN THE TROPICS

In order to tackle the complex situation inherent in the conservation and development of mountain watersheds, governments, their technical staff and the universities have experimented with divers strategies but with varying degrees of success. One such strategy envisages integrated planning and management for these watersheds.

This was conceived a working strategy for mountain area conservation. It has been applied since the beginning of the century in the Alps, the Rocky Mountains and the Andes, and in Asia and in Japan under the inspiration and motivation of foresters, who from the start were aware of the need to maintain optimum interrelations among forests, water, wildlife and soils in mountain ecosystems.

As time went on, efforts have been made to perfect this strategy, by adapting it to different problems and social, political and institutional situations in the respective mountain regions. All along the aim has been to secure conservation and development together. Six major variants have been devised: torrent control; hydrological-cum-forestry management; integrated management of micro-watersheds; and (the most recent development) the rehabilitation of water ecosystems. Watershed planning and management has also been a strategy involving institutions, and has promoted an expanded productive capacity of the watershed-as-system, compatible with the potential and the limitations of the system in question.

Integrated watershed management, as understood by FAO, consists in the formulation and application throughout a catchment basin, both upstream and downstream, of an integrated series of actions designed to secure sustainable development and to keep as low as possible any negative environmental effects on the water resource used by the downstream population.

Sustainable development in watershed management could take a lead from the San José de Limones Ecological Village Project (1997), where the following approaches are taken up:

(a) economic, social and cultural development respecting the limitations of the natural environment, human – family – values, and operating permanently in the territory in harmony with nature;
(b) diversified economic activity, grounded in profitable agricultural and forest development, and less polluting in the use made of natural, human and landscape resources, in a manner more in harmony with the local context;
(c) autochthonous architecture, and landscaping in harmony with the bioclimate and relying on appropriate technology; and
(d) a high degree of self-management achieved through participation, organization, training, education and the publicizing of achievements, together with the decisive support of public institutions in the provision of infrastructure and of essential services.

Watershed management is a powerful planning tool involving a holistic approach emphasizing the inter-connection between the natural resources used by upstream and by downstream dwellers. It translates into a practical application both of the ecosystem concept and of the principles of ecological science, and into approaches conducive to sustainable development. In addition, it facilitates monitoring and evaluation of the impact of investment in slope conservation in its role in watershed management and the protection of the strategic value of this resource.

3. OPERATIONAL DIFFICULTIES IN WATERSHED MANAGEMENT

Even though watershed management in its formulation and application has its carefully structured methodology, and is its own justification, it must be admitted that at the present time the approach has little to show for itself, at least as far as Latin America is concerned.

Management, then, has been difficult of application, among other reasons because the institutions concerned were not conceived with the notion of integrated approaches such as that required when the watersheds are segmented in character, and the institutions themselves are often so many watertight components. A further source of difficulty is to be seen in the conflicts of interest that arise between people and enterprises in the upper and in the lower reaches. This is because no suitable solution has been found for dealing with externalities seen in runoff pollution, or because government policy is inconsistent or, again, due to the absence of any clear incentive policy to attract sustained participation by the population or, lastly, because successful results are never convincingly demonstrated but come to light only in the medium term (whereas the political context, particularly that in Latin America, expects immediate results).

Watershed planning and management entails policy decision calling for positive action, with close institutional coordination throughout the watershed-as-system, both within the watershed itself and beyond, for putting to work policies for sustainable development, where the strategic value of water is accorded priority. Decisions here must be geared into the policy for regional development, with joint-management and self-management approaches, compatible with the potential and the limitations of the ecosystem.

Most countries in the Region are experiencing financial difficulties and a generalized recession, where only now are signs of recovery beginning to appear. Activities are at the lowest possible level, and only certain projects are being executed, with loans from the international banks (projects for watershed protection where water and especially hydraulic schemes are under way) while other projects are going forward with grants. Macroeconomic readjustment keeps construction activities for torrent control in a semiparalysed condition. Where greater activity may be noted is in the abundance of legislation governing land use, though these are of only partial efficiency. Again, little work is being done in reforesting hillsides and the banks of watercourses. A start is being made with agricultural assistance programmes receiving support from multilateral banking sources.

A further factor that explains the falling-off in the execution of watershed management projects is the failure to provide tangible demonstrations of the effects and the benefits achieved.

The traditional planning-execution project cycle has failed to make benchmark assessments using selected indicators, whereby project impact can be measured against the initial situation; and, apart from exceptional cases, no monitoring and evaluation system has been included in watershed projects. What is lacking is a mentality of measuring performance and using specific tools for the purpose. And this is why the heads and representatives of financing institutions and donor countries are not receiving convincing replies to their enquiries as to the extent of project achievements. However, as noted by Sudradjat R., in connection with the Upper Solo Watershed Conservation Project (Wonogiri), it seems that a start is being made in according importance to this component.

The absence of monitoring and evaluation has led to difficulties both in obtaining financing and in assessing the cost-effectiveness of operations and, again, in correcting and improving plans. To remedy this situation, managers, technical staff and the beneficiaries have to be persuaded of the importance of monitoring and evaluation. The additional cost entailed in the measuring operation will be justified by the availability of reliable, objective information that will enhance the progress of any project (Hernández 1995).

4. WATERSHED PLANNING AND MANAGEMENT IN ACTION

An example of the planning process can be had by reference to an actual case of a design for an "ecological village" in a watershed.

From the start, the aim here has been to encourage a participatory approach in an attempt to secure sustainable rural development down to the local level by involving the population so that due account

can be taken of people's needs and encourage a favourable disposition on their part for making their own financial contributions. Participation means involving policies and representatives of the institutions so that the feasibility of proposals will be more assured.

Participatory planning, then, is a matter of guiding and organizing in such a way that the population of a given hydrographic unit may come together and, with help from facilitators, identify problems and needs and work for benefits that can be recognized in measurable terms by families, individuals and groups living in the watershed or within its area of influence.

A first step is problem identification, through the participatory and environmental approach for the respective holdings.

Discerning solutions for problems that have been so identified in workshops and field evaluations is the key to successful watershed management, but the solution adopted needs to have its place within the context of sustainable local development implied in the very definition of watershed management.

The planning process must be disciplined if difficulties are to be avoided. The options decided on will never please all residents because there will always be conflicts of interest. Planning must take systematically into account the following matters: data collection, identification of leaders, forming the planning committee, problem-identification workshops, identifying alternatives (coopting specialist help here), workshops for deciding among such alternatives, devising execution strategy, and political approval of the project by the local authorities and other competent persons or bodies.

The principles of watershed planning described here have been applied in the Project for the Ecological Village at San José de Limones, Mérida. The aim was to bring into being a self – i.e. participatory – managed habitat with support from government and private institutions, offering better living conditions, sustainable agriculture and protection of the forest.

San José de Limones is a settlement scheme coming under the National Agrarian Institute. It is designed for 14 families, on a 85-ha site which, as intended, will have an influence extending to the entire Limones area, the Andrés Bello municipality and Mérida State.

Decisions are arrived at in participatory planning workshops involving the local community and benefiting from the experience of an interdisciplinary team, with qualified persons from various government offices and from the University of the Andes.

Detailed surveys of farms have been carried out for the purposes of diagnosing plant diseases, establishing the soil fertility situation, and the state of conservation of springs, housing conditions, and people's health.

In the light of the survey findings on-farm, family and community matters, a series of proposals have been drawn up in terms of five main components, thus:

- promotion, integration, organization and training: establishment of the civil association (with corporate status) and of the co-management body; issuance of clear ownership titles; study courses promoting diversified economic activities with social development in view; community services and environment protection;
- agroecological assistance for holdings in an attempt to devise a sustainable forest ecosystem; study courses/workshops on agroecology; establishment of agroforestry systems comprising banana, coffee, *Erythrina* spp.; technical assistance visits; monitoring and evaluation; use of organic fertilizers and liming; integrated pest control; assistance for farm accounts and marketing; establishment of demonstration farms and plots; agroforestry rehabilitation; and forest and wildlife protection; and studies on biodiversity and fauna, and on breeding in captivity of local wildlife species having an economic interest and food value;

- agroecological planning for each holding: promoting organic farming where production is pursued along sustainable lines for bananas and coffee, and brings down production costs and improves the marketing process and thereby raises household incomes;
- infrastructure and basic facilities: an architectural, town planning and landscaping proposal, to improve housing conditions. A model dwelling has been designed adapted to the bioclimatic and cultural conditions of the San José de Limones area. Houses will be built by the future occupants themselves. A biodigester, earthworm hatchery and compost maker will encourage organic farming. A Communal Centre is to be set up, and this will inculcate the integrated approach among the population and otherwise facilitate educational activities, the running of a dispensary, training and dealing with tourists and visitors. Alternative technology, such as the use of solar panels, will also be demonstrated.

  The above model design will be accompanied by another, this time in the form of plans for tourist cabins, to be built in a second phase of the project. Paths will be laid out starting from the Communal Centre and penetrating into the woods and thus help to promote ecotourism and agritourism. There is also a model for a small church.
- Environment protection. The fourth component of the project concerns building awareness as to the need to protect the forests and their importance where water sources; also wildlife, since the sound management of the lapa (*Agouti paca*), which is much appreciated for its meat. This component calls for a programme of environmental education and protection coordinated by the Ministry of the Environment.

The project is managed for the first two years under a partnership arrangement with the Civil Association and with government bodies before being transferred to self-management.

The foregoing components call for support from the Government and the local municipal authorities for the four basic problems needing to be solved, namely: installing an electricity supply; improving the roads; obtaining clear ownership titles; and starting up the rural dispensary and the school. For the latter the main concern will be to educate for work.

5. STRENGTHENING INTEGRATED MANAGEMENT OF MOUNTAIN WATERSHEDS IN THE TROPICS

The main challenge here is to set in train a process whereby the people can be involved in a philosophy of sustainable development in a context of explosive population growth, economic restriction, in turn leading to social stress, and an open market economy (Hernández 1996). Within such an institutional and social context it is proposed to take action in five major areas:

Education and training

- The aim here is to develop novel educational approaches for watershed management. In Latin America, considerable effort has been made since the Watershed Management Congress was held at the Universidad de la Plata in 1961. However, the realities are that adjustments are called for in the educational model. At least four basic areas need to be addressed: (a) mountain ecosystems and agroecology; (b) modern planning processes; (c) public policy; and (d) sustainable development and the globalization of the market. The training given must strengthen managerial capacity specifically for dealing with watershed environments.

Planning

- Encouragement must be given to holistic and strategic approaches to natural resource management by the various institutions, by the political authorities and by civil society.
- Work objectives need to be set which will be geared to: the social and economic realities of the locality; efforts for sustainable local rural development compatible with the limitations inherent in the natural environment; human and family values; agricultural and forest development that is less polluting but more endogenous and profitable in the use made of human, natural and landscape resources; an autochthonous architecture using alternative technology; a high self-management component through participation, organization, training and education together with decisive support from the public institutions in the provision of infrastructure and essential basic services; technical assistance for holdings; environment education inculcating the protection of forests and biodiversity.
- There is the need to strengthen coordination and establish inter-state agreements, since among the difficulties confronting watershed management here is the fact that operations are carried out in territorial units falling under more than one political authority and are thus difficult to coordinate.
- There is the priority need for financing projects having a monitoring and evaluation component, since the absence of any system for measuring selected indicators leaves one with no means of determining project effects.
- Stability must be a feature of medium-term policy for watershed conservation, especially in the case of watersheds of strategic importance for domestic, industrial and agricultural water supply, and the conservation of aquatic ecosystems. The lack of stability in policies has been among the cause of failure in matters of rehabilitation and conservation.

People's participation

- It is important to secure meaningful participation on the part of the population. Experience points to a clear correlation between the level of people's participation and the level of efficacy of projects (Dutta S.K. *et al*. 1996). The advantages are many and wide-ranging. Thus, it is possible to arrive at an accurate identification of priorities, the contribution of innovative ideas, the incorporation of people's own traditions and lore, development in self-confidence as the project proceeds, a jealous control over resource use, self-support over the medium and longer terms; a strengthening of the people's own forms of organization and the bringing into being of a virtuous circle of improvement. The participatory element must be a genuine one, with no personal preferences shown or any manipulation of the community (Klisberg 1997).
- Promoting co-management and self-management. As emerges from the evaluation of watershed management projects all over the world, the projects that have succeeded are those where there has been effective integration of the people and their participation in design and execution. For this reason, watershed management must impart thrust to policies designed to secure consensus and participation, in particular through workshops for participatory planning. Yet participation must go well beyond the formulation stage and be seen as having an active role in management in order for the project to get under way.

The role of the forest to be emphasized

- Data on deforestation in mountain areas are alarming, along with those for stream and river pollution. Accordingly, specific action is required in the case of the rain forest, since this is an ecosystem of strategic value as a source of highest quality water and in maintaining biodiversity; rehabilitating riparian stands, chiefly those in catchment basins feeding water systems, with the purifying effect that these forests bring about; reforesting with quality species in areas having a

pronounced slope; rehabilitating areas abandoned after felling for mining needs; and promoting activities to demonstrate that mountain forests can respond to multipurpose management.

- Society is clearly gaining in awareness of the importance of the cloud forest as a source of highest quality water in mountain watersheds; and their protection is a matter of priority (Jiménez Escobar 1996). Through the action of their root biomass, stands growing on the banks of rivers and streams have the effect of purifying polluted water from nearby farmland. This function is fully borne out scientifically. Again, and as shown by the other "voluntary papers" presented at this Congress, the forest has had an important role in rehabilitating areas that have been degraded by mining operations and in improving environments where the slag has been dumped.

Finance

- There are serious difficulties in project execution because traditional – government – sources of financing are limited, so that the private sector has to be called in, though this sector itself needs convincing that there are environmental, economic and social benefits to be had from watershed management that take time to bear fruit. Another line of activity calling for creativity, determination and persistence (Hernández 1991) is that of finding novel possibilities of financing from the private sector or multilateral banking arrangements. The recent teleconference on investment in mountain areas called for by the Mountain Institute has reported positive experiences in identifying alternative sources of financing.
- To summarize, the proposal is to concentrate action on watershed planning and integral management in catchment areas of a truly priority importance, especially those feeding water supply systems, basins where institutions are in need of strengthening action affording certainty of obtaining financing over the medium and longer terms and where suitable work teams can be formed that have a clear, strategic idea of what is meant by modern watershed management and of the importance of the participatory approach. There needs to be a leader and promoter of the watershed project, a person making it his concern that not only shall objectives be achieved but that the results shall be characterized by quality. It must be a project in which there are political undertakings making for far-reaching inter-institutional coordination and for the creation of a system of monitoring and evaluation and management.
- What is said here may offer a contribution to strengthening the watershed management concept. As we approach the twenty-first century, such a concept will continue just as in other periods to demonstrate its validity as a formula for optimizing the use of administrative resources for the sustainable development of mountain areas.

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Integrated watershed management for sustainable development of renewable natural resources

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SUMMARY

The tangible problems in watershed degradation and management of natural resources have been discussed in a historical perspective and sequence of cumulative environmental changes. Anatolia (Asia Minor) was taken as a representative country in the eastern Mediterranean basin for the analyses of common integrated watershed management issues, and prospects and comments were discussed in three sets of factors as a vicious circle in degradation of watershed resources. The political opportunism in deterioration of renewable watershed resources was also emphasized. The origins of all problems with which watershed managers are faced were presented in the socio-economic impact group factors such as population explosion, lack of education, migration and poverty in the vicious circle of Figure 1. It is believed that participants in this Congress will find many common views which prevail in their home countries.

Keywords: Integrated watershed management, degradation of watershed resources, socio- economic impacts, community participation.

INTRODUCTION

A watershed is traditionally considered to be a topographic and hydrologic land entity for the planning and sustainable management of renewable natural resources. The distinction between watershed and river basin is generally considered to be only the size. Although in many instances both terms are used synonymously, watersheds are small drainage areas and the larger drainages are referred to as river basins (Riggs 1961). However, the historical perspective and the conceptual development of integrated watershed management has always been attributed to small mountainous drainage areas where forests and natural vegetation have been dominant land use types intermingled with other types of land use patterns. Therefore, the evolving of this concept as a scientific discipline has originated at forestry schools of universities and its field practices have been carried out mainly by forestry organizations. Mountainous small watersheds have usually been taken as project land units with the purpose of controlling erosion, torrents, floods and maintaining sustainability of usable water yield. These objectives, in a narrow sense, have always been tangibly connected with the management and development of renewable natural resources and sustained productivity of land and water resources.

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Since the management of each single or group of natural land resources has its own peculiarity coordinated with the main objectives, the major task of the watershed manager is to integrate all planning and management activities into a whole to fulfil the main management objectives and sustainability of precious resources for the continual welfare of the community living in the watershed. The classic definition of watershed management has somewhat been improved by entering the concept of integration and better sustainability of land, water and economic and social resources to upgrade human welfare in a quality environment. As Eren stated (1977) "There is one common element in nearly every scheme of land development – an increased demand for water", if then a wise and effective integration of all efforts and activities towards the sustainability of quality water yield is attained, the objective of whole-scale development for prosperity without environmental degradation may be harmoniously fulfilled. The concept of integrated watershed management is not only an effective approach and practice within a small watershed, but also an integration of outcomes of small watersheds constituting a colourful mosaic in a large river basin.

Anatolia, as a whole, and its western and south-western coasts are typical representative sites of the ancient civilizations which flourished and disintegrated through history in the eastern Mediterranean basin. Socio-economic and environmental conditions in this region and socio-political progression and sequence of degradation in the ancient city-states are also typically identical in the whole Mediterranean basin. Therefore, it is pertinent to take the Anatolian case representing the region as an example for discussion in this Congress in Antalya, Turkey.

HISTORICAL SEQUENCE OF CUMULATIVE ENVIRONMENTAL DEGRADATION IN EASTERN MEDITERRANEAN BASIN

In the past, Anatolia has undergone an almost complete cycle of forest and soil destruction, and regeneration. In the light of archaeological and literary evidence we can trace the circumstances and results of this process in Anatolia more completely than in any other Mediterranean country. Alongside archaeological and literary evidence, pollen analyses and archaeobotanical studies in and around Anatolia essentially reveal that forest and woodland showed a serious degradation during the last 2000 years due to ever-increasing and excessive interference by man with the natural environment and careless exploitation of natural resources (Aytuğ & Görcelioğlu 1996).

As William Brice states (1968), it seems that the process of erosion first became seriously active in the third century B.C. According to the historian Strabo, it was at this time that the port of Ephesus (Efes) began to suffer from siltation. Despite continued efforts to keep it open, eventually it had to be abandoned about 600 years later, in the third century A.D. The ancient city Miletus (Milet) and Seleuceia Piereia (Antakya, Mağaracık) were other ports which were destroyed by siltation at this time, and the process appears to have been evident all around the coast of this country. As a consequence of siltation, these ruined ancient ports are currently many kilometers away from the existing coastal line.

Similar observations may be made in different countries of the Mediterranean basin, such as Greece, Italy and Libya. In fact, the people who lived during the ancient civilization of Cyrenaica in Libya took good care of the soil and water utilization, and the land has undergone a severe accelerated erosion process during the centuries after the collapse of this civilization and devastation of the conservative land use system (Balcı *et al*. 1979). This era may be called "the first cycle of the erosion process" in the region.

The effect of the Selçuk Turkish conquest in Anatolia was simply to change the socio-economic conditions and relieve the devastating impact of large-scale exploitation of land and water resources during the Macedonian and Roman Empires. Under the legacy of Turkish Civilization in Central Asia, Selçuk Turks had, in a moderate way, imposed their way of life on the land and water resources and on

protective practices in Anatolia, their new home. This sort of conservative approach towards renewable natural resources provided an excellent opportunity for recovery, replenishment and regeneration of plant communities and forests. The period of the first 200-300 years of the tenth century A.D., during the Selçuk Empire, was a smooth and gradual transition to Ottoman Turkish Empire which was the beginning of a new large-scale imperial socio-economic enterprise.

Although during Turkish Ottoman times no consistent effort was made to reestablish and restore the destructed forests and soils of the country, the former deliberate exploitation ceased, and as Anatolia regularly exported a proportion of its population to rule and administer its wide empire, and the impact of the people on the land became less, a natural regeneration of vegetation may have occurred in many regions of the country. Thus, it seems that by early Turkish colonization, a reasonable sustained balance was attained between the natural reserves of land and water resources and the demands made upon them.

An attempt was made by a variety of means, including emperors' decrees and orders, to try to maintain the balance between the supply and demand for land products. In fact, Fatih Sultan Mehmet (Mehmet the Conqueror) issued a decree in the fifteenth century forbidding the grazing and growing of row crops on steep slopes of Kağıthane and Alibey Creek watersheds, which are the subcatchments of the Golden Horn Basin near Istanbul.

This sort of legislative measure prevented the Golden Horn from heavy siltation until the twentieth century. However, the sustained balance within the watershed ecosystems became upset with the gradual increase in population over the past two centuries and, in particular, with the drastic impact of the phenomenal rise in population since the foundation of the Republic. Thus the population has dramatically boomed from 10 million in the 1920s to 65 million in 1996, which exerted great impact upon land and water resources resulting in a serious cumulative environmental degradation. So, the land and water resources in Anatolia are now faced with a crisis for the second time in its history. This era may be considered to be the second cycle of erosion process and the devastation of natural sustained balance of ecosystems.

Besides the demographic impact, a great industrial expansion has also taken place which imposed a heavy pressure on natural resources. Despite all these inadequacies and alarming adverse circumstances in watershed degradation, Turkey fortunately has very able and effective public organizations with well trained and experienced technical personnel who are aware of the causes and effects of the problems with which we have been faced. This situation, then, greatly differs somewhat from the situation which prevailed during the first cycle of degradation process in Anatolia.

It is clearly evident that the population explosion in Turkey and in neighbouring countries constitutes the backbone of the huge problems associated with, and which endangered, the sustainability of natural ecosystems within watersheds. Since the late 1950s there has been a rapid and uncontrolled migration by rural populations to the urban industrial centres and big metropolitan cities in Turkey. One of the main causes of such demographic transformation is inadequacy of agricultural land on mountainous areas and the decrease in soil fertility and severe erosion on steep slopes. The economic dilemma of the rural populations because of land degradation and the drastic fall in the size of the usable crop fields per capita force the people to leave their homes for better living standards which they hope to attain in big cities. This situation has created dual economic, social and environmental problems: (1) abandoned villages and eroded crop lands behind them; (2) unhealthy creation of instant districts and communities in municipal watershed areas of big cities. Unlawful occupation of precious forest land by migrating settlers in municipal water-producing catchments resulted in environmental pollution, water shortages and siltation of reservoirs which were due to the lack of infrastructure. This sort of undesirable and primitive urbanization has also created a variety of socio-economic conflicts which forced the people into many illegal acts, crime and social unrest.

In parallel to this type of occurrence, another shocking mispractice in the use of land which has been rapidly increasing is the occupation of good and fertile first-class agricultural lands by industrial plants and new settlements (Balcı & Uzunsoy 1980). Since the quality of water has always been a very precious asset in the Mediterranean basin under semi-arid climatic conditions, sustained usable water yield is gradually diminishing or portrays an irregular water regime because of the cumulative degradation in environmental balance.

A review of the papers to be presented at this Congress submitted by participants from all over the world indicated that the problems they discussed are mainly in accord with the arguments stated above. They are mainly in the following categories: (1) Rehabilitation and afforestation; (2) Erosion and sedimentation; (3) Watershed hydrology; (4) Snow and avalanche control; and (5) Watershed economics.

PROSPECTS AND COMMENTS FOR SUSTAINABLE DEVELOPMENT OF WATERSHED RESOURCES

When we take Turkey as a transition-representative country in the region for many watershed management problems, it is pertinent to divide issues into two main categories: (1) technical problems; and (2) socio-economic tasks which may not be similar in many countries of the northern hemisphere. The climatic regions delineated in Turkey vary from "arctic mountainous" to "sub-tropical Mediterranean" superimposed by oceanic effects and very distinctive topographic features. The major causes of the technical problems are natural environmental factors in the developed northern countries, whereas, in developing countries, social and economic factors are the main cause of the deterioration. As Prof. Dr. A.N. Balcı stated: the interconnectivity among factors involved in the deterioration sequence of natural resources may be summarized in a vicious circle which includes a three-stage process (Figure 1). Each stage constitutes a set of factors. The first set of factors is called (1) *Socio-economic impact* which is considered to be the *activator* or *originator* of the other two consecutive stages. The social and economic factors – population explosion of un- or less-educated masses and migration associated with poverty – are the main reasons attached to human behaviour and population dynamics in local communities. The rapid increase in population upsets the sustained balance between watershed resources and demand which results in a heavy impact on the environment. Socio-economic desperation forces people to devastate forest and range lands, and water resources.

Thus the second stage of the vicious circle, (2) *Mis-use of land resources*, begins with (a) Conversion of forest and range lands to other improper uses, (b) Residential and industrial use of cropland, and (c) Mispractice in agriculture and forestry.

All these precursory activities and mispractices activate (3) *Actual tangible problems* such as (a) Erosion, torrents, landslides, (b) Floods, (c) Environmental pollution, (d) Degradation of hydrologic regime in a watershed, and (e) Water and food shortages. The third set of these tangible problems, like the other stages in this consecutive chain reaction, completes the cycle in this vicious circle and exceedingly accelerates the magnitudes of socio-economic impact at the first stage (Figure 1).

There is no doubt that all this physical degradation and consequences in various types of land use in a watershed demonstrate a shocking scene noticeable by the public. This alarming situation usually stimulates public awareness of non-governmental organizations (NGOs) and public authorities to find revenues and financial sources to restore the situation. It is our duty here in this Congress to be realistic and demonstrate the main reasons behind the huge problems. From the very beginning the origin of the problems taking place within the first set of factors in the vicious circle is mainly political opportunism. Somehow, the physical facts of watersheds and the political realities have to be brought together. That is the focus of integrated watershed management. Within this broad outlook, there is intimate concern both with (1) preventing deterioration of an existing sustainable and productive

relationship between the water and natural resources, and (2) restoration of those resources which have been destroyed in the past.

Thus, integrated watershed management actions and activities may be employed in two main approaches: (1) *Preventative approach*; and (2) *Rehabilitative approach*. The activities and administrative and technical measures may be employed in a consecutive sequence or in some cases take place concurrently in a particular watershed. For instance, conservation of soil and water resources may be achieved by legal regulations and proper use of land according to capability classes (preventative approach). Similarly, in some severe cases, technical measures like gully control structures, channel stabilization works and terracing (rehabilitative approach) may be mentioned.

Adult education and training is the key issue with high priority in developing countries which leads to better achievements of integrated watershed management activities.

In fact, similar integrated watershed management approaches have been employed in Asia (Nepal, Pakistan and India), Africa (Burundi and Rwanda), Latin America (Bolivia) and noticeable achievements have been attained (d'Ostiani 1997, Dutta & Ray 1997). There are also several successful examples of such projects in different parts of Turkey. The initiation of several watershed management projects emphasizing various aspects of integrated watershed approach goes back to the late 1950s. Several noticeable watershed rehabilitation projects realized in Turkey, including Behzat, Kızılcahamam, Vazgirt, Serabat, Askarbeyli, Çakıt, are worth mentioning. The most recent ongoing watershed rehabilitation project, as an integrated part of GAP (Southeastern Anatolian Regional Development Project), which has been implemented in 54 micro catchments covering approximately 400 000 ha (about 27% of the central Euphrates basin), is being supported by the World Bank and the Government of Republic of Turkey (Küçükkaya 1997).

The following comments and conclusions may be made for the achievement of sustainable development of watershed resources:

1) Education and community training through extension works are essential to raise the standard of living of rural communities. The transfer of small technologies such as agroforestry, apiculture, animal husbandry, range improvement, carpet weaving etc. is a short cut way to achieve the economic targets.
2) The community participation is a necessary approach but not sufficient for promoting the sustainable development of upper watersheds. An increasing attention should then be paid to the technical dimension of watershed management.
3) The watershed management policy and legislative measures should be designed so as not to give any open channels to local politics to lead people in misuse and mispractice in watersheds. This point should be controlled and monitored by public awareness supported by NGOs.
4) No matter how eligible and qualified the technical personnel employed by the governmental organizations are, lack of any coordination among these institutions may be a serious handicap to fulfilling the integrated watershed management goals. Therefore, it is absolutely necessary to achieve a good integration of the efforts and the forces rendered by the practising organizations.
5) Since each watershed is a unique topographic and hydrologic entity, technical and socio-economic measures should be based on sound data and results provided by genuine experimental research.
6) The key questions in management and rehabilitation may be more easily handled and achieved in smaller watershed units and it facilitates the integration of achievements in a mosaic of a river basin.
7) Water resource problems in Mediterranean countries as well as in many others have clearly illustrated the interdependence of individuals, communities, municipalities, states and nations.

The management of this resource to obtain maximum benefit for this and the next generation will require the cooperation of all people.

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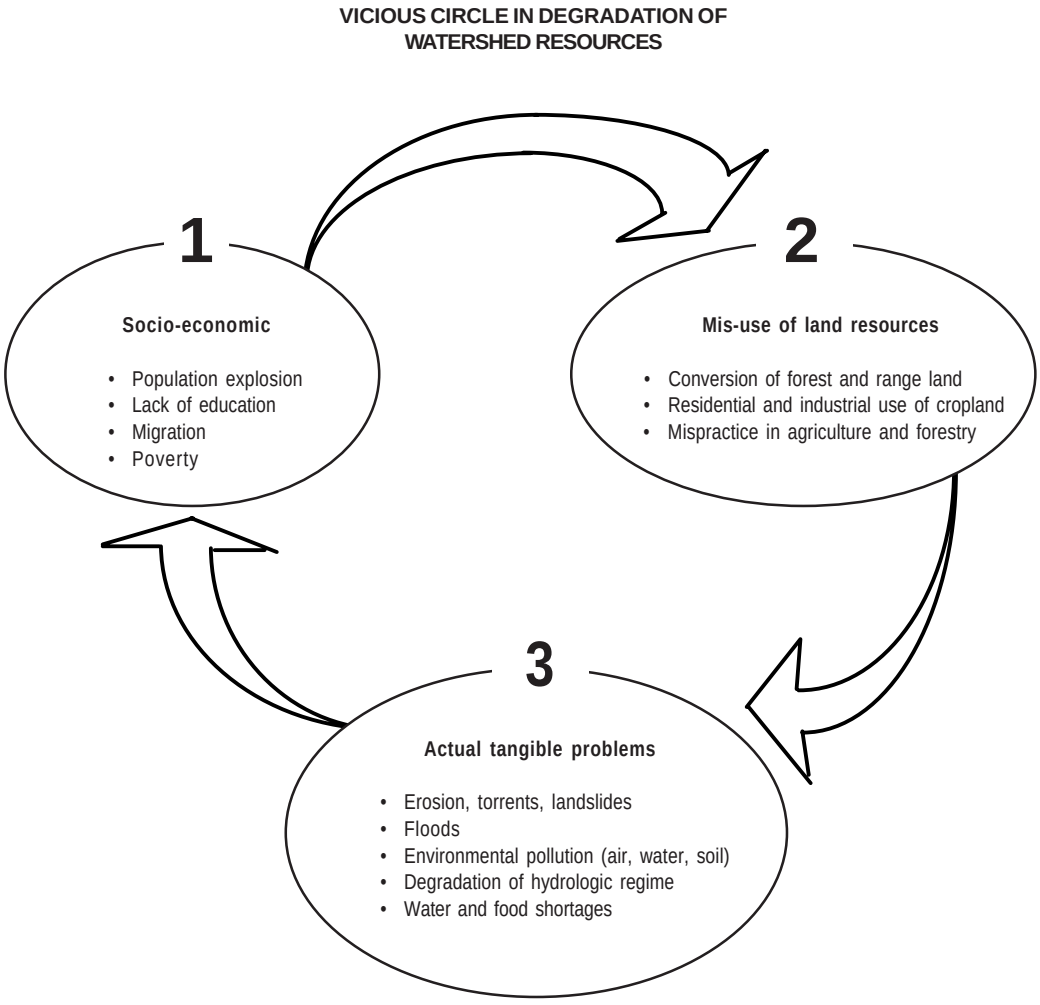
Figure 1. Interconnectivity of the groups of factors active in degradation of watershed resources in a vicious circle



Doon valley watershed management – an endeavour for sustainable eco-restoration through people's participation

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SUMMARY

The Doon Valley Watershed Management Project aims at arresting and reversing the ongoing degradation of the environment. The project, encompassing an area of 185 000 ha with 250 villages, strives to ameliorate the lives of the rural people and encourage their cooperation in the management of their environment and augmenting the productive capacity of their depleting natural resources in an integrated and holistic manner.

Mounting pressure of human population, reckless mining and quarrying of limestone, overgrazing and rapid urbanization in the valley have led to large-scale erosion and degradation of the valley's fragile ecosystem. The approach for this project is participatory watershed management. A village in a micro watershed is treated as a basic unit in which the innate resources are developed through community participation in all three phases of planning, implementation and maintenance of the assets so created. Village plans evolve from Participatory Rural Appraisal (PRA).

Project activities are carried out in select micro watersheds in an integrated manner with eight component activities, viz. Social Forestry, Horticulture, Livestock, Minor Irrigation, Agriculture, Soil Conservation, Community Participation and Energy Conservation. As women play a significant role in the management and exploitation of natural resources, female village motivators have been recruited to facilitate community motivation and to build up a bridge between the village women and the project staff.

Implementation of the watershed management project has generated job opportunities among the villagers, such as users' groups and savings/credit groups with revolving funds, supported by contributions from the villagers and the project. The revolving fund takes care of the future maintenance of the assets created by the project and also provides small credits to the needy villagers.

A case study of 10 villages where the project components were implemented shows that "Participatory approaches in planning and implementation have broken the 'dependency syndrome' to a great extent". The study also makes special mention of rural woman coming forward to talk about sustainable management of forests and natural resources.

Keywords: Eco-restoration, Participatory Rural Appraisal (PRA), revolving funds, watershed management; user's group.

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INTRODUCTION

The fragile ecosystem of Doon Valley has been constantly threatened by its unstable geomorphic location and alarming rise in the urban population. This situation is further aggravated by the rapid encroachment of farming lands into the steep hill slopes, thereby degrading the forest resources. Saxena (1995) noted that concentrated investment by the state government in reforesting degraded community forests has been largely ineffective because, being open access lands, neither the government nor the communities protect them. In practical terms, the people will cooperate with the project staff the moment they realize that they stand to gain from it. Man is in the centre of any development endeavour; so people's participation in watershed management has been considered as the main thrust. Prompted by local concern for the present state of dwindlement, the European Union and the state government concerned have agreed to finance a nine-year integrated watershed management project starting from 1993 in the Doon Valley with special emphasis on community participation (Dangroup 1990).

THE AREA

Doon Valley is roughly bounded by the Himalayas on the north, the Siwaliks on the south, the river Yamuna on the west and the Ganges on the east. The valley, which is about 80 km long, on average, and about 30 km wide, has a total area of 1853.86 km^2

The project area excludes all urban areas and the Rajaji National Park.

The terrain in the project area is divisible into four main zones:

a) In the north and north-east are steep, south-facing slopes of the middle hills along the Mussoorie-Kaddukhalridge. This area has a maximum elevation of 2 500 m.
b) The upper parts of the valley are deeply incised, old alluvial terraces.
c) The central valley of gently sloping pediments is crossed by broad beds of seasonal rivers.
d) In the eastern sector and along the southern watershed there are steeply dissected slopes on sandstone and conglomerates of the Shiwalik Hill. The average elevation here is 500 to 1 000 m.

The steeply sloping land of the middle hills is inherently unstable and susceptible to landslides which contribute to downstream sediment loads. Twenty percent of this area is classified as having a severe erosion hazard.

The majority of the population is composed of subsistence farmers with low incomes. In the hills the villagers are dependent on outside subsidies and remittances from migrant labour. The exodus of able-bodied males from villages to cities in search of livelihood is widespread.

Doon Valley was once rich in biodiversity. Unrestricted destruction of forests through the felling of trees, unscientific quarrying and mining, urban expansions, uncontrolled grazing, frequent flooding, landslides and invasion by wildland fires have reduced the once rich Doon forests to a valley of boulders with pockets of scrub forests here and there. The valley has become geomorphologically very unstable and its natural resources are no longer able to bear the ever increasing biotic pressure. Prompted by local concern for the present rate of dwindlement of the natural resources, the European Union agreed to finance the Doon Valley Integrated Watershed Management Project.

The approach of the Doon Valley Project is a participatory watershed management endeavour. The village is treated as a basic unit in which the innate resources are developed through community participation in all phases, namely, from project planning, implementation and finally in the sustainable management of the resources thus created.

Village plans evolve from participatory rural appraisals. This is an interactive, learning exercise in which the villagers draw up plans and maps for their own development. Later on, these very plans are

used as the basis for annual plans for the project. Ultimately, watershed management should become a people's movement with the project staff acting as facilitators.

The broad objectives of the project are:

a) To arrest and reverse the ongoing degradation of the Doon Valley ecosystems;
b) To improve the living standards of the villagers living in the valley;
c) To ensure positive involvement of the rural people in the management of their own environment.

On the basis of observations made on the various activities of the local people, those which directly or indirectly affect the Doon Valley ecosystem are agricultural practices, cattle management practices, demand and supply position of energy requirements of the people and other income earning avenues.

The project has taken up mainly two types of activities:

i) Activities which improve the health of the natural resources, like forests, grazing grounds, cultivable wastes, ground water, soil, etc.;
ii) Activities which indirectly reduce the pressure on natural resources by improving the existing production systems and creating subsidiary occupations for some extra income.

Accordingly, the components for project activities have been identified as: forestry, horticulture, minor irrigation, agriculture, energy conservation, animal husbandry and community participation. These activities have overlapping cycles through which they influence each other. It has been observed that in the past the development programmes could not be sustained because of the absence of local initiatives. To fill the gap and to encourage the local entrepreneurship, the project has earmarked a considerable large part of the total budget for community participation. The aspirations and initiatives of the villagers have been kept at the central focus of the project. To achieve this all the activities starting from planning to implementation of the programmes and subsequent maintenance of the assets created are to be done through active participation of the village communities.

THE INDIVIDUAL PROJECT COMPONENTS

The forests in Doon Valley come under two legal categories, reserve forests and civil forests. The civil forests are managed by the village self-government and are under the revenue department of the district. Such forests have long since lost their protective vegetative cover and are mostly boulder river beds or denuded hill-slopes. These areas are over burdened with biotic pressures. The reserve forests are managed and administered by the forest department. Though such forest areas have not changed significantly, the structure and composition of these forests have changed considerably through the years (Shedha 1982). The changes have come about in the form of reduction of the density of forests, lack of middle canopies and invasion of woody bushes in open areas.

Firewood and fodder are the two main items which are extracted from the forests. A rough estimate of the demand and supply position of these will show the extent of the pressure on the limited forest resources of the valley.

The demand and supply situations for fodder in the six sub-watersheds of the valley are given in Table 1.

Nomads such as Gujjars and Bhutiasho come down to the valley forests every year during the summers and graze their cattle in the reserve forest areas.

Thus, the balance fodder requirement is met from the adjoining reserve forests (91 454 ha). It is unlikely that the technical norms for dry matter fodder intake can be met now or in the near future. This results in a starved unproductive cattle force which is kept more for dung production than anything else, and which invades the forests every day without any control or regulation. Notwithstanding the

Table 1. Demand and supply of fodder in Doon Valley

Item units (tons dry matter)	No. of cattle[1]	Fodder requirements	Remarks
DEMAND	227 023	223 617	Dry fodder requirements per cattle are assumed to be 1.5% of body weight (av. 180 kg).
SUPPLY			
From non-forest			
(i) Cultivable areas (45 800 ha @ 2.75 t/ha)		126 868	
(ii) Cultivable wastelands (16 392 ha @1.25 t/ha)		18 698	
(iii) Common grazing grounds (15,694 ha @ 0.35 tons/ha)		6 482	

[1] The no. of cattle unit is based on the cattle census data of 1982.

religious and social constraints on controlling the cattle population, there is a clear need for new strategies aimed at controlling it.

The project tries to achieve this goal through an integrated approach to increase the productivity of the forests through plantations of the open and low density areas with fodder trees and bring some agricultural land under fodder production, increase cattle productivity through cattle health-care programmes and improve the local low productive cattle through natural breeding with highly-bred varieties. The project assumes that if the productivity of the cattle increases, the villagers will keep fewer cattle to meet their requirements. To reduce grazing pressure in the forests, certain other incentives are given to the villagers for stall feeding their cattle.

The position regarding firewood supply is grimmer. The dismal picture regarding firewood supply from the Doon forests may be easily understood from Table 2.

Table 2. demand and supply of fire wood

Item	House holds (No.)		Firewood	Remarks
	Rural	Urban	(tons)	
DEMAND	69 090	248 723	372 383	Such calculations are based on i. fuel requirements per household per year is 3.6 tons. ii. NEDA surveys show 55% of urban households use firewood as main
SUPPLY				
i. Scrubland (32 086 ha @ 0.5 t./ha)			16 043	
ii. Open forests (26 175 ha @ 2.0 t./ha)			55 350	
iii. Closed forests (68 094 ha @4.0 t./ha)			272 376	

The demand situation as shown in Table 2 does not include firewood exported to the adjoining fuel-deficient districts which obtain supplies of firewood from the Doon Valley forests.

Thus, it will be seen in Table 2 that supply is 8.5% less than demand. With the increasing population, this gap will increase. On the basis of the assumption that current demand is being met with the current level of extractions, there is no denying the fact that future increasing rates of extraction from the Doon Valley forests will far exceed sustainable levels.

To overcome this unbalanced demand and supply situation, the project has adopted the following measures:

i) Plantation of firewood species in deficient areas; and
ii) Emphasis on increasing use of bio-gas for domestic energy requirements which willnot only save the adjoining forests but also will save the cow-dung, a very useful manure, from being wasted by burning.

The pressure on the forests could be reduced considerably by improving the present marginal agricultural practices. Crop production in the Himalayan areas is primitive, primary cultivation being carried out with traditional wooden plough or by hand. Sowing is usually done by broadcasting. Although some modernisation has been introduced into the system, such developments are restricted to the Doon Valley proper. The hilly slopes of the Himalayas on the south-western side, as well as the north-eastern slopes of the Siwaliks, are still very backward as regards agriculture.

The limiting factors for agriculture have been identified as:

i) The availability of irrigation water;
ii) The limitation of soil; the high run-off during the monsoonic rains wash away the most fertile top soil;
iii) Cultivation of low-producing varieties;
iv) Non-availability of agricultural inputs like manure, improved implements and credit; and
v) Absence of gender sensitive programmes; all the previous programmes, whatsoever, were, as usual, directed towards the male communities; whereas, in the Himalayan region, the agricultural operations are carried out by women and the malefolk generally work outside.

The project is aware of these limitations and has taken up the construction of irrigation tanks, harvesting tanks, supply of agricultural mini-kits of high-yielding varieties of seeds, supply of agricultural implements, and vermiculture for production of compost *in situ*. A research project is also trying to find out ways and means of re-charging the dried-up streams for the supply of water for irrigation and other uses. To make the programme gender sensitive, women's groups are being formed and revolving funds are being created and maintained to make the programme sustainable. It has been realized that the simple introduction of high-yielding varieties of seed alone cannot improve the agrarian scenario of the area. It has, therefore, been emphasized that a low external input sustainable mountain agriculture system be developed with the participation of the villagers.

As has been previously mentioned, women in the Himalayan mountains play a very vital role in the management of their environment. It is women who are responsible for the circulation of biomass from forests, pastures and fields to homestead. But traditionally, however, most technical information for development and programmes for the betterment of the community have been directed towards men, and not women. The scenario becomes grimmer when it is understood that the majority of men work outside their villages. Advice on better management of natural resources has not reached women, who actually work and depend on such resources. To overcome this dilemma the project is trying to change from male-centred programmes to a sharing of knowledge with women. Women motivators, graduates from the local universities, have been employed on a contract basis to carry the programmes

to the village women. The women motivators, being women themselves, have a better understanding of the problems associated with women. Under such a programme the activities which have been taken up are skills development for some subsidiary occupations, formation of women's self-help groups, training in resource management and linking with the National Bank for Agriculture and Rural Development (NABARD) for credit facilities.

METHODOLOGY

The project is being implemented with participation from the villagers right from the planning stage to implementation and subsequent maintenance of the assets. Planning is done through Participatory Rural Appraisal (PRA) techniques (Mukherjee 1993). A feature of the PRA exercise is that, within a few days, project staff can identify some activity in each hamlet that will enlist the cooperation and participation of either all or the majority of the inhabitants, irrespective of economic and social differentiation. Women are especially receptive, favouring income-generating activities. A task force has been created to establish the initial rapport with the villagers. Once the confidence-building activity is over, the actual village planning starts. Sometimes some activities emerge during the confidence-building stage which are performed before the planning process starts, and these activities are termed entry point activities. Such activities include training of the villagers in health-care, sinking of hand-pumps for drinking water, adult education, etc. The villages are selected for planning on the basis of some pre-determined criteria, which contain both sociological and economic parameters as well as the erosion status of the adjoining areas.

The essence of the PRA planning lies in the appreciation of developmental agenda, reflecting their unique priorities and requirements. PRA planning incorporates the age-old, time-tested knowledge and experience of the village concerned.

During PRA planning, villagers speak about their other problems which may not be related to the project options. For such non-project options the project authorities contact the line agencies or NGOs for carrying out such works. The line agencies (usually Government Departments) and NGOs working in the project are shown in Table 3.

A percentage of the total expenditure for any component is recovered from the users' group as their contributions towards the Revolving Funds which will take care of the maintenance costs of the assets so created. The village plans so prepared are very flexible and at any stage the provisions made therein may be changed and modified by the villagers.

Table 3. NGOs and their activities

Line Agencies or NGOs	Work
Mushroom Extension Department	Training in mushroom cultivation
Adi on	Study of women's committee for future support
NABARD	Knowledge about revolving fund
Horticulture Dept. (fruit Preservation Unit)	Training in fruit preservation
AME (Academics for mountain environment)	Woman Welfare Programmes
PRAYAS	Marketing Research

Although there is a bias in the land-based activities in the project, the landless, poor, marginal farmers and women in particular have been given special attention through:

i) Skills formation;
ii) Linking the self-help groups with the NABARD and other bank loans or charitable organizations for credits.

PROBLEMS

The programme is basically land-based and, although certain activities have been identified to overcome this lopsided development, yet a major part of the benefits go to the haves rather than to the have-nots. With the present package of treatment it is not possible to attend to the problems of the landless class, particularly for the landless women who depend on natural resources for their livelihood.

Though the primary concern of the project is eco-restoration, the villagers' options differ greatly. As is revealed from the various village plans, irrigation, animal husbandry, agriculture and, in certain cases, the infrastructures such as roads and hospitals are some of the primary priorities of the villagers and environmental concerns get a back seat. The villagers are more interested in individual gains rather than being concerned for the management of the common resources. In the project some sort of bargaining is being done with the villagers to achieve environment-related goals. This may be due to the weakness of local self-government in this part of the country or to the absence of any example to show as to how such natural resources can be managed profitably on a sustainable basis for community benefit. So, much of the task with the project lies in building village level organization.

The project opts for merging the users' groups with the local self government (Panchayati raj system). At present one of the elected members of the village self-government is nominated by the Village Head (Pradhan) as a member of such users' group. But the *modus operandi* of the future merger of the users' group into the Panchayati raj system has not been clearly spelt out, in the absence of which the strategy for the withdrawal of the project from a village, once all the activities of the village plan have been completed, cannot be framed. As a result, every year the number of villagers under the supervisory control of the project staff increases, creating real management problems.

MONITORING OF THE PROJECT

A study of 10 villages where all the project components were implemented was undertaken by UPDESCO, an independent organization, during the period January to March 1996. The objective of the study was to throw light on local participation and in-built sustainability of project interventions. The report made special mention of the women of the project villages coming forward to talk about the sustainable management of their natural resources.

The strengths and weaknesses of the Village-level Groups (VLGS), as observed by the UPDESCO study of the 10 villages in the project area, may be summarised as follows:

Strengths	**Weaknesses**
1. Frequent interaction with	1. Project inputs given to the project staff. villagers are the only binding force of VLGS.
2. Dealing with different communities within and outside the group such as gaining experience and developing position ties.	2. Dependence on Project official for for petty matters.

3. Women talking on management of wood, grass and water.	3. Ignorance about the procedure of according procedures of according revolving funds.
4. Discussion on environment-related local matters	4. Still needs motivation for the fulfilment of of project objectives.

Table 4. Matrix scoring for components by village (based on participatory evaluation of activities with villagers in each village)

Division/ Village	Overall scoring of quality (Score out of 10 points for each component)								
	Forestry	Agricul-ture	M.I.	Hort.	Live stock	Energy consvn.	Soil con.	Comm. Partcpn	Overall Mean
Rishikesh									
Sangaon (1)	–	6	–	6	5	7	–	6	6.00
Tangoligarh (2)	7	6	7	6	6	8	7	6	6.63
Soni (2)	7	6	7	6	6	7	7	7	6.63
Dehradun									
Uniyalgaon	? 9	6	6	6	4	7	4	4	5.75
Majhara (2)	8	6	6	6	4	7	8	7	6.50
Kalsi									
Bhitarli (1)	6	6	5	5	5	7	3	5	5.25
Koti (1)	8	7	6	6	8	6	7	7	6.88
Rikholi (2)	6	6	6	6	6	8	7	5	6.25
Hasanpur (2)	–	5	7	7	6	6	8	7	6.57

Source: TA M&E Team, study of Project Impacts in 10 Villages of DVP
Notes: (–) No work in this Component planned or done
(1) Village where planning and implementation started in 1993-94.
(2) Village where PRA planning and implementation started in 1994-95.

CONCLUSION

The Doon Valley Project is a case study in integrated watershed management conducted in a participatory, process-oriented fashion. Efforts have been made at all levels to bring about resource sustainability and to motivate villagers towards becoming economically self-sufficient and less dependent on their natural resources. All efforts have been made to pinpoint the inter-relationship between environmental sustainability and economic betterment of the rural people. The project has a holistic vision in which concerns for both the environment and community development have been emphasized.

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A research programme for mountain forest management

C. Chauvin [1], F. Berger [1], B. Courbaud [1]

SUMMARY

The management of complex ecosystems such as mountain forests requires a multi-scale approach. In the Cemagref research programme, the question of the best way to intervene was broken down into three closely related questions: where (relevance), how (effectiveness), and why (understanding natural forest mechanisms to make action more effective). "Where" involves using overlapping cartography to study functions, particularly protection from natural hazards. "How" entails the study of silvicultural rules to be applied on a case-by-case basis, using relevant descriptions of irregular forest stands. "Why" requires us to understand and rely on natural mechanisms in order to minimize economic and ecological costs; it is articulated through a programme of modelling the dynamics of irregular stands, notably on the basis of a strict network of forest reserves.

Keywords: Forest, mountain, stability, multiple-use, silviculture, irregular stands.

MOUNTAIN FORESTS: A COMPLEX AND LOCALLY UNSTABLE ECOSYSTEM

Mountains are characterized by heavy constraints but more so by sharp contrasts at varying levels: external and internal massifs, stages of vegetation, exposure, ridges and combs, and finally the impact of human activity, which varies greatly according to accessibility and historical accident.

Certain mountain forest stands in France have been generally destabilized after the same sequence of contradictory treatment: overexploitation until the middle of the 19th century, subsequently strict protection, and in the last few decades the risk of neglect for economic reasons. Extremely homogenous and slender, often climactic, these stands constitute large surface areas that are vulnerable to wind and insects, requiring specific precaution in any intervention.

All forest functions are effectively threatened: not only production, but also landscape and protection functions against natural hazards, which are particularly acute in mountain areas. It is therefore important these areas do not fall into decay, and that these fragile structures are not restored in the long term.

Such multi-functional and long-term concerns often involve setting aside the two extreme solutions, which have become too financially inconvenient: pure and simple neglect of forests in their current state; oversimplification of silvicultural methods to keep forests profitable. A middle way is required to manage forests more economically, but without jeopardizing the ecological or economic generator.

Following the Strasbourg inter-ministerial conference in December 1990 on forest protection, which contained a specific resolution on mountain forests, the Cemagref in Grenoble set up a research programme on mountain forest stability. Here are the principles and results from the northern Alps area.

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The approach is multi-level: the question of how best to intervene was broken down into related levels: where to intervene (relevance), how to intervene (effectiveness), and why (understanding natural forest mechanisms to enhance any intervention).

WHERE TO INTERVENE?

The question "where" relates to normal forest functions and the study of forest conditions *vis-à-vis* these functions. Study of forests' protection function was particularly developed (Berger and Renaud 1994), and led to forests being split up into priority forestry intervention zones at *département* level in Savoie. The methodology involves overlapping three maps: a map of hazards (and protection from them), socio-economic values (and their protection), and a map of stands (which afford protection). Using the study, it was possible to locate and estimate the work required for the next 15 years.

Work is moving towards the study of forest mechanisms in checking natural hazards, notably avalanches and rock falls. Such work should enable maps to be compiled automatically, with scope extended to the potential risks which forest cover currently counters.

HOW TO INTERVENE?

First and foremost, the development of appropriate silvicultural treatment for mountain forests implies a descriptive tool; in this case, a typology of mountain stands was carried out on a 1/4 ha scale based on the thorough description of 11 plots of about 30 ha each over the whole northern Alps region (Chauvin 1994). The main descriptor is the area covered by different layers: the choice to use height as a division criterion rather than traditional methods based on tree diameters, reflects concern about obtaining representative dynamics of forest stands and a diagnosis of their stability. These aspects are vital as management is usually extensive (Renaud *et al.* 1994).

Created jointly with the Office National des Forêts, this typology became the focus of training sessions for personnel and is now operational. Now the rules of tree marking can be adapted to various situations: state of stands, expected functions. In this way, the typology forms the basis of a silvicultural guide being drafted by a mixed group of researchers and foresters.

The method is applied on pilot sites where technical and economic aspects of various types of silviculture and exploitation (by tractor, cable, helicopter) are monitored and assessed.

WHY INTERVENE?

A knowledge of forest mechanisms is necessary to envisage new solutions and predict consequences. Therefore models were made of both *Epicea* growth in irregular stands and its regeneration. The motor behind the model is light, which is essential in inter-layer competition; the scale used was the tree, the basic functional unit in irregular stands (Courbaud 1995).

Fundamental multi-disciplinary research on forest mechanisms was also carried out together with universities and the National Natural History Museum on a network of non-exploited forests studied at interrelated scales: selection of typical plots, exhaustive description of stands, posture, insects and diseases, followed by detailed studies of carefully cartographed sites, including tree spacing and soil and humus characterization.

Studies were also carried out on various managed and non-exploited plots to understand forest protection mechanisms against avalanches and rock falls.

CONCLUSION: FOREST MANAGEMENT, GENERAL METHOD FOR A CASE-BY-CASE APPROACH

Where, how, why: these questions are not new to forest managers, and the methodology as analysis of functions and constraints, diagnosis of the stands, choice of a suitable silvicultural/ exploitation combination are the basis of classic forest management.

However, in recent years, this essential planning tool has been updated in a specific way to incorporate better mountain forest diversity and multi-usage. Using modern tools such as informatic cartography, typology and modelling, this research programme attempts to summarize and make more accessible the multitude of current information necessary at all levels to optimize foresters' action in a given area.

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Summaries of voluntary papers

(also published in Spanish, French and Turkish)

DYNAMIC PROCESS MODELS AND EFFECT EVALUATION OF FOREST HYDROLOGY FUNCTION

Ou Rungul, Ou Song, Wang Jiyong, Wong Youngde, Lin Hui [1]

Taking the forest status as the main characteristics of a basin system, this paper describes the dynamic process of forest hydrology action and deduces the hydrological dynamic-equilibrium equation and the hydrological action equation of the catchment system. At the same time, the mathematic models, which vary with time and space, of crown interception process, soil infiltration process, surface run-off formation process, natural process of water storage and water release, and ground-water output process have also been established. In order to make it easy to handle the data with a computer, the above successive process models have been discretized. Then the hydrological characteristic values and forest statuses in different periods are compared and evaluated by means of digital simulation. Therefore, the quantitative effects of forest action on hydrological control and water conservation are given.

Keywords: Forest hydrologic effect, modelling, evaluation, hydrological simulation.

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THE AFFORESTATION OF MINE AREAS AND ABANDONED MINES – AN UNAVOIDABLE WAY TO THE RECOVERING OF THE ECOLOGICAL ENVIRONMENT IN MINING AREAS

Sun Cuiling [1], Gu Wanchun [2]

Modern mine industries produce much waste and slag, which damage the ecological environment of mine areas. This paper discusses the current situation of environment pollution in mine areas and the urgency and importance of its control and management. The authors point out that forests are an important part of the ecological environment and afforestation is the unavoidable way to recover and improve the ecological environment in mine areas. Preliminary ideas concerning the patterns, methods, technical measures for afforestation of abandoned mines and mine areas are stated.

Keywords: Abandoned mines, afforestation engineering, ecological environment.

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RECLAMATION OF BAUXITE WASTE THROUGH AFFORESTATION

Shyam Lal [1]

This paper presents the results of an experiment designed to reclaim the red mud, an inevitable waste of bauxite ore mining, and to improve the ecological and environmental conditions of the mined area.

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POTENTIALS FOR APPLYING BIOSOCIAL MODEL TO WATERSHED MANAGEMENT IN INDONESIA

Endang Setiawan [1]

Watershed management actions are implemented through a nation-wide Project of Reforestation and Regreening launched in the late 1970s. The Ministry of Forestry was appointed the leading agency for planning and implementation of the Project. Planning of watershed management is initiated with strategic planning called "The plan of land rehabilitation and soil water conservation practices in watershed". During its implementation, some revisions to the emphasis were made.

Watershed management has applied the ecosystem model, and the watershed plan is formulated based on an analysis of biophysic and socio-economic institution factors. The soil erosion factor has been used as the main grounds in this formulation. Evaluation of watershed management implementation conforms with this planning thought, focusing on watershed land use, socio-economic and hydrological conditions.

While revisions to the planning framework have been made, conforming to Provincial and Regencies Spatial Plan, shortcomings are apparent with regard to (1) defining the socio-economic process to only the inside-watershed society (population living within the area of the watershed); and (2) difficulty in accommodating resource use by stakeholders in order to ensure socially sound management. Possible erroneous prediction and conclusion on society-environment relationships that could result from this situation, in turn, could lead to biased management actions. Biosocial model as developed by Thomas M. Bonicksen, a framework for analysing and organizing environment-society relationships in natural resources management, is elaborated as an option to accommodate the shortcomings. The use of computer simulation in applying biosocial model is proposed.

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PROGRESS AND LESSONS LEARNED FROM UPPER SOLO (WONOGIRI) CONSERVATION PROJECT TO CONTROL SEDIMENTATION IN THE WONOGIRI DAM, INDONESIA

R. Sudradjat [1]

A soil and water conservation project has been conducted in the Solo Watershed (120 064 ha) to reduce the suspended load of the six tributaries of the Solo River which flows into the Wonogiri Dam. Land rehabilitation and soil conservation measures were conducted through vegetative techniques and physical structures. The result of evaluation after five years of project implementation (1989-1994) shows the increase of lifetime of the dam from 27 years to 50 years and the increase of agricultural products, animal populations and farmers' income.

Food products increased by 32.8%, estate plantations by 13.7%, animal husbandry by 65.2%, forestry 22.3% and fisheries 37%. Income of farmer participants of terrace rehabilitation and social forestry increased by 270% and 280% respectively. Employment opportunities absorbed 370 man-days/a for terrace rehabilitation and 240 man-days/a for social forestry. Animal populations increased by 200% for cows, 150% for goats and 270% for sheep. Per capita income increased from 4.79% in 1988/1989 to 10.27% in 1992/1993.

This project is interesting not only for its success in technical and economic aspects, but also for the concept of the programme which necessitated coordination and cooperation of several institutions.

Keywords: Wonogiri Dam, catchment area, sedimentation, social forestry, farmer participation.

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FOREST AND AGROFOREST BEHAVIOUR OF *SWIETENIA MACROPHYLLA* KING IN SELECT SUBSEQUENCES IN THE SIERRA MAESTRA, CUBA

Adalberto Marrero Rodríguez [1], **Arsenio Renda Sayous** [1]

Swietenia macrophylla King, an introduced meliaceous species in Cuba, yielding premium wood, has performed satisfactorily in the Sierra Maestra, in its pure form in mixed stands in agroforestry systems. It has also demonstrated a highly important role in the conservation and improvement of mountain soils in various sub-watersheds, thanks to rapid growth, gaining between 1.23 m and 1.65 in height per year after six years from planting and releasing over 7.2 kg/year per tree macronutrient-rich leaf litter to the soil. The performance of this species at age six years is described and compared with that observed in certain other countries of Central America and the Caribbean.

Keywords: *Swietenia macrophylla*, agroforestry, sub-watersheds, leaf litter, surface run-off.

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STUDY OF THE BEHAVIOUR OF SOIL REINFORCED WITH FIBRE AND CEMENT FOR THE STABILIZATION OF FOREST ROADS

Carlos Cardoso Machado[1], Amaury Paulo de Souza [1], Roberto Mauro de Almeida [2]

A sandy soil, geotechnically classified as gneiss saprolith, was collected at a slope near the Vila Secundino in the county of Viçosa, Minas Gerais State, Brazil. The soil in its natural state was mixed with plastic fibre and cement and studied for simple compression. The results of rupture and of resistance to simple compression on proof bodies of natural soil and of mixtures of soil-fibre and soil fibre cement are presented.

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FOG FORESTS AS WATER COLLECTORS AND REGULATORS IN THE COLOMBIAN ANDES

Henry Jimenez Escobar [1]

The current situation as regards the exploitation of fog forests in Colombia in relation to their capacity to collect and utilize atmospheric or mist water as well as in the production and regulation of the resultant volumes of water in the drainage cycle is described.

Water balances of different drainage basins in the Colombian Andes have been drawn up where the high zone of such basins corresponds to fog forests. The analyses reveal a regulating function on the part of the forests as regards the basins' water production: during periods of rain, an overload of water is produced in the basins and in periods of little rain the water reserves held by the forests are discharged.

It has been possible, on the basis of the hydrological evaluations, to ascertain the importance of fog forests in the role of collecting atmospheric water and regulating volumes of water. The effects of inadequate management or the deterioration of fog forest areas are reflected in the change in water availability in terms of quantity and quality.

Recommendations are put forward concerning the requirements for evaluating the potential contribution from mists to water entering the basins and the important role of fog forests in this process. The need to implement projects for the environmental assessment of the forests with the aim of creating incentives to conserve and restore them is considered.

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VEGETATION MANAGEMENT IN THE REHABILITATION OF THE RIVER SECO BASIN – TRIBUTARY OF RIMAC

Pedro Julca Chuquicaja [1]

Desertification in Peru is a phenomenon which originates from the loss of plant cover in all its forms. Through physical geography, it presents a climatic diversity which determines various plant formations, these being made up of thickets with a composition in terms of flora which is very varied in its different strata.

Regulating run-off and controlling soil erosion are related directly to the vegetation in a basin. Over-exploitation and the irrational use of vegetation have led to an impoverishment whose consequences are reflected in accelerated soil erosion, the loss of regular volumes of flow in springs and the reduction of the soil's production capacity, reflected in the increase in poverty among the rural population.

The basis of this study is an analysis of the effects of deforestation in the River Seco basin during a 30-year period and an examination of the underlying causes.

The summary's general conclusions take the River Seco basin as a model, giving recommendations which may serve as a starting point for the management of other basins on the western slope of the Andes seeing that they have similar characteristics.

The summary also includes a graph, drawn up on the basis of the volumes of discharge of the River Rimac in a 30-year period and their effects on the supply of water to the city of Lima, which has a population of seven million inhabitants

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AFFORESTATION OF AGRICULTURAL LAND BY NATURAL FOREST COLONIZATION

Christian Gauberville [1]

The observation of natural colonization of former agricultural land in central France has demonstrated that afforestation using economically valuable species is possible in certain circumstances.

A bibliographic synthesis of the general principles of colonization of this land was used as a reference point to understand the field dynamics.

Finally, the study of various soils and plants present could be used as an instrument for forecasting the probability of economically-valid natural forest colonization.

Keywords: Agricultural land, natural afforestation, oaks, willow.

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THE EFFECT OF FOREST EXPANSION ON RISES IN WATER LEVELS: NOTES ON SOME MOUNTAIN WATERSHEDS IN FRANCE

Antoine Hurand [1]

How can we explain the effect of mountain forest expansion, which has been considerable over the last hundred years, on rises in water levels?

The study of small experimental catchments (in the southern Alps and Massif Central) and models drawn from wider catchments (Pyrenees) underlines the importance of initial hydrological soil status and reveals the existence of a saturation effect. The mitigating effects of forest expansion are especially important on initial degradation, providing hydrological effects and helping to check erosion.

While difficult to discern, increasing forest cover tends to have a stabilizing effect on water levels by reducing the scale of average rises. However, historical extremes in water level rises should be maintained as a reference point for land use planning, because threshold levels will have been exceeded irrespective of forest development.

Keywords: Mountain forest, rises in water levels, hydrology, catchment area, model- making.

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RESTORATION, CONSERVATION AND SUSTAINABLE MANAGEMENT OF THE FORESTS ON THE FRENCH SOUTH-WESTERN ALPS

Daniel Vallauri [1]

The guiding principles of forest policy in south-western Alps reflect most of the modern forestry concerns, as expressed in Strasbourg, Rio, Helsinki and the mountain forests protocol of the Alpine convention: restoration, conservation of forests and their biodiversity, sustainable management and development in mountain areas, protective function of forest. Furthermore, the evolution of forest policy in south-western Alps for the two last centuries can be used as an example. The main characteristics of the ecology of the region are still partly the consequences of centuries of farming, deforestation and soils degradation that affected the region till the end of last century and the launching of the programme of forest restoration for erosion control in 1860. Close to the beginning of the 21st century, management of old forest stands on former agricultural lands, restoration of areas subject to erosion, sustainability of erosion control achieved through Black pine stands, are all questions faced by forest managers. This paper is a short introduction focused on the importance of the ecological background of those problems and emphasizes that knowledge of long-term ecological trends helps solving them.

Keywords: Forest ecology, dynamics, restoration, afforestation, erosion.

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ESTIMATING THE UNIVERSAL SOIL-LOSS EQUATION'S COVER AND MANAGEMENT FACTOR FOR FOREST ECOSYSTEMS NEAR ISTANBUL, TURKEY

A.N. Balcı, N. Özyuvaci, S. Özhan, A. Hizal

The regional application of the Universal Soil Loss Equation (USLE) and its reliability should be tested by using local measured experimental data, particularly for various forest ecosystems. Although there has been some attempt to apply the USLE to forest lands (Hızal 1984, Balcı 1996) in Turkey, a more elaborate estimation of the C factor based on experimental data published by Balcı *et al*. 1993, and Uslu 1971 was made. In this paper, the C and P factors were combined in a single numerical value as cover and management factor (CP). The unknown CP factors were computed through the equation by using the known and measured numerical values of other factors. The CP factors were found to be varying from 0.011 to 0.024 for old-growth oak-beech forest and pseudo maqui ecosystems, respectively.

Keywords: Erosion loss, forest ecosystems, sediment yield, cover and management factor.

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A STUDY OF SHATALARAB OR TIGRIS-EUPHRATES RIVERS WATERSHED, PROBLEMS AND SUGGESTED SOLUTIONS

M. Sait Ketene [1]

The Shatalarab (Tigris-Euphrates) watershed, which is called Mesopotamia, covers about 900 000 km^2, distributed in Turkey, Syria, Iraq, Iran and Saudi Arabia. High rugged mountains, hills, plains and deserts are the main ecological regions in the watershed.

The Euphrates and Tigris rivers originate from east and south-east Turkey, flow toward Syria and Iraq, join near Kurna to make Shatalarab and pour into the Basra Gulf. Tigris and Shatalarab receive many tributaries coming from Iran.

Rainfall changes according to ecological regions, it increases from south to north and from west to east. In arid areas and low plains it is 100-180 mm, in upper plains and hills is 200-400 mm in the mountains it is 400-1200 mm.

Average total stream flow of Euphrates is 35 500 million m^3 , or which 90% originates in Turkey, 10% in Syria , none in Iraq. Tigris' flow south of Baghdad is 52 000 million m^3/a, of which 40% originates in Turkey, 30% in Iraq and 10% in Iran. Tigris before, joining Euphrates, received the Karha tributary and Shatalarab received the Akroun tributary. Their average waterflow is 26 000 million m^3; accordingly the total flow of the watershed is (35 000+52 700+26 000=114 300 million m^3 .

Irrigated land by the year 2000 will be about 2.1, 0.65, 2.7 and 1.0 million ha in Turkey, Syria , Iraq and Iran, respectively. They add up to 6.35 million ha. If the available water is used rationally, with a consumption of 10 000 m^3/ha, the water used would be 63 500 million m^3 in all sharing countries, which is about 60% of total water production of the watershed.

Watershed problems are: physical as floods, droughts, erosion, sedimentation, vegetation cover destruction in the upper parts; salinity, high watertable and swamps in the lower parts.

Among the technical problems are: the use of old irrigation systems, reservoirs sedimentation and lack of reliable measurements and data in some parts of the watersheds.

So far the Tigris tributaries below the Diyala confluence and specially Karha and Karoun river flows have never been included as watershed production. All these waters have been controlled by Iran completely and caused many technical and ecological problems for southern Iraq.

Among the legal problems: lack of agreements or treaties among the sharing countries for water use or the development of the watershed considered the most important. Every sharing country has different arguments and sometime they become hostile.

To solve problems it is urgent to reach an agreement on equitable, reasonable and rational basis for water use and development of the watershed as one natural unit. Therefore it is suggested to establish a joint authority to deal with all aspects of the watershed. Cooperation between the participants should be based on good will and a better understanding for solving all problems in the watershed.

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RESULTS OF THE WORKS ON REVITALIZATION BY AFFORESTATION OF DEPOSOLS OF THE LIGNITE MINE KOLUBARA

Slobodan Smit, Zoran Miletic [1]

Production of energy from coal is accompanied by extremely unfavourable effects of degradation of the environment (soil, water, forest, etc.) Elimination and mitigation of degradation effects, by biological recultivation, is as necessary and urgent as the production of energy. Areas recultivated by afforestation will enable in the future the development of forestry and agricultural production, wildlife management, fishery, recreation tourism, as well as environmental protection.

The newly established forest ecosystems on the deposols of the spoilbanks of REIK Kolubara perform several functions simultaneously: protection, amelioration, economic and aesthetic functions.

The establishment of forest plantations over these substrates supplies the input of fresh organic substances on the surface of the ground, thus activating the biological processes of decomposition (fermentation, ammonification, saponification, etc.). Intensive processes of organic matter decomposition and the generation of inter-stage products enable new syntheses and the production of microbiological, mature humus. Consequently, under forest plantations on deposols, the process of humification and biological accumulation of nutritive substances is reflected on the permanent increase of potential fertility of soil and its complete revitalization.

The correct choice of the species for afforestation according to the characteristics of the substrate, as well as adoption of all the necessary measures of timber stand improvement and protection, enables a good production of timber volume and confirms the economic function of these plantations.

Visual appearance of the landscape with lakes, rolling hills, and mixed broadleaved/coniferous plantations, with a great number of ornamental species, satisfies all decorative/aesthetical criteria.

Keywords: Afforestation, deposols, revitalization, recultivation.

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The following summaries are published only in the original language

SOIL EROSION AND COMPLEX SYSTEM OF AGRICULTURE AND FORESTRY IN NIHEGOU WATERSHED, CHUNHUA COUNTY, SHAANXI PROVINCE, CHINA

Liu Bingzheng[1], Wu Faqi [1]

Owing to the loose, homogeneous and uniform texture of loess, steep slopes are subject to severe water and soil loss during heavy precipitation. The movement of transferred soil destroys resources, decreases soil fertility and production and constrains local economic development. Systems of improved local husbandry techniques, which have proved effective in soil and water conservation, are described in some detail.

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STUDY ON SMALL WATERSHED SOIL EROSION CONTROL AND AGRICULTURAL DEVELOPMENT TECHNIQUE IN LOESS GULLED-HILLY AREA

Sun Baoping[1], Zhao Tingning [1]

In order to study the most appropriate model of soil erosion control and small watershed agricultural development techniques, the Ministry of Forestry and the China Science Academy appointed the Beijing Forestry University to implement three National Key Research Programmes of small watershed soil and water conservation, and agricultural development techniques, respectively, in the period of 1981 to 1985, 1986 to 1990 and 1991 to 1995, taking the Huang-jiaercha small watershed of Xiji County in Ningxia Hui Autonomy Prefecture as the case research site. The achievements of the three programmes indicate the best approach to the soil conservation problems of the area. Huangjiaercha small watershed's soil and water conservation practice shows that soil loss of small watersheds has decreased 98% while crop yield per unit area and average income per inhabitant have increased 526% and 566% respectively. The soil erosion control measures and their benefits are discussed in this paper.

Keywords: Lloess gulled-hilly area, soil erosion, soil and water conservation, small watershed comprehensive harnessment, agricultural development.

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AN ANALYSIS OF THE EFFECTS OF A FORESTED CATCHMENT ON FLOOD OBSTRUCTION IN THE RESERVOIR AREA OF THREE-GORGE PROJECT OF YANGTZE RIVER IN WEST PART OF HUBEI PROVINCE OF CHINA

Wang MingYuan[1]

Based on comparable data analysis in the forested and the unforested catchment, run-off yield decreased by 57.5% and flood peak between 20% and 90% for each flood in the forest watershed compared with those of the unforested watershed during the observation period from September 1992 to Ju1y 1993. In the rainy season, the most obvious characteristics of water conservation in the forest catchment refer to increase in absorption (interception and infiltration) and consumption (transpiration) for succeeding rainfall.

Keywords: West part of Hubei Province, forested catchment, flood obstruction.

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SOIL EROSION AND SUSTAINABLE DEVELOPMENT IN CHINA

Yu Xinxiao [1]

The problem of soil erosion in China is reviewed and data on soil loss and decreased agricultural production are presented. Promising alternatives to current practices include integrated management of small watersheds, ecological farming, closure of vulnerable regions to agricultural activity and intercropping with trees.

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REHABILITATION OF DEGRADED FORESTS – AN APPROACH THROUGH INDEXING DEGRADATION

G.A. Kinhal [1]

It is estimated that in India over 10 000 km^2 of forest area are degraded every year and measures are now being implemented to stop the degradation process and rehabilitate the forests. The most important step in any rehabilitation scheme is the identification and selection of appropriate sites. Currently, the selection of degraded sites is done ocularly with ample scope for subjectivity. This paper proposes a Forest Degradation Index (FDI) to identify the intensity of degradation and assist a forest manager in prioritizing the sites for rehabilitation. Such an index is expected to enhance the effectiveness of investment by ensuring proper selection of sites.

Keywords: Degraded forests, rehabilitation, Forest Degradation Index (FDI), bioindicators.

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REHABILITATION OF OPEN-CAST COAL MINES IN SINGRAULI REGION OF UTTAR PRADESH AND MADHYA PRADESH

Shyam Lal[1]

Measures taken to rehabilitate the mined area are described. These measures have resulted in stabilizing the erodable coarse-grained soil type of sandstone origin which covered the coal seams. A diversity of quick-growing tree species and shrubs were planted and it is now proposed to plant species such as *Dalbergia sissoo, Albizia lebbek* and *Tectona grandis* along cleared strips. *Prosopis juliflora* will be maintained as a ground cover.

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REHABILITATION OF FLY ASH DUMP YARD SHAKTINAGAR SUPER THERMAL POWER STATION THROUGH AFFORESTATION

Shyam Lal [1]

The percent of ash in coal used by thermal power stations is about 30-35%. This ash is dumped in the area surrounding the stations and during the dry summer season, particularly, causes problems of air and water pollution. The study showed that leguminous tree species can be grown successfully on these ash dumps. Growth rate is comparable to that of other plantations raised in the area and the ash dumps are now well covered by vegetation.

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IMPROVING PRODUCTIVITY OF SODIC SOILS

Krishna Govind Prasad [1]

The past few decades have witnessed a sharp degradation in the quality of soil resources in India. According to Abrol (1990) forests and grasslands which have a vital role in providing and maintaining ecosystems so essential for agriculture and livestock have been fast degrading. India has 15% of the world's population and only 2% of the world's forest area. The per capita growing stock is 5.2 m^3 against the world average of 46.7 m^3 and the per capita availability of forest areas is only 0.08 ha against the world average of 1.0 ha. Interpretation of satellite imagery has shown that the country might be left with only about 8 to 10% of its geographical area under closed forests, in contrast to the figure of 33% recommended as minimum for ecological security by the National Commission on Agriculture. The country's requirements, including fuel and industrial wood, in 1980 were reported to be around 200 million m^3 and according to the National Commission on Agriculture, these requirements will rise to 300 million m^3. Thus, unless the yield and production can be increased considerably, over-exploitation, further resource depletion and environmental degradation are inevitable.

Future strategies will, therefore, need to address problems, not only of aggregate food production and nutritional security of the people, but also the regional imbalances and improvement of the socio-economic conditions of the majority of the rural population whose existence is based on rain-fed agriculture and non-wood forest products. Future increases in production must come entirely through biological reclamation of degraded soil and problem areas. To reach this aim, concerted efforts will be required to develop technologies for optimum utilization of larger fraction of soils having one or more soil-related constraints.

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FOREST RESOURCES IN WATERSHED PERSPECTIVE

Hikmat Ramdan[1], Endang Hilmi [1]

Forests have important roles in the support of sustainable watershed management, leading to both tangible and intangible benefits. Sustainable forests mean sustainable watersheds. Efforts to improve the valuation of forest resources should be made through an evaluation of all forest components. Knowing the real value of forest-land resources will reduce the large-scale conversion of such land and thus the conversion will be done very carefully. In watershed perspective, forest resources have more tangible than intangible benefits. Implementing land-use plans, strengthening political will, and the health watershed model are some recommendations towards attaining a healthy and sustainable watershed.

Keywords: Forest functions, watershed perspective, forest valuation.

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INDIGENOUS SPECIES TO REHABILITATE CRITICAL AREAS IN THE TROPICS

Suhardi [1]

Deforestation has resulted in large areas of cleared land in Indonesia. The paper describes silvicultural experiments designed to provide data on species selection for reforestation of denuded areas.

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WATERSHED MANAGEMENT IN MYANMAR

U Sein Thet [1]

The paper gives a general description of the problems of watershed management in Myanmar and outlines the principal actions taken in the resolution of these problems both in the short term and long term.

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THE ECONOMIC ANALYSIS OF WATER QUALITY IMPACT – A CASE OF FOREST HILL SLOPE IN TAIWAN

Kouchung J. Lee [1]

Changing land use in watersheds and consequences of this change are described and quantified. The marginal cost of improved management practices in watershed is estimated.

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LAND-USE AND DYNAMIC OF ECOSYSTEMS – CRITICAL IDEAS AND VIEWS ON THE SUSTAINABLE DEVELOPMENT OF MOUNTAIN AREAS

Wolfgang Weinmeister [1]

Based on ecological criteria, the idea of sustainable mountain development is investigated. Research areas such as energy flux, the dynamic of development (speed), disturbances, demographic developments, natural hazards, land use, influence of economy and recent research fields are dealt with in this paper.

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RESTORATION OF PROTECTION FORESTS IN THE BAVARIAN ALPS

Dietmar Brinkmann [1]

The paper contains information on the condition of protection forests in the Bavarian Alps, the goals and ameans of restoration efforts, the results after the first 10 years.

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THROUGHFALL AND STEMFLOW IN A MONTANE EAST AFRICAN RAINFOREST

Johan Uebel [1]

The Ulugurus form one of the major stream source areas in Tanzania. Over the last century large areas of the mountain range have been deforested as a result of the expansion of peasant agriculture. In 1909 the German administration declared 277 km^2 of the upper part of the range preserved. The Uluguru Mountain Integrated Soil Conservation Project (Lulandala 1992) includes miscellaneous soil conservation methods aiming at mitigating the streamflow soil erosion from the catchments. The results will be evaluated within the Catchment Forest Project.

Throughfall consists of direct throughfall, crowndrip and stemflow. The high spatial and sometimes temporal heterogeneity of tropical forest canopies require elaborate sampling designs. An additional water input of so-called horizontal precipitation (cloudwater) condenses on the leafage of the forest canopy and may contribute to hundreds of mm per year in forests subjected to fog and/or clouds. The objective of this minor field study is to estimate net precipitation in the upper, forested part of the Mlali catchment, a mainly north-west facing catchment in northern Ulugurus, close to Morogoro town.

Thirty aluminium troughs, ten on each site, were placed in fixed positions within the forested part of the catchment. The forest is mainly to be regarded as two-storey with generally dense undergrowth and epiphytes abundant on all three sites. Gross rainfall was obtained from two similar troughs outside the forest. Stemflow was measured on 15 trees in connection with the throughfall measurements, by use of longitudinally cut hose-pipe.

Between 23 April and the 3 June 1995, mean throughfall was 920 mm for the three sites, which corresponds to 96% of gross rainfall. This result is congruent with other studies on throughfall in rain forests. The used methodology gives reliable data and thus a satisfactory experimental design for throughfall collection. The largest amount of throughfall was recorded on site No. 2 (1 500 m a.s.l.) in the middle of the catchment where selective cuttings for firewood occur frequently. Hence the typical two-storey structure of the rain forest is less pronounced on this site, which might explain the larger amounts of throughfall due to lesser canopy interception. Estimating the extent of canopy interception and evaporation losses require daily values of temperature and wind speed at canopy level. These meteorological data were not possible to obtain within this study. Site No. 3 was placed close to the edge of a ridge and the highest situated (1750 m a.s.l.) and probably most cloud-exposed site in the study area. However, recorded throughfall only amounted to 90% of gross rainfall. This is most likely a result of the absorbing capacity of the large amounts of epiphytes at this altitude.

The large difference in collected stemflow between site No. 1 and No. 2 cannot be explained by differences in precipitation. A relevant explanation is difficult to find but the great discrepancy is most likely caused by site and tree specific structural differences, i.e. tree and diameter distribution, vertical stratification and branching geometry.

The tested methodology for throughfall collection has been proven reliable and functional for long-term measurements. To be able to relate stemflow to crown area, all trees within a plot should be sampled.

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EFFECTS OF A REGULAR SELECTIVE CUTTING ON STREAMFLOW CHARACTERISTICS OF ORTADERE EXPERIMENTAL WATERSHEDS IN MATURE OAK-BEECH FOREST ECOSYSTEMS NEAR ISTANBUL, TURKEY

A.Nihat Balcı[1], Necdet Özyuvacı[1], Süleyman Özhan [1]

Calibration equations for streamflow and water yield between the control (W-I) and treatment (W-IV) of watersheds as an integral part of the Ortadere paired experimental watersheds in Belgrad Forest are presented. The effect of 11% removal of the standing volume by regular selective cutting in old-growth oak-beech forest ecosystems was discussed. Correlation and regression coefficients of the calibration equations were found to be very highly significant. The gross variation in water yield immediately after the treatment was detected as the difference between measured and calculated values. Net increase in water yield in certain months (March, April and June) as the difference between the gross increase and the confidence limit for single values were found to be significant. Streamflow hydrographs based on daily flows for these months were developed.

Keywords: Paired watersheds, water yield, hydrograph, interception loss.

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PROBLEMS RELATED TO LAND USE IN THE WATERSHED OF ÖMERLI (ISTANBUL)

Cemal Fidan [1]

Only building of water reservoirs is not sufficient to supply water demands of a city. Besides, protection of the watersheds of the reservoirs is very important for this purpose. Thus, the water problem of Istanbul has not been solved yet in spite of building many reservoirs due to insufficient protection measures. For example, the southern and western parts of the watershed of the Ömerli water reservoir which is located in the Kocaeli peninsula, 28 km from the city centre of Istanbul, have been occupied by illegal urbanization. During the urbanization activities, the vegetation cover in the watershed was destroyed. As a result of this, the water storage capacity of the water reservoir has been reduced by erosion.

On the other hand, a wrong afforestation policy such as changing the natural deciduous species to coniferous in the watershed areas has caused a reduction in the amount of water filling up the reservoir reduce due to interception. In addition, illegal buildings without purification facilities pollute the reservoir lake. This matter not only increases the expenses of cleaning of water but also threatens human life. The department which is responsible for the protection of the watershed of the Ömerli water reservoir cannot prevent illegal settlements and apply the improvement plan due to bureaucracy.

The problems related to the Ömerli water reservoir have been generally caused by corruption in state departments and by political pressures. Therefore, it is not possible to solve the problems by application of the laws and regulations without removing the political pressures.

Keywords: Erosion, pollution, land use, immigration, protection.

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THE ROLE OF FORESTS IN AVALANCHE CONTROL

Halil Gerçek [1]

Avalanches can be defined as the mass movement of snow cover on the bare areas of steep slopes by internal and external forces. Beginning from old times, forest cover has been accepted as the best tool for preventing this mass snow movement, and people living an the foothills established protection forests against avalanches.

Generally, a healthy and dense stand of trees is considered as the best protection against avalanches, but how tree species stabilize the snow on steep slope is not clear, actually it is a common observation that denuded or bare slopes have more frequent avalanches than abundantly forested ones.

In fact, a dense forest cover cannot resist the tremendous force of large snow masses in motion. Hence to control huge snow masses that start above the timber-line zone, structures must be installed above this zone, as well as in the area to be forested.

Keywords: Avalanche control, forest-avalanche interaction.

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DISTRIBUTION OF SNOW AND AVALANCHE DAMAGE IN THE TURKISH FORESTS ACCORDING TO REGIONS AND NECESSARY MEASURES TO BE TAKEN

Mehmet Kanat[1], Ali Küçükosmanoğlu [2]

Avalanche damage was recorded in six Forest Region Directorates of Turkey between 1987 and 1992. It was found that the most severe avalanche damage occurred in Artvin located in the Eastern Black Sea region of Turkey. Snow damage was also recorded in Kastomonu Forest Region Directorate. Protective measures against snow damage are proposed.

Keywords: Snow, avalanche, damage, forest, Turkey.

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THE BALANCED MULTIPLE USE AND PROTECTION OF WATERSHED RESOURCES THROUGH INTEGRATED WATERSHED MANAGEMENT FOR SUSTAINABLE DEVELOPMENT

M.Y. Kilinç[1], N. Gülbahar[2]

The innovation in the planning of natural resources of watersheds has been called “sustainable development” for the last decades. it could be defined as the wise-use of natural resources without wasting, deteriorating and polluting while keeping the natural resources productive forever for the dynamic equilibrium in nature. It requires interdisciplinary participation.

The multiple-use concept may be either area-oriented or resource-oriented.

There are continuously interactions among watershed resources. In other words, the relationships of several natural resource products to one another can be classified into three groups: a) complementary, b) supplementary, c) competitive.

These relationships are dependent upon the range of the production functions. Before implementing the plan, which kind of relationship confronts it has to be determined.

In this paper, detailed explanations are given for each concept and parameters mentioned above. Further in the paper, it an attempt is made to analyse and synthesize the parameters involved in planning sustainable development. As a result, certain solutions are given and some recommendations are made for the problems faced by the planners in practice.

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A CASE STUDY OF PARTICIPATORY WATERSHED REHABILITATION FOR EROSION CONTROL IN TURKEY: "THE EASTERN ANATOLIA MICRO-CATCHMENT REHABILITATION PROJECT"

İsmail Küçükkaya [1]

The Eastern Anatolia Micro-catchment Rehabilitation Project is funded jointly by the Government of the Turkish Republic and the World Bank. Total project costs over the six-year disbursement period will be US$ 110 million, of which US$ 77 million is the foreign credit component. The remainder is funded by the Government of the Turkish Republic. Implementation began in March 1993.

The project's primary objective is to stop the degradation of agricultural land, forests and pastures of the Central Euphrates basin. Investments in direct rehabilitation are supported by complementary investments targeted to raise the incomes of the villagers and farmers who are affected by the project, and upon whom the long-term sustainability of the improvements depends. The villagers and farmers in the micro-catchments participate in the planning and contribute to the implementation of the project in their local micro-catchments. This is the first large-scale application in Turkey of the participatory development approach for watershed rehabilitation.

However, there are much larger areas of Eastern Anatolia which also require rehabilitation. Therefore, this project must also provide the basic model and lessons for rehabilitation of all these degraded areas. The project will rehabilitate a total of 54 micro-catchments across three Provinces-Adıyaman, Malatya and Elazığ. Three micro-catchments are selected for investment in each province each year. Implementation in each micro-catchment is over a 4 or 5-year period. The 54 micro-catchments will account for approximately 400 000 ha, about 27% of the area and 25% of the number of micro- catchments of the central Euphrates basin.

Highlights of the project's work to-date are described and discussed. Special emphasis is given to the evolution of the participatory approach used in the project. Lessons learned are described.

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REHABILITATION OF TURKEY'S MOUNTAIN ECOSYSTEMS: THE CASE FOR REFORM TO INCREASE PRIVATE SECTOR INVESTMENT IN AGROFORESTRY

İsmail Küçükkaya [1]

Deforestation is a major primary cause of erosion and resource degradation in the mountain ecosystems of Turkey. These mountain ecosystems are quick to degrade, and slow and expensive to re-establish, while lower altitude forest ecosystems in the country are more favoured. Additionally, the net removal of the forest systems is reducing the capacity of Turkey to meet the long-term national demand for timber.

The solution of these large-scale problems will require investment by both the public and private sectors. Reforestation is the most powerful tool for rehabilitation of these areas. The public sector must focus its efforts on rehabilitation of the areas where the private sector will not invest because of the low returns or high risks involved. Additionally, Government must provide a policy environment which favours private investment in reforestation and related measures which will also serve to rehabilitate and protect the mountain ecosystems at risk.

Private investments in forest-related ventures can range from establishment of conventional poplar and walnut plantations, through to agroforestry applications including grafting and planting pistachio, using poplars as field boundaries, and planting selected areas to almond and oak for erosion control and income generation in formerly forested areas.

However, there are currently legal and institutional barriers which limit private sector investment. The legal and institutional framework must be modernized to allow the full potential of the private sector to be achieved. This is also necessary to harmonize Turkey's situation with elsewhere in Europe. Only in this way will Turkey's forest industries be able to attract significant levels of private investment from Europe.

This paper reviews the current legal and institutional situation in relation to the short and long term development of private forestry and agroforestry in Turkey. The impacts of the current laws and regulations on investment are described. Necessary reforms are suggested.

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THE EASTERN ANATOLIA WATERSHED PROJECT – AN APPROACH TOWARDS SUSTAINABLE LAND MANAGEMENT

Jim Meiman [1], Ismail Özkahraman [2]

The Eastern Anatolia Watershed Project is an attempt to bring sustainable development to 400 000 ha in east-central Turkey in the Central Euphrates basin. Since its inception 3 1/2 years ago, good progress has been made on 15 of the 54 targeted micro-catchments. The major problem is related to rangelands. Solution to this problem requires both careful analysis of the related technical and social parameters, as well as clear legislation regarding the use of public lands.

Keywords: Watershed, range, soil conservation, farmer participation, Turkey.

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EFFECTS OF CLIMATE AND PHSIOGRAPHIC FACTORS ON FLOODING AT WATERSHED OF TRABZON-MADEN CREEK

Arslan Okatan[1], Mahmut Reis[2], Alaaddin Yüksel [3]

In this study, factors affecting flooding in the Trabzon-Maden Creek Watershed were investigated. Soil samples from different aspects, altitude and land management classes were taken according to Factorial Design to determine hydrological, physical and chemical properties of soil, and to understand the sources of soil loss with flooding. Relationships between some soil properties and climate-physiographic factors are discussed.

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AN INVESTIGATION ON THE CAUSE AND RESULTS OF FLOOD DISASTER WHICH OCCURED IN MELYAT CREEK WATERSHED NEAR RIZE-PAZAR

Arslan Okatan[1], Mahmut Reis [2]

In this study, the cause and effects of the flood disaster that occured in the Melyat Creek watershed after 2 hours of heavy rain in August 1995 were studied. Melyat Creek watershed is located in the East Black Sea region, 30 km far from Rize.

For this purpose, samples of soil were taken from research plots chosen from forest lands and tea lands (*Camellia sinensis* (L) O. Kuntze) in order to determine flood damage that occurred in the Melyat river basin. Soil profiles were dug according to "Factorial Trial Design", and a sufficient number of degraded natural samples of soil structure were taken from different depth (0-30 and 20-50 cm). These soil samples were evaluated and the same physical, chemical and hydrological soil properties were determined to obtain the causes of soil loss which occurred as a result of the flood. On the soil samples, the differences between erodibility index values were determined. The results of the analysis showed that: general average erodibility index values of soils in the study area were found to be greater than the suggested limit values. That is why the watershed soils are susceptible to erosion as the relation between the overflow and plant cover were explained.

These results related with the soil properties because of the damages resulting from the conversion of forest areas to the agricultural areas, especially in the structure of the surface soil, there has been a change that increases erosion.

Keywords: Flood, erodibility, watershed, soil properties, agriculture.

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RECULTIVATION OF OPENCAST COAL MINE WASTE DUMPS BASED ON REFORESTATION – A CONTRIBUTION TO SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL PROTECTION IN SERBIA

Dragana Drazic [1]

The development of forest plantations established in the process of recultivation of opencast lignite mine waste dumps in the Kolubarsko-Tamnavski Basin has been researched. The analysis also includes an account of the development of trees and shrubs in the parks established on deposols. In addition, the possible use of these areas as picnic and recreation centres has been considered.

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WATER POTENTIAL OF FOREST REGION ON THE GOC MOUNTAIN

Ratko Ristic [1], Grigorije Macan [1]

The water potential of forest regions is very important for creating a strategy of water supply in Serbia. Specific annual run-off has the highest values in forest regions (l0-30 $l*s^{-1}*km^{-2}$), with first-class water quality. Forest vegetation increases "loss" of water by processes of interception and transpiration, but decreases the intensities of evaporation, surface runoff and erosion. One of the protected resources is the catchment area of Gvozdacka River, located in the forest region of the Goc mountain, in Central Serbia. The catchment area is afforested 91.6% (total area is 37.3 km^2), 64.4% is under quality stands of *Abies alba*, *Picea abies*, *Fagus moesiaca* (over 500 m a.s.l., with the layer of litter 10-25 cm deep) and 18.5% is under artificial plantings (*Pinus nigra* and *Pinus silvestris*). Specific annual run-off amounts to 17.96 $l*s^{-1}*km^{-2}$. Forest vegetation has significant influence in retention of air pollutants, transported by dry and wet deposition.

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