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By

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INTRODUCTION

The term soil erosion according to Fox (1950) covers 'a wide range of physical and chemical actions such as removal of soluble matters, chemical changes, disintegration by frost or rapid changes of temperature, attrition by dust charged winds, scouring by silt laden currents, alternate impact and suction by storm waves, land slides and so on.' Erosion is partly a natural phenomenon useful to man by which soil is formed from rocks. But accelerated erosion due to misuse of the resources of land, water and soil is today one of the most difficult and pressing problems confronting man himself. Both engineering and biological methods have been used but erosion is still without a plausible check. Vast tracts of fertile land are rendered useless in the wake of industrialisation and development. Erosion has posed a serious challenge in the United States, Japan, South and North Africa, North China, Mesopotamia, India and numerous other countries. In India we are aware of the "advancing deserts" of Rajasthan and erosional losses, floods etc. in other parts of the country.

The problem has received the attention of foresters, ecologists, soil scientists and engineers only recently. The erosion of Siwaliks has been studied (Glover and Hamilton, 1935 ; Gorrie, 1951) and various methods to check it have been suggested. Recently Puri (1949, 1954) has analysed the problems from different angles and suggested that to check erosion losses of the soil the escarpment must be kept under tree vegetation. The Central Arid Zone Research Institute is attempting to check erosional losses in Rajasthan in collaboration with UNESCO. The Indian Council of Agricultural Research, especially the Wasteland Reclamation Committee, is giving attention to this problem in collaboration with the state forest and agriculture departments.

In connection with our ecological studies on the vegetation of the Kashmir Himalayas, some observations were made on this problem. The places studied were : Tangmarg, Gulmarg, Khilanmarg embracing the Ningal Nullah Zone and Baramulla district in South Kashmir ; Banihal, Quazigund and Shopian in North Kashmir and Kud, Batote and Ramban valley in the Jammu province.

Causes of erosion :

As in the Hoshiarpur Siwaliks (Glover and Hamilton, 1935 ; Puri, 1949) the accelerated erosion here also, seems to be the result of a number of factors, acting singly or collectively, such as the disturbance in the original cover of vegetation, excessive grazing, the presence of very undesirable forest biota, exposure to drought, excessive snowfall, etc. Mention may here be also made of the most important factor—the malpractices brought in by man himself.

Diforestation is the commonest factor at play here, which is responsible for causing erosion. Ruthless fellings have exposed soils to the direct effect of rain,

snow and drought and soil deterioration and erosion, of the gully and sheet types has set in over extensive areas in Kashmir. This has assumed serious proportions at many places in Gulmarg, Baramulla and Banihal and the extent of erosion increases as each day passes on. One dreads that a time may come when the whole area will not only be barren and devoid of any vegetation but may also not have any layer of soil, unless steps are taken now to check it.

The socio-economic conditions of the hilly tribesmen are such that they are in the main dependant on the nearby forests for their daily requirements. The natives collect even the forest litter from the forests for fuel and manure. The removal of litter, which is the only source of mineral return from the plant to the soil, depletes the soil of its richness. The soil is exposed, becomes dry, loses porosity and gives way to erosion.

Grazing is yet another destructive factor for the soil. It is a practice for the nomadic tribes to come with their herd of cattle and sheep during the summer months in these forests, since by far the large part, grazing is permitted. Whyte (1957) writes "the control of fluctuating grazing was made the responsibility of the forest department in 1939, but this appears to have had little effect and the problem is as acute as ever." Kashmir had admitted the maximum number of grazing animals, the number shooting up to 5,126,400 in 1947–48. The net area of forests under the control of forest department open to grazing is 10,525 sq. miles and grazing incidence expressed as number of acres per animal is 1·3, which is very inadequate. Conifer forests in this valley are remarkably pure having little or no broad leaved species. There are no or very less Oaks, Rhododendrons and laurels. The deciduous broad leaved species are also fewer and occur scattered in gullies and nallahs. There is no proper natural water conservation in pure coniferous forests. Lack of water conservation also promotes erosion.

Amongst the natural factors affecting erosion, surface geology, formation of rocks, are important ones for consideration.

Flood plain alluvium, moraines, etc. are easily affected by erosion as seen both in North and South Kashmir. Unstable rocks erode easily as seen at many places on way from Jammu to Srinagar. Heavy precipitation causes landslides and promote sheet erosion in surface deposits.

Methods to check erosion :

The control of erosion, when it has already assumed such large dimensions is not easy and in many cases not possible. It is always better to 'nip the evil in the bud' than allow this menace to grow. This too, cannot be acquired by a single means. Stanley A. Cain (1959) gave eight measures 'that comprise conservation practices,' *viz*. Preservation, Restoration, Maximization, Beneficiation, Rentilization, Substitution, Allocation and Integration. Of these, according to him, Preservation, Restoration and Integration involve general ecological principles, while the others do not use the ecological approach directly.

Preservation :

This connotes, in Cain's own words : "the protection of certain natural areas from consumptive areas." The excessive felling and cutting of trees should be thus minimized as far as possible. The practice of collection of all forest litter by natives and nomadic tribes may probably be best checked by education or legislation.

Since grazing in all the areas under study, cannot be completely stopped, a system of restricted and rotational grazing may be helpful. The area open to grazing for some time has to be closed for the following years to facilitate forest regeneration and maintain thick ground flora.

Restoration :

..."repair of the biosphere, return of the eco-system to homeostasis".....We can safely put in here, the best means to check soil erosion, the afforestation. Before that the role of vegetation as a factor to check erosion is to be clearly understood. Lutz and Chandler (1946) cite the following points in support of the vegetational check of erosion : (*i*) infiltration of water is favoured due to high soil porosity under vegetation ; (*ii*) surface accumulation of organic matter increases the water holding capacity of soil, (*iii*) root systems of the vegetation hold the soil mechanically, and (*iv*) protection against wind is afforded. The forest vegetation also shields the soil from direct efforts of drought, snow and rain.

State forest department has already started this practice though in very restricted areas, and it has met with good success. Forest compartments 72 and 73 in Baramulla region afford good examples. In compartment 72, mixed planting of *Pinus*, *Cedrus*, and other species has been done. The plants are thriving well and have checked erosional losses of soil to a great degree. As against this, we have compartment 73, just opposite to compartment 72, where plantations have not been made and soil is actively eroding.

Another example is afforded by Shankaracharya hills near Srinagar which are heavily eroded. Forest department took up the planting of coniferous species like *Pinus wallichiana, P. roxburghii, P. sylvestris, P. insignis, P. gerardiana, Cupressus arizonica, C. sempervirens, Juniperus* sp., *Cedrus deodara* and broad leaved species like *Aesculas indica, Fraxinus* sp., *Juglans regia*. These have checked some erosion.

The problem of afforestation in itself is a complicated one. The most important is the selection of suitable species for a particular area. This can be accomplished by dividing the whole area into different catchment zones depending upon the climate, soil and biota and suitable species for each zone should be selected from those growing there. Emphasis here should be, however, on the successional trends of the vegetation. Lutz and Chandler (1946) state that the agent most effective in preventing accelerated erosion in any region is the climax vegetation. However, the well-stocked communities representing stages of succession near climax, also to a great extent help in preventing erosions. Since Oaks are the climax vegetation all over the Himalayas, planting of Oaks and other broad leaved species is suggested in areas where Oaks are absent or their growth is less. This would serve a dual purpose. The broad leaved species would help in proper water conservation in the coniferous forests.

Afforestation has been helpful also in checking erosion of unstable rocks, probably by checking the seepage of water (Puri, 1951).

The erosion in cultivated soils due to primitive cropping practices can be best checked by introducing advanced systems, *e.g.* proper terracing of fields, making of furrows across the slope, etc.

Construction of temporary check dams is very helpful in checking surface runoff of the soil due to heavy precipitation and steep slopes.

To summarize, the following species are suggested for general afforestation out of which selection could be made in accordance with particular needs of the

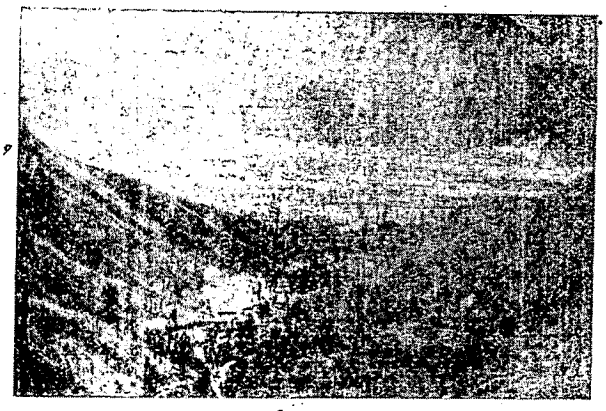

Fig. 1

Fig. 2

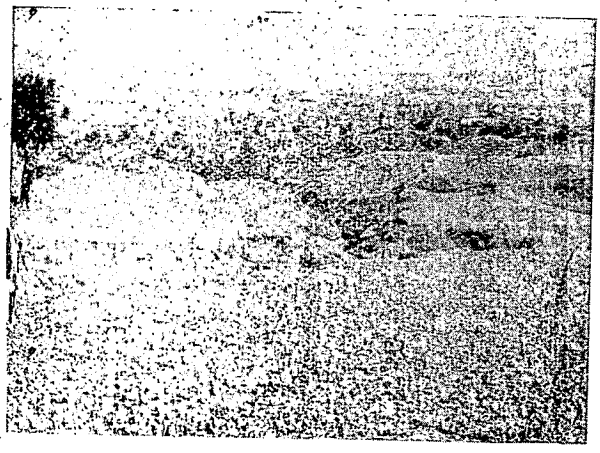

Fig. 3

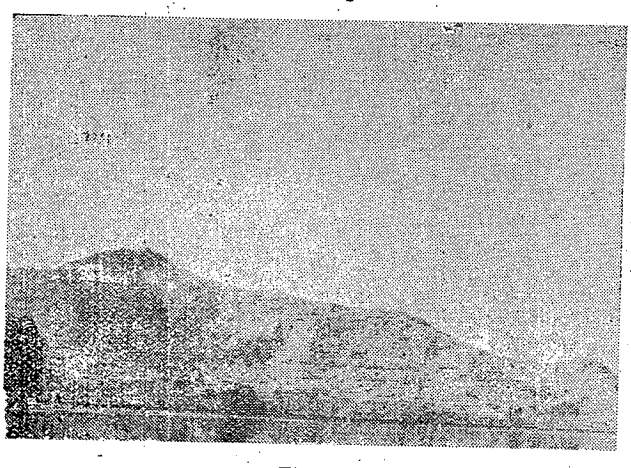

Fig. 5

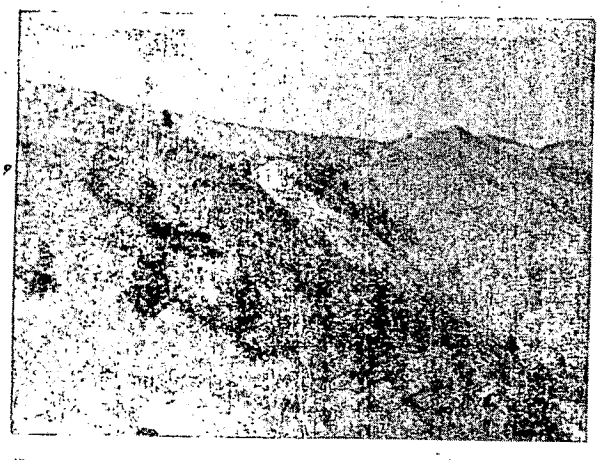

Fig. 4

Fig. 1. Showing the afforested comptt. 72, Baramulla against the bare comptt. 73, showing signs of erosion.

Fig. 2. Showing washing away of surface soil (sheet erosion) due to lack of proper vegetal cover, Gulmarg.

Fig. 3. Showing gully erosion, Baramulla.

Fig. 4. Showing cultivation in a forest area, a neglect of proper terracing and check which enhances gully erosion.

Fig. 5. Afforested Shankracharya hills, a successful effort to check erosion.

areas. The list has been based on the observations on the vegetation of Kashmir and adjacent areas in the Western Himalayas.

Altitude M.	Habitat	Species
3630–4090	Rocky substrata and Glacial moraines	*Juniperus communis* *Juniperus squamata* *Lonicera angustifolia* *Rhododendron campanulatum* *R. anthopogon* *Rosa microphylla*
2180–3630	Glacial moraines	*Abies pindrow* *Betula utilis* *B. cylindrostachya* *Lonicera angustifolia* *Pyrus foliolosum* *Quercus semecarpifolia* *Rhododendron campanulatum* *Rosa microphylla* *Salix denticulata*
2270–2180	Glacial moraines	*Abies pindrow* *Acer caesium* *A. pictum* *Betula cylindrostachya* *Juglans regia* *Lonicera angustifolia* *Picea smithiana* *Prunus cornuta* *Quercus semecarpifolia* *Rhododendron arboreum* *Salix lindleyana* *S. wallichiana* *Skimmia laureola* *Taxus baccata*
	River beds and flood plain deposits	*Aesculus indica* *Alnus nitida* *Betula cylindrostachya* *Juglans regia* *Salix lindleyana* *S. wallichiana*
	Abandoned cultivated fields	*Indigofera gerardiana* *Pinus wallichiana* *Rosa macrophylla*
	Rocky soil	*Corylus colurna* *Lyonia ovalifolia* *Pinus wallichiana* *Quercus dilatata* *Rosa macrophylla* *Viburnum nervosum*

Altitude M.	Habitat	Species
1670–2270	Flood plain deposits	*Acer caudatum* *Cedrus deodara* *Juglans regia* *Populus alba* *Populus nigra* *Salix wallichiana* *Platanus orientalis* *Pyrus communis* *P. pashia* *Quercus incana* *Parrottia jacquemontiana*
	River beds and near nullahs	*Aesculus indica* *Rhus chinensis* *R. cotinus* *Ulmus wallichiana*
	Abandoned cultivated fields	*Pinus wallichiana*
	Rocky soil	*Celtis alpina* *Fraxinus excelsior* *Ilex dipyrena* *Litsaea umbrosa* *Parrottia jacquemontiana* *Pinus wallichiana* *Quercus incana* *Rhododendron arboreum*
910–1670	Quartzite rocks	*Pinus roxburghii* *Quercus incana*
	Also on limestone	*Woodfordia fruticosa* *Skimmia laureola*
	Near river banks and nullahs	*Albizzia lebbek* *A. procera* *Cedrela serrata* *Cinnamomum tamala* *Platanus orientalis* *Pyrus pashia* *Rhus cotinus* *Rhus chinensis* *Xanthoxylum alatum*

Further down, species of ***Albizzia, Anogeissus latifolia, Acacia modesta, A. catechu, Bauhinia purpurea, Dalbergia sissoo, Olea cuspidata, Salmalia malabarica*** and ***Syzygium cumini*** may be planted with success.

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