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# WATER CONSERVATION, SOIL EROSION AND LAND USE

MAXIMUM economic production from the so-called marginal lands is much under discussion at the present time. Marginal land is generally assumed to be land which in the eyes of the planner of proper utilization is not producing some particular crop or 'crops' up to its theoretical capacity. There have been frequent references in *Nature* during recent weeks to the need for better use of such land, and the attention of appropriate authorities in Great Britain has been directed at different times to the rival claims of hill farming, forestry, national parks, Nature reserves, and so on. A session at the recent Newcastle meeting of the British Association was devoted to the same topic (see *Nature*, October 15, p. 640).

Much of the marginal land in Britain is hill or mountain land, above the 600-ft. contour. This is the land which receives the highest rainfalls, from which most of the rivers flow, and from which many of the great cities of the country obtain their water supplies.

Although meteorological records of the amount of rain which falls on different parts of Great Britain are reasonably complete, we know very little about the behaviour of water *after it falls* on the land, whether it be on forest, moorland, grassland, cultivated land or other type of land surface. City dwellers read in a detached kind of way of an inch or more of rain falling in a day or part of a day in some hill country remote from centres of population; but few realize that 1 in. of rain falling on an acre represents 100 tons or 22,400 gallons of water. We do not know for British conditions how much of that water will run off immediately into the streams and the rivers if it falls on forest, grassland or arable land respectively, and how much will enter the ground. Yet every dweller in the hills and the mountain valleys knows that run-off is frequently rapid and excessive, that streams with quite small catchment areas swell into flood in a couple of hours and as quickly die down again—'flash floods' as the Americans call them.

Much of this excessive and rapid flooding would occur in any event, irrespective of the type of vegetative cover or land use. But probably the greater part of it is due to a complete neglect or lack of appreciation on the part of land users and planners of the principles of land hydrology in relation to land management. Schemes of afforestation, grassland improvement and land drainage are undertaken in hill and marginal lands with little regard to the bad or good results these measures may or may not have lower down in the same valley.

Closely linked with conservation and management of water is the world-wide problem of soil erosion. Many people would like to think that erosion does not occur in Great Britain, or that the damage caused is negligible and does not deserve serious consideration. Only rarely do we find the sensational gullying of other lands, although some of the ruin left after war-time clear felling of forest land was just as serious. Our escape is due not so much to the types of soils in Britain or to superior methods of farming, as to the type of rainfall. The English drizzle and Scotch mist do not have the same erosive power as the torrential types of rainfall of high intensity/frequency against which special measures have to be taken in many other countries. In some of the agricultural areas of the United States of America, for example, they have to cater for intensities of more than 10 in. per day or 3 in. per hour.

British rainfall can, of course, produce gullying when it falls on sloping land unprotected by crops or adequate natural vegetation, as on the denuded area near the smelters at Landore, Swansea. British rainfall has, however, a much more widespread, insidious effect difficult to recognize until the eye is trained to note the symptoms. Slow, sheet erosion is very common in the hill lands of Britain, on both cultivated land and permanent pastures. It is not an exaggeration to say that most of the top-soil on sloping Welsh fields has over the years slipped gradually to the lower third of the field, and is prevented from going farther by the hedges which fortunately happen frequently to be laid out on the contour. On these sloping and on other generally undulating fields, the eroded areas are recognizable either by the type, depth or stony nature of the soil, or by the thin germination and early maturing of the crop, or by premature burning of parts of pastures in dry periods.

There is no need to make sweeping or sensational statements about erosion in Britain; it is, however, desirable that those concerned with land management should not close their eyes, but train them to recognize the symptoms and the degrees of damage. It would in many cases then be necessary to recommend the simpler conservation practices applicable to British conditions. These would include prohibition of ploughing on land likely to be seriously affected, the introduction of ploughing and cultivation on the contour, the planting of intertilled crops such as potatoes also on the contour, and the retention wherever possible of contour hedges, or pasture strips laid out on the contour. On many hilly areas, contour ploughing would be much more economical than up-and-downhill ploughing, which frequently entails going uphill empty and ploughing downhill only.

Much more important to the well-being of the British land is a wider appreciation of the relation between land management and the behaviour and control of the water which falls on, and flows out of, the hill lands of Britain. The present and apparently ever-increasing incidence of floods is one of the symptoms of lack of balance and proper control in the management of the hills and their waters, small or large. Nearly every winter or spring, the people of Shrewsbury and similar valley towns have to submit to flooded streets and houses; they look disconsolately to the west and wonder whether the people who live and work and use the land in the Berwyns or the upper reaches of the Severn can do anything to hold all this water back in the hills. But hill farmers and others who are responsible for using the land upon which most of the rain has fallen are actually doing everything possible to remove this water from their land as rapidly as possible. Reservoir authorities do wish to hold the water out of the rivers in their collecting basins, thus doing something to alleviate the problem of disposal of excess water; but most other persons and authorities take all possible steps to ensure that the excess flows to lower levels as rapidly and as soon after it has fallen as possible, often with little regard for the cumulative effects of such actions in the lower reaches.

Drainage schemes must necessarily play an important part in any development of marginal land for beef, crop and tree production, subjects very much in the public eye at the moment. According as these schemes progress, the hills will lose their capacity to act as a sponge, to absorb heavy rainfall, guide it into the ground-water reserves and control its reappearance over a long period of time in the form of springs. Before drainage, a so-called 'poor' section of hill land, of deep *Molinia* or *Sphagnum* bog, may be able to absorb anything from 75 to 100 per cent of the rain which falls upon it, except of course when it has reached saturation point after a long rainy period. When it has been drained, it may be able to retain only some 25 per cent of the rain that falls. Hence, if 100 acres are drained and 50 per cent of a day's rain runs off in a matter of hours, then since 1 in. of rain is equivalent to 100 tons of water per acre, 5,000 tons of water per 100 acres per day may be added to the flood peak, in the year following draining. Drainage of hill land is also necessarily practised in afforestation; but the increase in flood water is only temporary and falls again in a few years when the trees have become established and can contribute even more effectively to water conservation.

Anyone trained to appreciate the water-conserving capacity of different types of natural vegetation must feel concern at the almost universal desire to clear bog, bracken, scrub and other types of natural vegetation, and to replace these with 'improved' grasslands. Waste lands are not always completely useless, and sometimes the best way to use hill land is not to use it at all. In the absence of adequate data on run-off from different types of natural and sown or planted vegetation, it can only be surmised with reasonable certainty that much of this waste land has an important part to play in conserving water. It is questionable, for example, whether the Colesbourne land in the Cotswolds improved by Sir George Stapledon and his colleagues had after treatment as high a capacity to conserve water in the Thames catchment as it had when it was covered by scrub and matted herbage. This is a question which merits investigation in all hill improvement schemes.

The water régime in the hill lands is out of gear. Water rushes off in the winter, hills are bone dry in the summer, perennial streams have now become seasonal in flow, cottagers have to deepen their wells to reach the water, and all this in a land with a good rainfall. Great and expensive engineering works or the construction of storage reservoirs are not needed except for town water-supplies or hydro-electric works. What are needed are the fundamental hydrological data to provide a basis for understanding the behaviour of water after it falls on hill land. The utilization and management of hill land could be adjusted for maximum conservation if we knew the comparative capacities of the various types of natural vegetation referred to above, if we would achieve some type of classification of slopes in relation to rainfall intensity/frequency and optimal land use on the American pattern. A great amount of information has been obtained on these aspects of land use in the United States; but it is not generally applicable other than in principle to British or other conditions. Each country must obtain data for its own types of vegetative covers and climates.

With a widely distributed network of standard run-off measurement plots on all the major soil and vegetative types of the country, it would be possible to amass data indispensable for planned land use in the hills. At present we have the meteorological data of the water just as it reaches the land, and presumably the major river authorities have records after it reaches the rivers, on such aspects as height and frequency of floods, silt loads and so on. Between these two stages, the sequence of knowledge is broken and quite inadequate, and yet the missing data would be of the greatest value. It would then be possible to state with reasonable accuracy for a particular catchment area what the effect on stream flow and seasonal availability of water would be if 1,000 acres of properly sited forest were planted, or alternatively if 1,000 acres of bracken were cleared and sown to a close-cropped grazing mixture. The vegetative cover of national parks could be kept at an ecological level most suitable to the dwellers alongside the waters which flow from the parks.

There is both a beauty and a purpose in natural unexploited vegetation, in the scrub and bracken-covered hillside, the bogs, moors and waste places. The waters flowing from them are in general clearer and more uniform in flow over the year than those from 'well-utilized' catchments. With a little more knowledge of land hydrology, we could probably evolve a greater and yet safer economic utilization of the hill lands of Britain, and at the same time improve the yielding capacity and economic value of the valley lands, at present exposed to the ever-recurring risk of damage from the waters which pour down upon them from the hills.



# THE VEGETATION OF WESTERN NEW SOUTH WALES

## The Vegetation and Pastures of Western New South Wales

With special reference to Soil Erosion. By Dr. N. C. W. Beadle. Pp. 281. (Sydney: Government Printer, 1948.) n.p.

THIS account of the vegetation of the western part of New South Wales deals with an area of some 150,000 square miles. In it are described the soils, the natural vegetation, the pasture lands and the effects of grazing, and soil erosion. The country is usually referred to as the "Western Plains" and is characterized by its flatness and the paucity of mountain ranges and hills. Four large streams, the Murray, Darling, Lachlan, and Murrumbigee Rivers, pass through the region. Practically the whole is covered by recent alluvial and detrital deposits of clays, sands, gypsum, etc. In the north-west the climate is of the desert type, while the greater part is classified as steppe type. Eastwards of the steppe climatic region and extending to the coast, outside the area under consideration, is the humid climate. Water supply is the main controlling factor in the distribution of the different types of vegetation.

Dr. Beadle classifies the plant communities essentially on a successional basis. Six plant formations are recognized: forest, woodland, mallee, scrub, saltbush, and grassland. Of forest, there are only small outliers of the dry sclerophyllous *Eucalyptus dealbata – E. sideroxylon* association with xerophytic shrubs and a poorly developed herbaceous layer. Three subformations of woodland, or communities dominated by trees in which the length of the bole is less than the depth of the crown, are accepted: tall woodland of the *Eucalyptus woollsiana* association, savannah woodland of five associations, and shrub woodland of two associations. Species of *Eucalyptus* and *Acacia* are the most important constituents; but sometimes *Callitris, Casuarina, Geijera, Flindersia, Eremophila*, and other genera are represented. The scrub formation is divided into three associations with acacias dominant in two and *Casuarina* and *Heterodendron* in the third. The saltbush formation includes all treeless areas dominated by low-growing perennial bushes of *Atriplex* or *Kochia*. The spaces between the bushes is occupied by annual or low perennial herbs and dwarf shrubs. In contrast, the treeless areas dominated by perennial grasses constitute the grassland formation with three associations named after the dominants: *Astrebla lappacea, Stipa aristiglumis*, and *Chloris-Danthonia*.

With few exceptions, the plant associations are not reliable indicators of the soil zones since they are determined primarily by rainfall. Yet soils are important in so far as they govern the amount of water available to the plant. Many species can tolerate, and flourish under, a wide range of conditions; but some are more confined and can be used, with care, as indicators of soil texture, soil reaction, or abnormal soil moisture.

Western New South Wales is, as a whole, a dry area; but wind is not the only agent in soil erosion. In spite of the low rainfall, water has been the agent in extensive sheet erosion and gullying. Extremely valuable accounts are given here of wind erosion (with scalding, formation of moving sand dunes, and occurrence of dust storms) and water erosion. It is definitely stated that the causes of all erosion in western New South Wales can be traced either to over-grazing by domestic stock and rabbits or to timber-removal, or to a combination of these two factors. The sheep is a selective grazer, and plants mostly disappear in order of their palatability—the palatable perennials first. It is possible by noting the occurrence and abundance of certain species to trace the stages in pasture degeneration. Drought is regarded as a secondary factor in erosion, accelerating it only where some primary factor has been operative.

A very full account is given of the five major formations noted above with discussion of the physical features of their ranges, their constituent species and their structure. Numerous photographs make up the bulk of 161 text figures. The succession within the