TRANSACTIONS
OF THE
ROYAL SOCIETY OF NEW ZEALAND

GENERAL

VOL 1 No. 5 MARCH 20, 1963

[Continued from *Transactions of the Royal Society of N.Z.*, Volume 88, Part 4.]

Conservation of the Soil

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[*Received by the Editor, October 30, 1962.*]

I wish to express my pleasure on being asked to chair the Conservation Section of the Tenth New Zealand Science Congress. This is the first occasion that conservation has received the status of a Section in a New Zealand Science Congress.

Conservation of natural resources is a continuing process whereby man's increasing knowledge is applied to produce with continuing increments not only man's immediate needs of food and shelter, but also the opportunity and facilities to develop the whole of man's potential within a changing environment.

In New Zealand, the Soil Conservation and Rivers Control Council is the authority dealing with soil conservation and flood protection. There are other organisations and groups of people actively participating in conservation. The National Parks Authority administers 4,528,327 acres of land where the purpose is to reserve natural regions in perpetuity for the benefit and enjoyment of the people and safeguard those acres from cultural development which depends upon the plough, fire, power saw and domestic animals.

Legal restrictions on man to try and prevent critical depopulation of some marine and fresh water fish are the outcome of some understanding of the value of conservation practices. The Regional Planning Authorities that hope to provide orderly urban and industrial expansion and, inter alia, prevent the waste of fertile land provide an aspect of conservation.

In advocating the protection of the native forests and birds and the preservation of sanctuaries and scenic reserves, the Forest and Bird Protection Society are enthusiastic conservationists.

The Tussock Grassland and Mountain Lands Institute was conceived in the hope that it would be in the vanguard of soil and water conservation thought and activities in the highlands of the South Island.

The recent proposal to establish a Nature Conservation Council to advise the Government on the conservation of native fauna and flora and natural features of scientific interest or places of lasting natural beauty is a very healthy sign in the development of this country.

Published by the Royal Society of New Zealand, c/o Victoria University of Wellington, P.O. Box 196, Wellington.

Contemporary understanding of conservation extends far beyond man's oldest and most fundamental occupation—the quest for food.

During the past two decades in New Zealand the term soil conservation has become a household word throughout the land.

A start has been made to teach the children at the schools and the students at the colleges some of the principles and practices of conservation of the soil, of water and of other natural resources. The conservation idea heralds a change in the thinking of men in their use of resources provided by nature.

This movement stems largely from the realisation of the extent and severity of soil erosion in many lands and particularly in those countries that have been settled and developed by Europeans in the past few centuries. The technical achievements in altering rapidly the surface cover of huge areas of the earth during very recent times have led to benefits to the material comforts of men and also to changes in some of his ways of thinking.

An important contribution of conservation to New Zealand already has been its effects on the thinking of the people. In a score of years soil and water conservation has brought about a marked change of thought not only amongst the people directly connected with the land, but amongst people in all the different walks of life—the school teacher, the clerk, accountant, civil servant, farm adviser, bank manager and others.

The acceptance of two basic ideas helps in an approach to an understanding of the concept of conservation of natural resources.

(a) A philosophy incorporating the idea that the earth is the product of design, orderliness and pattern in which man has been privileged to possess several and particular talents.

(b) An appreciation of the natural phenomenon that in all physical things there is nothing permanent but change. There is birth, growth and development, decay and regeneration in the plant and animal kingdom; water is continually in motion in the hydrologic cycle; the soil gives of itself to plants which in turn nourish the soil to maintain a continuum of physical things.

In the understanding of a group of wild animals (e.g., a herd of red deer), a community of plants (e.g., tussock grasslands) a stream of flowing water (e.g., the Waimakariri River) or a soil, the particular component under observation is part of a pattern where change occurs in an orderly fashion under natural conditions.

The low-tussock grasslands on mountain slopes, for instance, are made up of many different and closely inter-related parts—biotic, climatic, edaphic and topographic. The component parts have an influence one upon the other and under natural conditions they form an integrated whole, a landscape with a mantle of indigenous grasslands. There is birth, growth and development, decay and regeneration of the individual plants as part of the orderly change of plant life. The soil, the plants and other components of the grassland complex have developed in an environment where there has been continual change. The weather with its seasons is not constant, the insects and other elements of the biota fluctuate in numbers and the volume of vegetative cover varies. In this environment of change, soil and vegetation have grown up together on the slopes of hills and mountains so steep that the soil would fall downhill if it were not held in place by vegetation. This has been possible by normal and orderly development because the components of the complex plants, animals and factors of the soil, topography and climate—are knit together in an integrated whole.

In normal succession, as a change in the character of the vegetation occurs it is accompanied by an orderly change in the character of the soil, of micro-

climate, animal life and other factors. Whatever the cause, all the changes occur together and the important fact is that the changes are in harmony. The presence of a well-developed soil mantle is evidence of successful integration between climatic and topographic factors, vegetation and animal life, over a long period of time. Soil stability is one useful and obvious index of this integration.

On the other hand a rate of soil erosion incompatible with the formation of such a soil mantle is evidence of disintegration. It is an indication that a change of drastic proportions, over and above the normal amplitude of environmental stress, has taken place. This disintegration begins usually with such a reduction of vegetative cover as to expose the soil to destructive forces and soil erosion occurs. Bare soil leads to soil erosion. Field records taken over a period of years that show a real increase in the extent of bare soil can give early evidence of disintegration. (I am indebted to the late Lincoln Ellison, Utah, who visited the tussock grasslands with me in 1956 for thoughts on the concept of integration of the component parts of a whole ecosystem.)

Soil Erosion Long Ago

"A nation loses contact with the past at its peril". Soil erosion brought about by misuse of the soil dates back a few thousand years.

About 8,000 years ago when man started to till the soil, he started to remain longer in one place, and parts of the earth became permanently settled. The valleys of the Tigris and Euphrates in Mesopotamia were among the first to be settled permanently. The waters of these rivers were used to irrigate the crops grown on cultivated land. Increased food supply gave rise to an increased population. The irrigation canals were lengthened and more land was irrigated.

The catchments of the Tigris and the Euphrates became overgrazed with sheep, goats and camels and the excessive cutting down of the forests exposed bare soil to erosion. As a result muddy and debris-laden waters choked the irrigation canals and the task of cleaning them became too great a drain on the available labour and time. Agricultural production fell and the Babylonian cities could no longer be supported.

The excessive cutting of the forests and the overgrazing of the grasslands—the reduction of the vegetative cover which exposed the soil to erosive forces—while not understood by Nebuchadnezzar and his countrymen of those years yet recorded a message on the Mesopotamian landscape that could be read long after the decline of the Babylonian empire.

The Phoenicians about 5,000 years ago, seem to have been the first people to suffer serious soil erosion as a result of cultivating steep land. When they established the towns of Tyre and Sidon on the eastern shores of the Mediterranean they began to clear the forests from the hillsides and cultivate the sloping land. Rains caused serious soil erosion. It is of interest to note that the Phoenicians recognised the problem and set about building stone walls across the slopes to arrest the erosion. They failed in their attempts, but the ruins of the walls may be found today.

These two cases of soil erosion of ancient times show the dangers of removing the protective vegetation from steep lands in the river catchments and exposing bare soil to eroding agents.

Plato, some 23 centuries ago, was aware of the protective value of vegetative cover when he wrote about Attica.

"Contemporary Attica may accurately be described as a mere relic of the original country. All of the rich, soft soil has moulted away, leaving a country of skin and bones. . . . There were also many lofty cultivated trees, while the country produced boundless pastures for cattle. The annual supply of rainfall was

not lost, as it is at present, through being allowed to flow over the denuded surface into the sea, but was received by the country, in all its abundance, into her bosom, where she stored it in her impervious potters earth, and so was able to discharge the drainage of the heights into the bottoms in the form of springs and rivers with an abundant volume and wide territorial distribution."

Soil Erosion in the Very Recent Past

In N.Z. in the late 1940's, some officers of the Soil Bureau made a reconnaisance survey of the extent and degree of soil erosion in the High Country of the South Island and a soil erosion survey was made of the southern half of the North Island.

New Zealand is a land of 66 million acres—44 million acres are used for agricultural purposes, and 22 million acres comprise indigenous forests (11.5 million acres), National Parks and Reserves (5.2 million acres) and a large unspecified area comprising mountain tops, lakes, rivers, towns, boroughs and roads (5.3 million acres).

In the southern half of the North Island the area surveyed was 15,250,000 acres. Little erosion was found on 5,648,000 acres or 37% of the area surveyed, on 4,270,000 acres or 28% of the area soil erosion was of sufficient degree to warrant the application of soil conservation practices to check the gradual loss of soil and the remaining 5,332,000 acres or 35% was mostly in forest, much of which was potentially erodable soils.

In the South Island high country 10,393,500 acres were surveyed. There was no erosion to slight erosion on 3,413,900 acres, or about 33% of the area, on a little over 50% of the area, 5,203,000 acres, moderate to extreme erosion had occurred and bare rock and scree covered 1,776,300 acres, or almost 17% of the area surveyed.

In general, too much forest has been cleared, and the problems of soil erosion have been created as a result of the great decrease of protective forest and grassland cover on the steeplands in the upper reaches of the rivers.

In 1941, the Soil Conservation and Rivers Control Act was passed in N.Z. The purpose was to make provision for the conservation of the soil resources and for the prevention of damage by erosion and to make better provision with respect to the protection of property from damage by floods.

This Act provided for the setting up of a Council which is the parent administrative authority in Wellington and decides on policy and the allocation of taxpayers' money to the different works throughout the country. The Act also provides for Catchment Boards, which are the soil conservation authorities in the different catchment districts. A Catchment Board consists of not less than 8 and not more than 15 members in which the number of elective members shall exceed the number of non-elective members. The administration of this Act is of particular interest in that the local Catchment Board comprises appointed members from State Departments and the other members are elected triennially by the local ratepayers in a district. The districts of the 13 Catchment Boards cover about 60% of N.Z. Within these districts Catchment Boards are the organisations authorised and charged by the people to make provision for the conservation of the soil.

In addition there are the Waikato Valley Authority and the Waitaki, the Northland and Eastern Bay of Plenty Commissions which have duties and responsibilities similar to Catchment Boards.

The method of defining districts by river catchment boundaries so that a whole river system is within the district of one administrative authority is an admirable one. Great credit is due to the men of 1941 who had the vision to

design this system. Conservation of the soil is the solving of problems affecting land, water and people. Technologically many of the soil problems can be solved without undue delay, but the supply of adequate finance and the obtaining of the co-operation of the several people concerned do cause delays in applying remedial measures to soil erosion problems. These delays are often costly to the people of this country. Soil conservation and river control cannot be divorced, as the management of the land in the river catchment can adversely or beneficially affect the flooding and debris deposition in the lower reaches of the rivers. In the South Island a great deal of the problem land is Crown Land, administered by the Lands Department or the Forest Service.

The extent and degree of active co-operation of the Lands Department and the N.Z. Forest Service with the local Catchment Boards and the Soil Conservation and Rivers Control Council will determine in a large measure the progress of soil conservation work on much of the South Island's eroded lands in the coming decade. Through the publicity and information programme of the Soil Conservation Council and Catchment Boards over recent years people are now aware of the nature and type of many of the problems.

To know that the condition of the Waitaki and Waimakariri Catchments is good or bad is a matter of importance to many people today. Their condition in the future will be of consequence to a greatly increased number of people.

Soil Conservation and Rivers Control Work Being Carried Out.

Much of the soil conservation and rivers control work is being carried out in New Zealand with financial assistance from the taxpayer.

For the year ended March 31, 1962, such work included the planting of trees on 4,183 acres of land to stabilise soil, the constructing of terraces, banks or other mechanical methods of regulating water runoff on over 3,000 acres, almost 125 miles of conservation fencing to control grazing practices on erodable lands, the construction of 1,209 gully control dams, the construction or improved maintenance on some 2,478 miles of drains to discharge excess water from on or in the soil, the maintenance or improvement of 1,042 miles of river channel, and the constructing or protecting of 165 miles of artificial river banks. A soil conservation service is assisting in the preparation of conservation farm plans in co-operation with the farmer to enable the farmer to get maximum production from his parcel of land without detriment to the soil or his neighbour downstream.

In addition to the type of works indicated above, conservation thought has introduced to this country a system of classifying land according to its capability. An inventory of the land is prepared by recording the physical components of the environment from which the capabilities of the different parcels of land are classified into a series of standard classes. Such a system by making use of all the available knowledge of science and that gained by land use experience has much merit.

The use of aeroplanes to supply manures to the grasslands on the great areas of hill and mountain country in N.Z. was inspired largely by men appreciative of the value of soil and water conservation. The leadership of the Soil Conservation Council in the early development of aerial top-dressing is now of historic interest.

In the North Island, which was largely forest covered before European settlement, a major contribution of soil conservation work is afforesting gullies and steep, unstable soils.

In the South Island the great reduction of the "burning off" of the tussock grasslands is an important and far-reaching soil conservation measure. Fire has

been the most destructive force in the story of the tussock grasslands. The control of fire and the revitalising of the tussock grasslands is one of the major soil-conservation tasks.

Conservation thinking is bringing about a remarkable change in man's outlook towards the use of the forest and grasslands in the upper catchments of important rivers.

On sloping arable land mechanical "contour" practices have been introduced and the value of regulating the runoff of surface water has been clearly demonstrated.

A happy outcome of the application of soil-conservation practices on many of the farm properties has been increased production with increased gross income to the farmers. This is by no means always so. However, by fair and competent judgment of the onsite and offsite benefits of different conservation practices, subsidy money from the taxpayer can be used to assist the local land occupier in maintaining and improving the asset—the land.

I conclude with this thought.

I suggest the changing times and the continuing increase in the population of this country warrant an inventory being made of the soil and the water resources.

The land inventory would provide a readily interpreted source of information on the soil, the different types, location and extent, the extent and degree of soil erosion, the slope, the vegetation on the different parcels of land, and the present use being made of the soil. The quantity of water available for hydro-electric development, irrigation of land, industrial purposes, household requirements, domestic and stock requirements is limited. Plentiful supplies in the past are today sometimes no longer adequate.

Segments of this information are available today—e.g., certain information about the soils, the discharge of water in some rivers.

The information contained in a national inventory of the land and the water resources, collected and presented as an integrated whole, would be of great value in guiding the growth and development of N.Z. in an orderly fashion.

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