SOIL CONSERVATION PRACTICES IN FRANCE

PART II

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Summary

In this second article on counter-erosion practices there is a brief geographical and historical discussion of New Zealand high-country. Possible application of French corrective measures is then considered, and some engineering works are described in detail. The need for a comprehensive survey of New Zealand high-country is stressed. Such a survey should aim at assessing grazing potential of various high-country plant communities. There is need for intensive investigation into the possibility of introducing exotic species into high-country forest and pasture, as well as into methods of protecting existing indigenous species. Specialised training in watershed management is essential if the many complex problems in New Zealand are to be solved. In the meantime, valuable work can be done by high-country specialists in various Government departments. If correction in problem areas is to become a reality, practical measures should be undertaken in the near future.

INTRODUCTION

In Part I an account was given of soil conservation practices in France. Possible application of some of these overseas techniques to the control of soil erosion in New Zealand is now described.

A parallel has already been drawn between the unsatisfactory conditions obtaining in France prior to 1860, and in high-country watersheds in New Zealand today. That these conditions can be ameliorated if not completely corrected is evident from perusal of relevant European literature. That similar success could be expected in New Zealand following a vigorous and well-planned attack is within the realms of probability.

NEW ZEALAND HIGH-COUNTRY

With the exception of the ranges parallel to the East Coast of North Island most of the Dominion's high-country lies in South Island. Here, as to be expected due to the greater elevation and more rugged terrain, the scale of erosion is more spectacular. In this article it is proposed to deal exclusively with South Island problem areas.

Relatively few people can claim anything but a scanty knowledge of the high-country gained during motor trips through the passes of the Southern Alps, from a day's shooting in the foothills, or from the pages of an illustrated magazine. It is from high-country farmers, deer-stalkers, and the occasional scientist that most information must be gained. At this stage it would be appropriate to deplore the almost complete absence of information on high-country in scientific publications.

Throughout its length the major mountain system of the Dominion is oriented north/south at right angles to the warm, prevailing north-west wind. It is this orientation which gives rise to the high rainfall of the West Coast and Main Divide, and the relative drought of some areas situated well in the lee of the main chain. We have here, then, conditions somewhat similar to those obtaining in the French Alps, i.e., "green", and "dry" alps. Thus some areas fringing the Canterbury Plains and parts of Marlborough fall into the "dry alp" classification, while the West Coast and headwaters of the major East Coast rivers would be considered "green alps". This classification has important implications from the point of view of successful plant introduction. Generally it is much easier to succeed with plant introduction under a moist climate than under a dry one. The desiccating effect of the north-west wind is considerable in the vicinity of Porter's Pass or the Rakaia Gorge. In parts of Central Otago and South Canterbury (Waitaki Basin, for instance), the difference in precipitation between west and east is more than 60 inches. Such differences alone pose great problems to the forester introducing new tree species.

There is thus a wide climatic range from one side of the Southern Alps to the other . . . ecologically the range is equally wide. One has but to travel by road from Otira to Springfield by way of Arthur Pass to observe this. Contrast the lush, sub-tropical growth of podocarps, rata, and kamahi in the vicinity of Otira with the xerophytic mountain beech communities on the dry slopes of Mount Torlesse and the difference is obvious.

While there is no regular geological change from west to east there are marked differences in the geology of different regions. Thus most of Marlborough and Canterbury contain greywacke, Otago schist, Fiordland granites and gneiss, and Westland a mixture of these. There are relatively few problems where granites and gneiss predominate, but susceptibility to erosion varies in the other rock types. Where greywacke and schist occur, especially along shatter-belts as is so common in New Zealand, the danger of accelerated erosion is extreme.

From early accounts it is fairly obvious that conditions were not always as they are today in the high-country. Even today it is possible to discover evidence of a primitive forest cover in areas which have been under tussock-grassland since European occupation. Patches of forest which can only be described as relict are still to be found in tussock-grassland areas. It seems evident that even one hundred years ago forest covered much more of the watersheds of the major rivers than it does today, and that bare mountain sides, and shingle-slides were not so common as they are now. A certain amount of geological erosion must always have been in evidence, but slopes so completely denuded as they now are in the majority of Canterbury river catchments would surely have excited some comment in the past.

What then is the cause of this progressive deterioration in high-country watersheds? Even allowing for the impact of introduced animals on the indigenous community it is difficult not to accept the hypothesis of Holloway (1954) that the unstable conditions have been caused by a steady change toward a climate essentially hostile to forest, and even tussock-grassland, over a number of centuries. Fire, too, has played its part in the destruction of the primitive vegetation . . . not only the fires of the early European settlers but also the "Fires of Tamatea."

When the above factors are considered in sum it will be seen that in many parts of the New Zealand high-country conditions are as serious as one would expect to find anywhere on the globe. Difficult climate in the east coupled with a geological make-up far from satisfactory, and an unstable indigenous plant community do not make for easy corrective measures. When other factors such as low population density and advanced stage of erosion in many problem areas are considered it will be seen that workers in the counter-erosion field are faced with a difficult task.

APPLICATION OF EUROPEAN CONTROL METHODS

In New Zealand, the dangers of transport of detritus in the wide flood-plains of the major rivers might seem negligible at first sight. Therefore it might be asked, "are we justified in erecting costly structures to prevent this transport?" The answer to this question must be in the affirmative. Engineering works in the lower reaches of our major rivers, while they attenuate the flood danger in many cases, have only a limited life so long as material is allowed to accumulate around them. Only when feeder torrents of these major rivers cease to transport material will lands adjoining the lower reaches of the rivers be safe from flooding.

Engineering Works

To ensure complete correction of areas in which erosion is already well advanced some engineering works must be envisaged high-up in the catchments of major streams. Such structures will also be needed at a later stage to protect roads, railways, and bridges where these are constructed in threatened areas.

This is not to say that the classical system of correction as practised in France must be slavishly followed. Indeed it is doubtful if the country could stand the financial strain such a programme would impose. Enough has been described of new engineering works in Part I to show that these structures are undergoing constant modification. Always the aim is to find a structure that will do an equally good job at half the cost. Workers in this country will be able to benefit from the constant research which is being carried on overseas. This does not mean that there should not be investigation of the country's own problems; it is only meant to show that New Zealand has the opportunity to catch up one hundred years of research in a very short time.

So far have engineering structures evolved that it is doubtful if New Zealand will ever see transverse dams of the classical type. More efficient structures costing as little as one half have been recently designed. Although these have yet to undergo the full test of time it appears that they are completely efficient. One of these has already been described . . . this is the "basin-dam" of Genet. The same worker has recently patented two other structures. So suited do they appear to New Zealand conditions that they are described in a little more detail.

Genet has long considered that there is too much waste of time and material in building a solid dam of the classical type. His argument runs as follows. A dam which completely blocks the path of a torrent must be sufficiently strong to resist the enormous pressure of floodwaters and transported material during the filling stage. Once the dam has been filled with sediment it acts only as a retaining wall to the material behind it. For this purpose there is no need for such solidity so that much of the material used in the construction of the dam has been wasted. Genet proposes to replace the solid dams with structures which are essentially filters.

(a) *The Comb-Dam*

A better understanding of the text may be gained by reference to Fig. 1. The comb-dam is a transverse structure which may be likened to a gigantic hair-comb set in the torrent bed. Foundation for the structure is a low, rugged, reinforced concrete wall spanning the torrent bed. From the top of this wall two rows of reinforced concrete teeth are erected much in the manner of a tank-trap. On the upstream side the teeth are more solid and so spaced that only the larger elements in suspension are arrested. The second row has smaller teeth, more closely spaced. Smaller material is collected here but it should be noted that silts, sands and, to a certain extent, gravels are capable of passing these obstructions for some time. The object of the structure is simply to limit the mass movement of material. The advantages of this type of structure: selection of the filling material from larger elements, breaking of force of floodwaters by teeth, hence less danger of overturning, and considerable economy of time and material. In France its use is envisaged in the middle section of the torrent course. Teeth become more closely spaced in a downstream direction, and for complete efficiency some solid structure is erected on the outwash fan to collect the fine elements in transport.

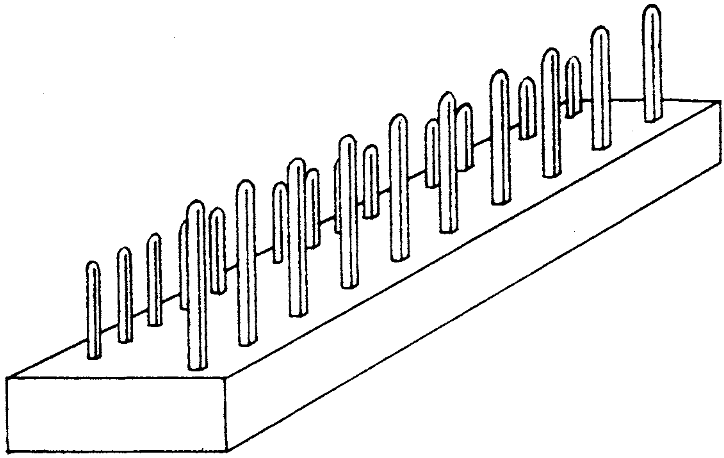

FIG I COMB DAM

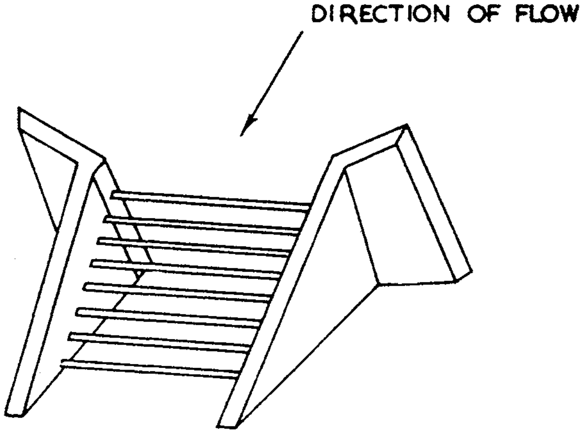

FIG. 2 FILTER–LADDER DAM

(b) *The Filter-Ladder*

Reference should be made to Fig. 2.

This structure has as yet not passed the stage of the experimental scale model but results there are highly encouraging and it should not be long before something is known of the performance of this dam under working conditions.

In this structure material in transport is arrested by the transverse grill (filter-ladder), which is inclined in an upstream direction and which acts as a filter. On each side of the grill are solid walls which run to each bank of the torrent. Due to the method of fixation of the bars forming the grill there is complete independence of each anchoring block. This method of fixation has not yet been disclosed as one of the big advantages of the structure is its suppleness and the system has been patented. Advantages are numerous. The force of floodwaters tends to lift the grill rather than flatten it. There is thus less risk of the structure being overturned. There is no vertical drop on the downstream side of the dam as in conventional dams so that there is less risk of erosion at the base. The grill, with its supporting blocks, acts as channel for the floodwaters and prevents wandering of the current in the stream bed.

(c) *Other Engineering Works*

Recently designed structures may or may not turn out to be completely successful and adaptable to New Zealand conditions. Whether or not they do there are other structures which will most certainly find application in this country. These are the various types of secondary structures such as living-dams, steps, stone walls, etc., which must be used in the initial stages of establishment of vegetation in denuded areas, type of terrain all too often found in New Zealand. Scree and shingle-slides with little vegetation other than mat plants and occasional creepers are a striking feature of the Dominion's high-country. Only with stabilisation of slopes above and below these slides can there be any hope of arresting the downward movement. So long as there is removal of detritus from the toe of a slide gravity will continue to act; the more so if there is a ready supply of detritus above. It may be found that some form of stone wall in netting cages could be used to stabilise these sides . . . this method has been used successfully in France. The problem in New Zealand would be to find suitable places on the slide where these structures could be anchored, due to the great depth of shingle in movement.

There will, of course, still be need for engineering works in the lower reaches of rivers for some considerable time. Dykes, groynes, and breastworks will always be important in danger areas along the major rivers. It is not suggested that torrent control alone will remove danger of flooding for all time . . . what is contended is that torrent control, by decreasing surface run-off and amount of material in transport, will greatly lessen the burden on already overloaded downstream structures.

Sylvo-Pastoral Works

This is a field in which New Zealand workers have the greatest chance of achieving positive results in a short time and without the expenditure of great sums of money. As in all overseas countries the aim here must be to correct by purely natural means as far as possible. Costly engineering works should only be decided on in cases of absolute emergency and as a last resort.

The first aim in any corrective work in this country must be to prevent any further deterioration of forest and grassland communities in the high-country. To this end there is urgent need for an intensive investigation of high-country areas to assess the grazing potential of the various plant communities. Optimum populations of domestic and feral animals should be decided on and vigorous policing undertaken to ensure that these populations are not exceeded. There can be little doubt that in many areas the indigenous plant cover can be expected to recover if grazing pressure is lessened . . . in the case of feral animals this can be achieved by intensive hunting operations. Due to the economic significance of high-country sheep farming some grazing must always be expected so that the development of plant communities which will support grazing is desirable. This can possibly be achieved by the use of indigenous species (provided they are afforded some initial protection), but it is considered that exotic species will be needed to successfully restock badly eroded areas. This is essentially a New Zealand problem as we have in this country a flora which developed in the complete absence of grazing animals and we can learn little from overseas countries in this respect.

Apart from the danger of grazing animals there is the problem of control of fire in high-country watersheds. Kaikoura and Haast soils which have developed in the high-country are particularly prone to damage by fire. Loss of top-soil following burning is a common occurrence. Added to this the impact of fire on the unstable plant communities is serious. The mountain beech forest on the dry northerly slopes is almost always destroyed, and the absence of undergrowth in this forest type (due to high animal populations) allows rapid erosion by wind, rain, and frost-heave following burning.

While it is not contended that these protective measures supply the answer to high-country problems there can be no doubt that the indigenous vegetation is capable of playing an important part in watershed management schemes provided it is adequately protected. From a financial viewpoint alone the advantages of indigenous over exotic communities are obvious.

Supposing the first object of preventing further deterioration has been achieved the next step must be to repair damage done in and above the forest. In many areas this will already have been done in the course of protecting the indigenous vegetation. In others it is likely that some call will have to be made on exotic species and in particular on tree species which are adapted to the rigorous alpine conditions. Most of the trees listed in Part I are worthy of trial, but it should be emphasised that the field of selection is vast. Provenances of the listed species will be sufficient to occupy research workers for some time. Besides these there is a wealth of species from the American continent and Asia which may well prove to be adaptable to New Zealand conditions.

Much can be learned from French experience in the field of introduction of tree species. In particular the method of plant introduction through stages of scrub hardwoods to valuable softwoods could well be followed in many parts of this country where direct plantation is likely to meet with setbacks. Propagation of desirable species in true flying nurseries is another aspect which should receive earnest attention. Nothing should be overlooked to ensure that species selected are given the greatest possible chance to succeed in their new environment.

As well as this "reinforcing" of the forest zone there must be a vigorous attack on problems above the tree-line. While it is not suggested that work here will ever become as intensive as it does in Europe where population densities are much higher, there can be no denying the importance of a stable "upper zone" in all watersheds. Cases of damage due to detritus descending through the forest are all too common. Here, much can be done by protecting the indigenous vegetation, and recent experiments described by Sievwright (1956) would seem to indicate that there is every chance that indigenous pasture plants will succeed. Admittedly the experiments described were carried out at lower altitudes than one finds in the Alps, but conditions in the Mackenzie Country are extremely arduous and can be likened in many ways to those existing in alpine regions. Pasture improvement by introduction of indigenous or exotic plants must be considered an important aspect of soil conservation work in this country. Again, there is much to be learned from the experience of European workers in this field. In particular, the selection of as many nitrogen-fixing plants as possible from the indigenous vegetation is desirable. An early study of the alpine flora to select plants with this as well as other characteristics such as root-length, habit, etc., is called for. Methods of propagating these species must also be studied if there is to be any successful plant introduction on a large scale.

CONCLUSIONS

New Zealand has high-country soil conservation problems as serious as any country in the world. The cause of this deterioration in conditions appears to be difficult climate, unfavourable geological make-up, and an essentially unstable plant community which is unable to withstand the combined effects of grazing and fire. To remedy this state of affairs there must be a two-fold approach. Firstly, there must be constant protection of the indigenous vegetation, and introduction of suitable exotic species in both forest and pasture zones. Secondly, engineering works will be needed in badly eroded areas before any changes in the plant community can be envisaged.

Watershed management requires specialist training. At present this must be undertaken overseas and this is likely to remain the case for some time. Until such time as the country is able to train its own workers in this field much valuable work can be done by present workers in watershed management. There are high-country specialists scattered through a number of Government departments capable of carrying out survey and experimental work which will form the basis for later corrective measures. Their work would have an even greater value if the workers could be grouped under some central administration. Overseas practice is to vest control of range and watershed management in the Forest Authority.

Corrective measures described in these articles have in most cases been costly. The effects of past practices cannot be remedied overnight and costs will often appear to be disproportionate to the value of the land protected. What must be borne in mind is that in New Zealand the economy of the country is closely linked with the maintenance of stable conditions in high-country watersheds. In that case every effort must be made to ensure that the high-country tussock-grassland is kept in production.

There is an urgent need for intensive survey of the country's high-country. Problem areas must be assessed so that priorities can be allocated. Already some work has been done on the possibilities of introducing exotic tree and pasture plants. Much remains to be done. In the soil conservation field, "an ounce of prevention is worth at least a ton of cure."

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