SOIL CONSERVATION AND RIVERS CONTROL

EVIDENCE PRESENTED BY THE N.Z. INSTITUTE OF FORESTERS TO THE PARLIAMENTARY SELECT COMMITTEE ON SOIL CONSERVATION AND RIVERS CONTROL

Council of the New Zealand Institute of Foresters, on behalf of members of the Institute, would most respectfully draw attention to one particular aspect of soil conservation and rivers control work which, in the opinion of members, has been most seriously neglected. We refer to the continued neglect of the mountain lands of the Dominion and to neglect of the principle that rivers must be controlled from source.

We recognise the need for engineering works in the valleys and on the river flood plains; we appreciate the importance of the soil conservation measures introduced on the arable lands; we acknowledge the excellence of the work that has been done toward the stabilisation of the pastoral hill country, particularly through the development of aerial topdressing techniques; but we feel most strongly that concentration of effort in these directions, to the neglect of the mountain lands, has been unjustifiable.

All the more important rivers of New Zealand rise in the high mountains, draining vast areas of steep and rugged land at high altitudes. The correct management of these highlands we believe to be the only sure foundation for successful river control. We believe it to be essential to the safety of the lowlands. Rivers must be controlled from source if control is to be lasting and effective. This is the cumulative experience of all foresters and forest engineers in all countries. Control, in the long run, is totally dependent on the maintenance of healthy forests, grasslands and scrublands on the mountain slopes. The vegetation of the high mountains is the first and principal line of national defence against floods.

We therefore expected, following the establishment of the Soil Conservation and Rivers Control Council, a prompt and thorough enquiry into the condition of the mountain lands. We expected early, vigorous and impartial study of the mountain forests, grasslands and scrublands, with especial reference to their water yield and water regulation characteristics and to the manner in which these characteristics are affected by current land-use practices. These expectations, we regret, have not been fulfilled. The soil conservation and rivers control effort, to date, has been expended almost wholly in the lowlands. Very little work has been done in mountain country and, even then, largely in the valleys and on the intermountain plains. In no instance known to us has any thorough study been made of the vegetation of the steepest mountain slopes, or of any forests, scrublands or grass-
lands at altitudes exceeding 3,000 ft. We would liken the attitude of mind responsible for this failure to that of the man who maintained the interior of his home in meticulous order whilst entirely neglecting the repair of his roof. The high mountain lands, are, in truth, the roof of New Zealand.

**Definition of Mountain Land**

At this point it is essential to define more precisely the land with which we are concerned. The term “mountain land”, as used herein, is not synonymous with the popular term “high country”. This latter is a term we believe should be dropped. Its careless use is the cause of needless confusion and controversy. Much so-called “high country” is not mountain country. Many so-called “high country runs” do not embrace an acre of true mountain land. Much “high country” is plainland or valley land or easy tussock hill country. All land of this type we exclude from the category of mountain land even though it may be totally enclosed by high mountains or run in conjunction with mountain land proper.

Mountain land we define as land generally exceeding 3,000 ft. in altitude, together with the very steep lands immediately adjoining. These submissions refer to land of this type with one qualification. Our principal concern is with high rainfall mountain land. Where total annual rainfall is less than 25-30 inches, water regulation problems are seldom acute and foresters can rarely play any significant or direct part in land management. The semi-arid mountain lands we therefore exclude also.

Both occupied and unoccupied lands are included, the latter being by far the more extensive. The excluded lands, the semi-arid mountain lands and the intermountain lands, support by far the greater part of the total “high country” sheep population. The national importance of the industry based on these lands we recognise. We would most strongly support any case that might be presented for more vigorous research directed toward increase in their carrying capacity. We are well aware of the fact that only through radical improvement of the intermountain lands is there distinct economic possibility of the relief of high rainfall mountain lands from grazing pressure. But these problems are not our problems. Our problems are the problems of the high rainfall mountain lands, lands variously estimated to total from one quarter to one third of the land area of New Zealand.

We would ask that these definitions and qualifications be borne well in mind throughout the reading of these submissions.

**Management Objectives for Mountain Land**

For the mountain lands of New Zealand, as thus defined, we believe that there can be but the one prime management objective, namely, regulation of the water yield. Other land-use objectives we believe to be permissible only to the extent that no conflict with the primary objective is likely to arise. Useful water, in well regulated flow, is immensely more valuable than any other product of the mountain
lands. Mountain water, out of control, can do more damage in one day than can be recompensed in a decade through exploitation of other mountain resources. Regulation of the water yield should, we submit, be the recognised primary land management objective not only, as at present, for the State Forests of the high mountains, but also for all other high mountain lands, irrespective of tenure and irrespective of the nature of the vegetation. Currently, for one class of mountain land, the occupied Crown lands, the one objective would appear to be wool production; for a second class of mountain land, the unoccupied Crown lands, there is no readily discernible management objective at all; and for a third class of mountain land, the National Park lands, the primary land management objective is the development of recreational facilities.

We do not believe that there can be any substantial progress without resolution of these conflicts in management, i.e. without universal recognition of the over-riding importance of water as the prime product of the mountain lands. Water for power generation, water for irrigation, water for a multitude of purposes: the demand for water in controlled flow must leap upwards with growth in population and expansion of lowland industries. And, with every increase in the wealth of the lowlands, the demand for adequate protection against flood will grow. It is always the future that we must look toward in management of the mountain lands. Water, important now, will, without question, be of overwhelming importance in the years to come. As a nation, we cannot afford to do anything that will impair the water regulation values of the mountain forests, scrublands and grasslands. We cannot afford to neglect repair of the damage that has already been done.

Critical Features of New Zealand Mountain Lands

Most New Zealanders, if indeed they have given any thought at all to the matter, probably envisage the mountain lands of the Dominion as generally similar to the mountain lands of other countries. We rarely find appreciation of the fact that local conditions outstandingly suggest the probability of trouble.

1. New Zealand mountains, for the most part, are geologically very young mountains wherein the processes of mountain building are still active. Mountain slopes, in consequence, are very steep. Angles of slope commonly exceed the angles of repose of unprotected soil material or rock rubble. Rivers and streams, actively down-cutting, descend exceptionally steeply to the lowlands. Normal rates of geological erosion are rapid with by no means infrequent acceleration following major earth movements along fault lines or other natural disturbance of the state of equilibrium.

2. With respect to the principal mountain ranges, the country rock is of low erosion resistance. The schist and greywacke rocks of the main divide ranges are much jointed, faulted and fractured, with extensive shatter zones. They are particularly
susceptible to the disintegrating action of frost. The thin mantle of loose pumice sand that overlies the greywacke rocks of far northern ranges is, of course, readily stripped off by flowing water or even by wind.

3. Upland soils, likewise, are of low erosion resistance. They are typically silt loams or sandy loams of very weak crumb structure and this structure is readily broken down by frost, by the tread of animals, or even by the impact of raindrops falling on bared ground. The resultant silts and sands are rapidly removed by water and by wind. Fertility is low in all high rainfall areas and the soils of steep slopes are very shallow.

4. Mountain climates are severe and conducive to rapid erosion, particularly over the critical altitudinal ranges 3,000-5,000 ft.

(a) Total annual rainfall is always greater than on adjoining lowlands, probably rising to a maximum at about 4,000 ft. No accurate data are to hand for any lands above 3,000 ft. but annual totals exceeding 100 inches must be considered normal. On some western ranges annual totals may exceed 300 inches. High intensity falls of the order of 20 inches in 24 hours cannot be unusual.

(b) Frost action is by far more intense than in many mountain lands of much higher latitude. Daily freeze and thaw, for many months of the year, is usual. It is this diurnal fluctuation about the freezing point that is important, not the degree of frost experienced.

(c) Winds of strong gale force may blow for days or even weeks at a time. These may be cold with driving rain, hail or snow, or, in summer and across eastern ranges, hot and dry, scorching the mountain vegetation.

All these things, individually, are well known even where not well documented or instrumentally recorded. In sum they mean one thing only. They mean that acceleration of the erosion rate, already high, was inevitable immediately there was cultural interference with the vegetation. The state of balance established between the mountain forests, grasslands and scrublands, on the one hand, and the forces of normal geological erosion, on the other, was at all times precarious. This state of balance was irretrievably upset immediately exotic animals were introduced and fire was employed as a tool in land management. Though it has been argued that there is no such thing as (accelerated) erosion but only depletion (of the vegetation), with this argument we can have no truck; applied to the mountain lands it is demonstrably absurd. Under the conditions obtaining, depletion of the vegetation must result in acceleration of erosion. The more rapid the rate of normal erosion, the greater will the rate of acceleration be. It could not possibly be otherwise. The final consequence must be loss of capacity to regulate the water yield and concomitant increase in the destructive power of the rivers.
Some Critical Features of the Vegetation of the Mountain Lands

Acceleration of erosion rates was an inevitable consequence of depletion of the vegetation. Depletion of the vegetation was an inevitable consequence of the introduction of grazing and browsing animals and of the widespread use of fire. The native forests, scrublands and grasslands came into being in the complete absence of such animals and, primitively, were comparatively free from devastation by fire. These facts have already been reiterated *ad nauseam* but their true significance is not yet thoroughly well appreciated. Essentially they mean but one thing only. They mean that, once animals were introduced and fire was widely used, profound and largely irreversible readjustments in the vegetation were set in train. The first steps in this readjustment may be adequately summarised in the word "depletion".

The primitive vegetation, whether forest, scrubland or grassland, contained many species of plants of such pronounced palatability that they could not withstand even moderate pressure from animals. These were soon eliminated. Other species, entirely dependent on the maintenance intact of soil litter horizons, were eliminated when these horizons were destroyed by fire or by the trampling of animals. In these and other ways the density of the plant cover was reduced. Wind, frost and sun now had direct access to the soil surface. Frost tender, heat tender and drought tender seedlings no longer survived. Each and every stage in depletion paved the way toward a further stage. Shallow topsoils of weak structure were exposed to the forces of erosion. With loss of topsoils, and later of subsoils, additional plant species must disappear. With elimination of the most highly palatable species, other less palatable must bear the weight of grazing. Depletion of the vegetation, under the given circumstances, is an entirely normal and inevitable process.

The same thing happened, of course, where the primitive plant communities of the lowlands were exposed to animal pressure. These, also, underwent rapid depletion. But, in this case, the erosion potential was low and, more important, there was rapid replacement of the depleted primitive vegetation by introduced plants more fit to withstand grazing. Had these plants not been introduced we would, today, be faced with the same sort of problem in the lowlands that we now face in the highlands though, in respect to erosion and control of water yield, to a less extreme degree.

This brings us to consideration of the second important and critical feature of the vegetation of the mountain lands. Where a piece of lowland vegetation, consisting largely of palatable species, is grazed, year in, year out, depletion is soon evident; but, sooner or later, aggressive species of low palatability, the so-called weed species, make their appearance. And, for the lowlands, there are many such potential plant invaders, both native and introduced. Repletion, in other words, is a fairly ready process. For the difficult soils and harsh climates of the highlands, however, potential invading species are few. In the
continued presence of animals, very few native high altitude species display any marked aggressiveness. There have been no serious attempts to introduce new species apart from hopeless efforts to carry lowland species over to upland soils. Chance newcomers, e.g. sweet briar on the better soils, are few and far between. At altitudes greater than 3,000 ft., catsear and sorrel are commonly the only plant invaders.

The high altitude plant communities, in other words, are poverty stricken with respect to number of species, native or introduced, that are aggressive in the face of animal pressure. Depletion, consequently, is not followed by repletion but ends in the formation of a "plant vacuum". In time, undoubtedly, chance newcomers will fill this vacuum or there will be slow development of some new form of vegetation, consisting largely of native species, resistant to animal pressure; but there will be no guarantee that the dominants of the new vegetation will be thoroughly desirable species nor will there be any certainty that the new vegetation will be adequate for effective regulation of the water yield. In the meantime soils will remain bare.

(This statement of the elements of the situation and of the probable outcome of uncontrolled use of the primitive vegetation must not be taken as a plea for wholesale introduction of new species. Our strong bias is in favour of preservation of as much of the native vegetation as possible; but the facts of the case must be stated bluntly.)

Variations on the Theme

Present trends, in the high mountain country, are everywhere toward depletion of the vegetation and acceleration of erosion. There is, however, great variation in the extent of depletion and in the extent to which depletion has led to acceleration of erosion. The physical factors governing rates of erosion, factors of climate, landform, soil and bed-rock, are infinitely variable. There is great variety in the composition of the native forests, scrublands and grasslands and these have been subjected to varying animal pressure for varying lengths of time. Fire has not everywhere been employed or employed to the same extent. Any measure of uniformity in the condition of the vegetation and of the land is not to be expected.

At the one extreme, depletion is far advanced. There are no evident signs of repletion by either native or introduced species and the mechanical forces of erosion are in full control. Revegetation of the land, in many cases, will not be possible pending restabilisation of soils either by natural reduction of angles of slope or by engineering structures. At the other extreme, where the vegetation has never been fired, animal use has been slight and of short duration, and the vegetation displays greater natural resilience than normal, depletion may not be evident at first glance. It is certain, though, that there is depletion in some measure wherever animals are present whether conspicuous to a casual observer or not. It can be stated categorically that the vegetation of the mountain lands, forest, scrubland or grass-
land, remains in primitive condition only in the most remote corners of the country and then only on precipitous slopes inaccessible to animals.

Again, depletion of the vegetation and acceleration of erosion are not everywhere of the same economic consequence. Some rivers flow direct to the sea through narrow steep-walled valleys. Their water is not, and is not likely to be, employed for any useful purpose. Loss of control threatens no lowland interests or activities. Other rivers are wholly or partially subject to lake control. In other words, though depletion may be equally far advanced in two adjoining watersheds, it will be rare for this to give occasion for equal concern. Animal use can, in fact, legitimately be condoned or even encouraged in one watershed though regarded as totally indefensible on another, seemingly comparable, a few miles distant.

In effect each and every watershed presents its own peculiar set of problems though the theme, depletion of the vegetation, acceleration of erosion, loss of capacity to regulate the water yield, is a constant one. Each and every watershed must be the subject of intensive independent study before ever any sound solution to its problems can be reached. In each case answers to the following questions, inter alia, must be sought.

1. What is the present extent and rate of depletion?
2. What are the local agents of depletion?
3. To what extent has depletion resulted, and to what extent is it likely to result, in acceleration of erosion and loss of capacity to regulate the water yield?
4. What will be the economic consequences of loss of capacity to regulate the water yield?
5. Off-setting (4), what economic benefits will accrue from continuation of current land-use practices?
6. Can the agents of depletion be brought under control?
7. Will control of these agents, where possible, be followed by natural repletion of the vegetation?
8. Where control does not appear practicable, or where natural repletion appears improbable, what additional steps toward repletion must be taken?

These are difficult questions but, for each watershed, they must be answered clearly, avoiding all generalisations. Not until this can be done will it be possible to take really effective action.

Research the urgent need

To the above questions, we do not pretend to know the answers. We can only guess at some of them. On one point only can we afford to be dogmatic. There is urgent need for thorough methodical research. With every delay the task will become more complex, more difficult and more costly.

The work that must be done cannot be done by individuals; it cannot be done by members of any one scientific discipline working
in isolation. There is no man of sufficient genius to read the full story, avoiding all bias. No man can encompass the full range of natural sciences involved. Joint study of the watersheds by teams representative of all pertinent interests and disciplines is essential. But it will not be sufficient to bring about this co-ordination of effort, dispatching selected teams into the watersheds to make joint studies. The most competent team that could today be selected would very soon run into a brick wall of ignorance. At point after point there is a critical lack of essential information. A massive amount of fundamental research work must be carried out. The problems of the mountain lands have been neglected by scientists equally as much as by the rest of the community. A few items demanding early attention are listed below.

(a) Plant Sciences

*Taxonomy.* The plant species of the mountain lands are imperfectly known and imperfectly described. Where species cannot be readily identified, all vegetation studies are crippled. *Autecology.* Very few autecological studies of high altitude species, i.e. studies of the behaviour of individual plants under varying conditions, have ever been made. For even the most prominent species, next-to-nothing is known of their life cycle—requirements for growth, flowering, seed set, seed dispersal, germination, etc. Without this information, intelligent manipulation of the vegetation is impossible. Every lowland farmer knows these things for the plant species with which he is concerned: not even scientists can guess at them for the species of the mountain lands.

*Synecology.* Synecology embraces the study of plant communities, their origin and mode of development, plant interrelationships, and the inter-actions between plants and their physical environment. There can be no true understanding of the vegetation pending completion of synecological studies, but very little has been attempted.

(b) Animal Sciences

*Animal Ecology.* A thorough knowledge of the habits of the animals found on the mountain lands is the *sine qua non* of animal control. Some work in this field has been done in recent years but this must be considered a drop in the bucket in comparison with that which must be done. Effective control of animals will not be possible without much more information than we now possess concerning such things as feeding habits, mating habits, rates of reproduction, daily and seasonal movements, migration, herd territories, interspecific competition, etc. Some animals are currently not being studied at all. Hares, for example, though rarely mentioned as important animals of the high altitude lands, are present in large numbers to altitudes exceeding 7,000 ft. They may well be responsible for
much of the depletion of the vegetation now charged to deer, chamois or sheep; but no study of them is under way. Is anything really known concerning the feeding habits and food preferences of sheep at high altitudes? A search of all pertinent literature reveals little.

Entomology. The chain reactions initiated by grazing and browsing animals may well extend to insect populations. For example, conditions hostile to predators may be created, permitting upsurge of plant feeding insects to epidemic numbers. There is fear in some quarters that conditions in the mountain beech forests are now ripe for epidemics of bark beetles; in other quarters it is thought that final destruction of tussock grasses is wrought by insects. To what extent are these fears and opinions justified? A close watch is now kept on insect populations of the lowland grasslands and lowland timber production forests. Might this not be of equal importance for the forests and grasslands of the watersheds?

(c) Physical Sciences

Hydrology. Hydrological research in New Zealand, at least in respect to the mountain lands, is in its infancy. Some would say it is barely conceived. It is true that records are kept of the flow of many important rivers; but this is no more hydrological research than is the keeping of records of death rates from cancer, cancer research. We must know what happens to the water from the moment it falls on the mountain lands to the moment it reaches the sea. How much water is stored in the soil? How is soil storage affected by loss of soil litter or by compaction, through animal trampling, of top-soils? To what extent does depletion of the vegetation affect rates of snow accumulation and snow melt? What type of vegetation is the most desirable where the principal requirement is reduction of peak flood crests, or where the principal requirement is maximum sustained yields of clear water? These are typical of the questions that can be answered only through hydrological research. Answers must soon be required.

Climatology. Even more serious is the present neglect of research into the weather of the high mountain lands. Data essential to the interpretation of observed phenomena, and the records that must prove the very foundation of hydrological research, are simply not being collected. There is a thin scattering of rain gauges through the mountain valleys but we believe we are correct in stating that there exists no single well equipped recording station at an altitude exceeding 3,000 ft. There can be very few moderately well equipped stations at altitudes exceeding 2,000 ft. The lack of adequate climatic records will be a most severe handicap for many years to come. These records will be required for many
purposes. To cite one example: where plant introduction work must be undertaken, this, in the absence of climatic records, can proceed only on a trial and error basis. There will be many costly failures. But where records are to hand, particularly of micro-climates, the initial selection of species for trial will rest on a much firmer foundation. Trials need only be made of species and strains of known climatic suitability. These are but a few of the items demanding attention. Any competent observer familiar with the mountain lands could add extensively to this list. We have carried it this far only to emphasise the paucity of present knowledge at many vital points and the meagreness of the present research effort.

Current Research Activities Reviewed

There will be no lasting solution of the problems of the mountain lands without research. How much is being done? If current “high country” or “tussock grassland” research programmes are carefully analysed, it will be found that almost all effort is expended on the intermountain and semi-arid mountain lands. In other words, the total effort being small, the problems of the high rainfall mountain lands are receiving scant attention.

The tussock grassland research programme of the Department of Agriculture is not mountain land research. The research objective is largely the replenishment or replacement of the depleted tussock grasslands of the intermountain lands, particularly the semi-arid intermountain lands, by exotic pasture species. In the strict sense of the term, it is not even tussock grassland research. Carried through to a successful conclusion, this work, important in itself, may enable economic withdrawal of stock from the depleted, eroded, high mountain lands proper; but otherwise it can contribute little to solution of the water regulation and river control problems that confront us. It may, in fact, aggravate these problems since the improved intermountain lands will be extremely vulnerable to flood destruction from above. The semi-arid lands, intensively developed, will demand more and more water, in well regulated flow, for irrigation and other purposes.

The Soil Conservation and Rivers Control Council maintains a “high country” Research Station (Tara Hills) but here again, as is rendered inevitable by the choice of site, principal concern is with arid land problems. Conditions are quite atypical of high rainfall mountain land. Research objectives must necessarily parallel those of the Department of Agriculture. Concerning other pertinent research projects of the Council, we have little information but understand these to include land capability surveys (Waiau Valley) and tussock grassland surveys (Broken River Basin). This is work that does touch directly on the problems of the high rainfall mountain lands. Land capability surveys, even where the land-use patterns indicated as desirable cannot be immediately translated into fact, will serve to
emphasise the extent and importance of the mountain lands. Tussock grassland surveys will highlight particular research problems. Surveys of these two types will not, however, solve any problems. They will only bring the problems into sharper focus. Pending publication of the findings of survey, there is little more that can be said.

Various catchment boards, likewise, have undertaken land capability (or land-use or land-condition) surveys but we have seen no published results. The above remarks apply. With respect to other research activities of the boards little, also has been published. We know that there has been some excellent work done by individual soil conservators, work directly related to mountain land problems. We might single out the work done in North Canterbury where there has been measurement, over a span of years, of actual rates of change in tussock grassland, some of it true mountain grassland. At the same time, however, it is abundantly clear that conditions under which the soil conservators must work are thoroughly hostile to sustained research. From our own experience we know that part time research, conducted in professional isolation with a host of routine duties to attend to, is more likely to lead to frustration than to solution of complex problems. We have already stressed our conviction that mountain land research is not a task for individuals but a task for specialist research teams. We feel, therefore, that the research efforts of the boards must be dismissed as unlikely to lead to any comprehensive solution of mountain land problems despite the efforts of the soil conservators. If boards were in a position to recruit and retain the specialist teams necessary for the job, it might be otherwise; but this seems improbable. The present thin dispersed effort is the antithesis of that required.

Two Divisions of the Department of Scientific and Industrial Research are also engaged in mountain land research. The pedologists of Soil Survey are, without question, the present leaders in the research field. Even so, we are certain that they will agree with us when we say that much more information is required about mountain soils. In particular, we require more information concerning the changes induced in the soils through depletion of the vegetation and animal trampling and concerning the likely effect of these changes on the vegetation, in other words, further study of the soil-vegetation chain reactions initiated through the introduction of animals. The Botany Division, in the fields of plant taxonomy and plant ecology, is active within the limits of its resources but, again, we confidently anticipate agreement when we say that the effort is small in comparison with the importance of the subject. With the broad conclusions of the two important bulletins issued by the Department of Scientific and Industrial Research, dealing with the high altitude lands, we are in complete agreement.

The Department of Lands and Survey is not a research department, but, as the authority responsible for the administration of the greater part of the so-called “high country” and of much of the mountain
land proper, it must necessarily be concerned with research. We firmly believe that primary responsibility for land management research should rest with the authority responsible for land administration. We have welcomed the work of the department in the Molesworth-Tarndale-St. Helens country as a first major step in this direction. This work may well be regarded as one gigantic experiment. The Molesworth country, however, is again atypical of the high rainfall mountain lands. The problems of land management that it presents are more closely akin to those of the semi-arid inter-mountain plains of South Canterbury. The research emphasis falls, therefore, on problems of animal production rather than on problems of water regulation.

The research programme of the Forest Service appears to us to be the only research programme, other than that of the Soil Survey, that faces the critical water regulation issues of the mountain lands fairly and squarely. In saying this we believe we do not display professional bias. We have by no means infrequently, in past years, criticised the Service for its lack of interest in, and attention to, the high mountain watersheds. We are now assured, however, that the Service is taking vigorous action though we may be permitted to retain some doubts as to its sufficiency pending publication of results. We are informed:

(a) that preliminary surveys of all watershed forests have been completed, surveys essential to the design of an adequate research programme;

(b) that more intensive surveys of all important watershed forests are underway;

(c) that, complementary to this problem definition work, investigations of fundamental research problems are in hand;

(d) that, following the transfer of animal control activities from the Department of Internal Affairs to the Service, problems in animal ecology will receive greatly expanded attention;

(e) that animal control operations will no longer proceed on an extensive basis but will be conducted intensively, i.e. effort will be concentrated where the animals concerned are the most destructive not necessarily where they are the most numerous;

(f) that intensive empirical studies of experimental river catchments are underway, e.g., the Harper-Avoca Catchment in Canterbury, and,

(g) the item of greatest importance, that the required research specialists can and will be made available.

This programme of research, actively pursued, should produce results. Animal studies will, of course, cover all lands where the animals concerned are to be found. Vegetation studies, items (a) to (c) above, are primarily designed as forest studies but the programme appears capable of ready expansion to cover, not only the forests, but also the scrublands and unoccupied grasslands of the high mountain
watersheds—a most logical expansion since . . . .

(a) management objectives should be uniform throughout.
(b) the safety of the forests is largely dependent on the maintenance in a healthy condition of the scrublands and grasslands that lie above the forests.
(c) the Forest Service is already responsible for animal control and animal research studies for both forests and grasslands, and
(d) there does not appear to be any other authority prepared or willing to conduct the necessary research.

The Facts in Relation to Administration

At this point we must apologise for the length of this discourse. We have thought it necessary to begin right at the beginning, cutting through the smokescreen of irrelevancies that usually beclouds discussion of mountain land issues. Objectives must be clear before ever any administrative machine can be devised or redesigned to do a specific job. In brief, our thesis has been:—

1. For the high rainfall mountain lands, as distinct from the semi-arid mountain lands and the intermountain lands, the primary land management objective must be regulation of the water yield irrespective of the nature of the vegetation and irrespective of land tenure.

2. The condition of the vegetation of these high rainfall mountain lands, and trends in the condition of the vegetation, give good grounds for anxiety. The theme, depletion of the vegetation, acceleration of erosion, loss of capacity to regulate the water yield, is a constant one. This state of affairs is an inevitable consequence of the introduction of animals and of the past widespread use of fire.

3. There is urgent need for research into these matters since without this, there can be no serious attempt to correct the situation.

4. Mountain land problems, however, have not been given the attention they deserve. The Soil Conservation and Rivers Control Council, instead of leading the way, has, to put it crudely, buried its head in the lowlands. Where it has undertaken mountain land research it has chosen to deal with pastoral land problems of the semi-arid mountain lands rather than the water regulation problems of the high rainfall lands.

5. A direct result of this default in leadership has been chaos in the research field. Objectives have been imprecisely defined; there has been no firm allocation of research responsibilities; there is duplication of effort in some directions and complete neglect of fundamental problems in others; and technical resources have been spread too thinly to be of any effect. Only one research authority has made substantial progress in the field of fundamental research (Soil Survey), and only one
department has developed any comprehensive land management research programme (Forest Service).

These are the elements of the current situation. How did this situation arise? We believe that contributing factors have been many.

1. One of the principal factors has clearly been loose thinking as summed up in imprecise use of the compendious term “high country” a term which means many different things to many different people. We, ourselves, and scientists generally, have been as much at fault in this respect as anyone. Loose thinking is also patent in the popular belief that, though the forests of the high mountain watersheds are of vital importance in prevention of erosion and regulation of the water yield and should be safeguarded against exploitation at all costs, the grasslands of the mountain lands may, quite legitimately, be exploited. The truth of the matter is that grasslands and forests play an equal role in protection of the soil and regulation of the water resource, the grasslands being often more readily susceptible of damage, through exploitation, than the forests.

2. A second major factor, we consider, has been the fact that responsibility for land management research, with respect to the Crown lands, has not rested in the hands of the department concerned with the administration of these lands. Possibly of even greater importance, are actual deficiencies in the legislation under which it functions. There is nothing at all in the Lands Act making it mandatory for the Department of Lands and Survey to take considerations of soil and water conservation into account in the administration of land under its control. The nearest approach is in Section 13 (1) which rather vaguely says:

“It shall be the duty of the (Land Settlement) Board to carry out the provisions of this Act for ... the protection and care of Crown land”; and in Sections 184 (1) and (2) (n) which enable regulations to be made for the same purposes. The only mention of soil fertility is in Section 176 (2) (e) which prohibits the lighting of fires without permit in cases where the fertility of the soil would be injuriously affected; and erosion as such is mentioned solely in connection with reduction of value (rents, purchase price, etc.) when productivity has seriously declined (Section 143 (1) ). The regulation of water finds mention in Section 50 (2) but only in respect to construction of waterworks on land being developed; and river-protection is likewise mentioned once only, and in the same narrow context. When the extent, position, nature and over-riding importance of the mountain lands administered under the Lands Act is considered, the complete omission in this document of the words “soil conservation” and “water conservation” is nothing short of fantastic. Obviously it should be mandatory for all land-administering authorities to
so administer land that soil and water conservation values are not impaired.

In the same context it may be noted that there are deficiencies even in the Forests Act (1949). This Act authorises the Minister “to acquire use and develop land for the conservation of water and the stabilisation of soil”. It states that he may do these things but not that he shall. Again, in our opinion, it is essential that the use and development of land by the Forest Service, should, legally, be mandatory rather than permissive.

3. The third important factor, in our opinion, has been gross over-subdivision of the field of responsibility: the Department of Lands and Survey in administrative charge of the Crown lands but with no mandatory obligation with respect to soil and water conservation and not conducting its own research; the Forest Service in administrative charge of the State Forests, with no mandatory obligations with respect to soil and water conservation but conducting its own research; the National Parks Authority in administrative charge of the National Park lands, with mandatory obligations in respect to soil and water conservation (even though this may frequently be in conflict with its other obligation), but not conducting its own research; the Department of Internal Affairs, up to a very recent date, with no land administration obligations but responsible for control of the wild animals that pose the principal threat to the high mountain Crown lands, State Forests and National Park lands; the Department of Agriculture, conducting research into problems bearing closely on mountain land management but without responsibility in the field of land administration; the Department of Scientific and Industrial Research conducting research into fundamental problems of great importance in respect to mountain land management; and, superimposed on all this, the Soil Conservation and Rivers Control Council plus the Catchment Boards, rarely with land administration functions but with statutory obligations with respect to soil and water conservation and conducting research, the Council functioning initially under the Ministry of Works and latterly under the Department of Agriculture. Clearly it required super-human ability, on the part of the Soil Conservation and Rivers Control Council, in the exercise of its co-ordinating functions, to reduce the field to order.

4. And finally, the fourth important factor we believe to be the outcome of bias. As foresters we must inevitably be biased in favour of forest solutions to watershed problems and, were we responsible for the administration of the Soil Conservation and Rivers Control Act, we would inevitably lay undue stress on the forests and forest lands. We believe that, in the same manner, there has been undue bias in favour of engineering
solutions to river control problems and undue stress laid on the soil conservation problems of the agricultural lands, both to the neglect of the high mountain watersheds. We mean no disrespect to the men concerned. Bias there must be, however, where the burden of responsibility rests largely on the members of any one profession. Both engineers and agricultural techni-
cians are principally concerned with lowland problems and the accent has therefore fallen on lowland works.

Summary and Recommendations

We might best sum up by quoting pertinent sections from a report presented to the Council of the New Zealand Institute of Foresters by the Institute’s standing committee on Soil Conservation and unanimously adopted at the Annual General Meeting of the Institute (1956).

1. The Committee is unanimous that there are grounds for dis-
satisfaction and even anxiety with regard to the condition of the vegetative cover, forest, grassland and scrubland, of the high mountain watersheds.

2. The committee is unanimous that, as a pre-requisite to success-
ful attack on outstanding problems of watershed management, a much more vigorous research programme must be set under-
way. Present research is limited in quantity, uneven in quality, piece-meal and sporadic in nature, and cannot provide that fundamental understanding essential to sound practical manage-
ment of the watersheds.

3. The committee is unanimous that there are serious faults in present administration of the watersheds, faults arising through over-subdivision of the field of responsibility, through lack of clarity or even conflict in the pertinent legislation, and through failure to achieve the necessary co-ordination of effort.

4. The committee is of the opinion that this Institute could and should, play a prominent part in solution of these many diffi-
culties, but has found it by no means easy to suggest ways and means. It appears absolutely necessary, if any measure of success is to be achieved, for the Institute to speak clearly, authoritatively and without the slightest suspicion of axe-
grinding.

5. The committee, therefore, finds great merit in the suggestion that the Institute confine itself to the making of an earnest recommendation to the Government that the field be reviewed at an early date by a competent, impartial overseas authority with experience both in forests and in range land management; such recommendation to be supported by a statement of the Institute’s anxiety regarding the condition of the watershed forests and rangelands, of its disquiet re the lack of purpose and progress in pertinent research work, and of its unease re the seemingly unnecessary complexity of the present administration.
Failing acceptance of this, our principal recommendation, we would suggest action along the following lines:—

1. Amendment of both the Lands Act and Forests Act rendering mandatory the administration of the lands concerned in the interests of soil and water conservation.

2. Transfer of the Soil Conservation and Rivers Control Council from the Ministry of Works to the Department of Lands and Survey, and of the research staff of the Council (i.e. those officers of the Council engaged on mountain lands research) from the Department of Agriculture to the Department of Lands and Survey.

3. Clearcut division of the field of research responsibility between the two departments primarily responsible for land administration, and the Department of Agriculture, as under:—
   (a) The Department of Lands and Survey to be responsible for all research into the problems of the occupied mountain lands.
   (b) The Forest Service to be responsible for all research into the problems of the unoccupied mountain lands, the situation being further simplified by transfer to State Forest of all unoccupied mountain land not already State Forest land.
   (c) The Department of Agriculture to be responsible for all other soil and water conservation research (i.e. for the arable lands, pastoral hill country and semi-arid lands).

4. Responsibility for co-ordination of research to rest with the Department of Lands and Survey acting through the Soil Conservation and Rivers Control Council.

5. Catchment Boards not to engage directly in research (research officers to be transferred to the appropriate departments) though retaining, through the Soil Conservation and Rivers Control Council, a voice in the direction of research.

6. The Ministry of Works to remain the executive agent of the Council in respect to all river control and allied engineering works.

7. All research authorities to continue to make the best possible use of the technical resources of the Department of Scientific and Industrial Research in the fundamental research field (e.g. soil research, plant taxonomy, etc.).

In this manner we believe that an immense simplification of the present position is possible. There would no longer be any excuse for duplication of effort nor any excuse for neglect of important issues. All problems are, essentially, problems of wise land-use and responsibility would rest firmly on the three departments principally concerned with the use of land. The Catchment Boards and the Soil Conservation Council would remain the watchdogs of the public ready to advise, criticise and, where necessary goad the departments into action.