THE ECONOMICS OF SOIL CONSERVATION AND WATER MANAGEMENT POLICIES IN THE OTAGO HIGH COUNTRY

by

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THE AGRICULTURAL ECONOMICS RESEARCH UNIT

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PREFACE

The AERU has a continuing interest in the use of New Zealand's natural resources, particularly land, water and energy resources.

This report presents an economic analysis of soil conservation and water management policies for high country tussock grasslands.

With few exceptions, high country water and soil conservation measures are not obligatory for private stock owners. The government's policy has been to "encourage" the adoption of sound conservation practices vis-a-vis development subsidies and services to run holders that make such practices economically attractive. Services are extended in the form of detailed farm development plans--"Soil and Water Conservation Plans (SWCP's)"--along with followup management assistance and government cost-sharing of the required development expenditure. Some important questions which stem from this voluntary programme are: Do the SWCP's generate enough private benefits to warrant their ready adoption by farmers?; do the social benefits of SWCP's exceed the social costs?; and can modification of government cost-sharing arrangements lead to a higher level of benefit to the Nation?

The author addresses these questions and related policy issues using conventional benefit-cost analysis. Subject to data limitations, particularly with regard to quantifying the full social benefits of water and soil conservation measures, the author concludes that direct net benefits to farmers are highly variable and unequally distributed. The net social benefits of the programme are small but could be increased with an improved rationale for cost-sharing. This report will provide useful information and ideas for policy makers and planners concerned with high country land management, and should provide useful insights into areas where further policy research is warranted.

P.D. Chudleigh,
Director.

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LIST OF ABBREVIATIONS

AERU	Agricultural Economics Research Unit
BP	Before Present
CBA	Cost Benefit Analysis
DSIR	Department of Scientific and Industrial Research
HCPS	High Country Production Surveys, carried out by TGMLI
MAF	Ministry of Agriculture and Fisheries
NPV	Net Present Value
NAFSFRI	New Zealand Forest Service Forest Research Institute
OCB	Otago Catchment Board
SCRCC	Soil Conservation and Rivers Control Council
s.u.	Stock unit
SWCP	Soil and Water Conservation Plan
TGMLI	Tussock Grasslands and Mountain Lands Institute
WRC	Water Resources Council

CHAPTER 1

INTRODUCTION

1.1 Problem Background

The soils of New Zealand's high country vary between regions, but most are shallow, strongly leached and at least moderately deficient in plant nutrients, especially nitrogen and phosphorus[1]. The rate of chemical weathering of the parent rock material is extremely slow, hence any soil lost is replaced only in the very long term. With the notable exception of the southern schist, the eastern South Island greywacke regions and the North Island mountain forests, mountain vegetation has been little altered by man. The main threat to the montane, subalpine and alpine vegetation of these regions are introduced animals, particularly deer, hares, rabbits and opossums. Their introduction has been described as "one of the greatest ecological blunders of all time" (Wardle, 1977), and their sustained control is a vital part of watershed management over most of the high country.

Severe modification to original (pre-man) vegetation has occurred in southern schist and eastern South Island greywacke regions. Much of the sub-alpine forest area destroyed by fires lit by Polynesians from about 1000

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1 See for example the work of Holloway (1977), Dunbar and Hughes (1974), Connor (1974), Wardle (1977) and Howard (1978, 1979).

years B.P. was replaced by tall tussock grassland. Subsequently, this was largely converted into short tussock as a result of frequent fires and overgrazing by sheep and rabbits as a result of European settlement after 1850.

In their attempt to make tall tussock accessible to sheep and to provide fresh palatable growth, plant and litter cover was reduced and the ground exposed to erosive forces. In the schist region this has led to a steady loss of topsoil. In the greywacke region, which already had high rates of normal geological erosion, the changes in vegetation resulted in rapid increases in the area of alpine barrens, in the number and size of barren scree slopes, and in the formation of a multitude of new gullies. There was no re-vegetation of the exposed soil which was removed by the natural forces of water, wind and frost. Holloway (1975, p. 9) comments that "few mountain regions...display so starkly the results of land abuse". Since about 1870, there is evidence of relative stability of screes and other erosion features in greywacke regions, and doubts have been cast upon the view that European pastoralists were largely responsible for the barren condition of mid and upper slopes (Wardle, 1972; Howard, 1978, 1979).

The main economic use of the high country tussock grasslands has been the summer grazing of sheep and cattle, in conjunction with more intensive winter grazing on lower, better quality lands. Present grazing policy, as set out in Pastoral Lands Policy (Land Settlement Board, 1974), aims to destock eroded and erosion prone lands (classified as class VIIe and VIII lands) and to surrender to the Crown the leasehold lands which have been destocked. Destocking and surrender are normally combined with improvement (e.g. through oversowing and top-dressing) of lower lands. Development of the lower lands depends on on the economic benefits to runholders and on the persuasive power of catchment authorities who draw up soil and water conservation proposals. For properties with class VIIe (severely eroded class VII land) and VIII land, these plans aim at permanent destocking (retirement from all grazing), with the displaced stock units being relocated on lower country[2]. Government grants to runholders are provided for certain development works on this lower country providing an incentive to accept the retirement plan. However, it should be noted

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2 Land use capability classes are defined by Soil Conservation and Rivers Control Council (1971) as follows: classes I to IV are considered capable of arable, pastoral or forestry use, with respective limitations classified as none, slight, moderate and severe; classes V to VII are considered capable of pastoral or forestry use only, with respective limitations classified as slight, moderate and severe; class VIII is defined as "protection land" and is considered totally and permanently unsuitable for production use; it is either eroded or liable to erosion if the cover is disturbed.

that most soil and water conservation plans do not involve retirement of lands, but a range of soil conserving practices on land types that are retained in grazing uses.

The general aim of high country land use policy, as laid down in the Joint Policy Statement of 1973 (NWASCO, 1973), is to ensure that high country lands are primarily used for soil conservation and water management purposes, with prime concern being given to offside benefits (e.g. protection of downstream assets and public amenities from flooding, water requirements). Other uses are to be considered in relation to these requirements and are to be compatible with them.

1.2 Current High Country Lands Policy

The general policy on use of mountain lands is reported in the government policy statement "Deciding the Use of High Mountain Resources" (Department of Lands and Survey, 1979), and also in "High Country Policy" (Land Settlement Board, 1979). According to the Department of Lands and Survey the policy is as follows:

> "Recognising the instability and fragility of New Zealand mountains, the high degree of endemism of its biota, and the need to improve and maintain the condition of the mountains for the full and proper benefits of mankind, the use of high mountain resources must have regard to:

the conservation of natural resources;

the sustained production of water of high quality and of benefits from forest, pastoral, agricultural, mineral, and other resources;

the provision of opportunities for work, recreation, relaxation, and learning;

the safeguarding of adequate representative examples of all indigenous mountain biota and of important ecosystems in as natural condition as possible;

the preservation of natural landscape of outstanding scenic quality and the creation and preservation of cultural landscapes of high quality;

the promotion of a balanced relationship between natural landscape character and all forms of land and water use;

the enhancement of social, cultural, and environmental values; and

the retention and management of unallocated land for the maximisation of choice by present and future generations."

With respect to expressing this policy in measurable criteria, the goal concerning pastoral, agricultural and forestry uses is particularly important to this study. The goal is:

"to promote, intensify, and increase use for sustainable and diverse pastoral, agricultural, and forestry production in response to local, regional, or national priorities on land suitable for such purposes, consistent with economic viability, balanced land use, conservation of soil, and protection of natural resources."

In relation to soil and water conservation this means the encouragement of "management policies and practices that will lead to long term protection of water and soil resources", involving a number of methods:

(i) evaluating physical resources and identifying those areas in order of priority in which significant social and economic benefits are dependent upon maintenance or improvement of the condition of the land;

(ii) withdrawing unsuitable land from pastoral, agricultural, or other use and restoring and maintaining it with purely protective vegetation if necessary;

(iii) developing suitable productive vegetation and uses providing that in appropriate important areas revegetation is carried out only with indigenous species;

(iv) maintaining and improving the soil and water protection capacity of land under pastoral, agricultural and forest use through weed, plant, animal, disease, and fire control and other relevant management; and

(v) formulating and implementing adequate controls to enable pastoral, agricultural, forestry, and other uses to be maintained where these uses are compatible with ensuring minimum soil loss and water degradation.

The Land Settlement Board, as the statutory administering body for all Crown land, has decided that:

"(a) The Board's policy shall be that all class VIII and severely eroded class VII land should be retired from grazing and surrendered from permanent leases.

(b) All Crown land retired from grazing, either voluntarily or by the Board itself, or under a soil and water conservation run plan, shall be administered according to a management plan to be prepared for each area of land, having regard to its potential for improvement by known techniques, its importance in watershed protection, and its potential for other uses.

(c) The management plan shall have as its first and overriding objective the management, protection and improvement of the area for soil and water conservation. Other uses may be permitted to the extent that they do not conflict with the primary aim..."

With respect to retired lands...The Board has decided that:

"Where land to be completely retired from grazing under a Soil Conservation Run Plan can be separated by physical means, i.e. natural boundaries or a grant fence, it should be subject to a management plan. If a phasing out period for grazing is necessary, a pastoral occupation licence should be granted for this period after which the land should revert to the Crown, with an undertaking given that in the event of grazing again becoming available it will first be offered to the lessee of the property from which it was surrendered. Grazing becoming available after the expiry of the pastoral occupation licence will be made available on a grazing permit without conferring exclusive right of possession."

1.3 Objectives of the Study

In preliminary discussions with the government agencies concerned (Department of Lands and Survey, Ministry of Works, DSIR) and later the Otago Catchment Board, several points were made concerning the terms of reference for the proposed study:

(i) soil and water conservation plans (known in the past as farm plans and run plans and hereafter referred to as SWCP's) are drawn up for a wide variety of properties. Of those designed for high country properties, many do not include class VIIe or VIII lands and hence do not involve the retirement of land from grazing;

(ii) that the aim of attempting to value economically any soil and water conservation benefits was very ambitious; and

(iii) that there was an advantage in concentrating the research effort in one catchment board area. The Otago Catchment Board region was suggested as representative of several types and areas of accelerated erosion, and also because good records and co-operative personnel were available to support the empirical analysis.

As a result of these suggestions the project focused on the following objectives and scope of analysis:

(i) to examine past and present policy regarding soil and water conservation in the high country within a cost-benefit framework;

(ii) to evaluate the economic consequences of voluntary versus involuntary water and soil conservation policies; and

(iii) to examine Government cost sharing arrangements as a means of achieving an optimal policy solution.

1.4 Organisation of the Report

The remainder of this report is organised into five chapters. In Chapter 2, current knowledge about high country erosion processes and control mechanisms is reviewed and implications are drawn for an economic analysis of the problem. Chapter 3 reports the cost-benefit framework used for analysis purposes, and particular aspects of the problem which limit the usefulness of the results are highlighted. In the next section, Chapter 4, the main features of the Otago SWCP's are described in detail. Chapter 5 reports the results of the cost-benefit analysis and Chapter 6 contains the conclusions and implications for public policy.

CHAPTER 2

REVIEW OF KNOWLEDGE ON HIGH COUNTRY EROSION PROCESSES AND CONTROLS

To many New Zealanders it is an indisputable fact of life that the high country is in peril from erosive forces, and the basic solution seen is the removal of stock from erosion-prone high country land. Whether soil and water conservation plans are "doing the job" is basically a matter of faith. To quote one researcher:

> "While I have admitted that little can be seen in terms of overall catchment improvement from Soil Conservation run plans, I am of the sure opinion that 'value for money' has been attained; perhaps only because so little has been invested are the results so few" (Connor, 1974, p. 128).

Such a view often assumes a straight-forward relationship between soil conservation and destocking: erosion is assumed to occur mainly through the action of wind, frost and water, and is transported by surface water run-off; run-off is particularly high when vegetative cover is insufficient to protect the soil; vegetation cover is eaten by stock; therefore removal of stock will allow a better vegetative cover and erosion will be checked.

Researchers concerned with the processes of erosion are less certain about some of these relationships. A large number of questions have been raised in the last two years about previously accepted beliefs. This is well illustrated by the remarks of the chairman of the SCRCC and WRC at the New Zealand Association of Soil Conservators 1978 Conference:

> "There has been some debunking recently, and at this Conference, of some long held beliefs... For Example we have Howard saying that "alpine screes do not constitute severely eroding land and the majority do not pose any problem to downstream interest and values". Hayward's studies in the Torlesse Basin are interpreted as "casting grave doubts on the widely held assumption that fewer floods would occur if ground cover in the mountains improved". McSaveney suggests that "rainfall is overwhelmingly the dominant influence on present erosion rates". In Pearce's and O'Loughlin's paper we read that "in broad terms, then, the influence of forest cover on hydrology is a secondary one, which is over-ridden by regional differences in rainfall and its variability, topography, soil parameters and underlying geology". Mosley reminds us that "intense rainfalls may cause severe erosion under a dense, perfectly healthy forest cover". He and other authors point out that we have a far greater mass of material stored in our river channels than is being contributed to them and that "it is probable in most areas of New Zealand the processes of geomorphic change have not attained a state of equilibrium in which rates of change, and hence rates of erosion, are minimised". (Conway, 1978, p. 431-2).

The following summary of the current state of knowledge on such questions has been assisted by several recent scholarly works by O'Connor (1976), Dils, Burton and Hayward (1977), NWASCO (1977), and a number of papers published in the proceedings of the 1978 New Zealand Association of Soil Conservators Conference (1979).

2.1 Soil Stability and Transfer

The erosion concept covers the loosening, dissolving and removal of material and is thus made up of a number of processes. For the purposes of this summary, they are considered in strict order of occurrence. First come the loosening and detaching processes which in the high country of New Zealand comprise frost heave (on bared ground), wind and intense rainfall. Second, this material is available for transportation to stream channels by wind and water. Third, the material is then available for transportation downstream, principally as sediment and fourthly comes to rest, at least for a time, within a river channel, in a lake, or on the sea-floor, or on a plain. These shall be referred to as stages I to IV respectively. The separation of the stages is important.

In terms of measurement, we may distinguish between 'slope erosion', 'gross erosion upstream' or 'headwater erosion rates' which involve the quantity of material transported to the stream channels (stage II), and the 'rate of erosion' or 'sediment yield rate' (normally measured in tonnes per km^2 of catchment per annum) which is a measure of the quantity of sediment either passing particular points or deposited (stages III and IV)[3]. This distinction is important because

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3 For data on erosion rates, see Cunningham (1978), McSaveny (1978), Mosley (1978), and Pearch and O'Loughlin (1978).

headwater erosion rates may be quite different from sediment yield rates, and the former cannot be estimated from the latter except perhaps in the long term. Over a short period the ratio of sediment yield to headwater erosion may be quite low (Sutherland, 1978).

Two processes are important to transport measurement: the storage of eroded material between stages II and III, and the unequal distribution of quantities transported over time (stages III and IV). Storage of eroded materials in valley floors and elsewhere occurs until some 'extreme event' (Cunningham, 1978) takes place (e.g. a severe storm), which can provide the energy to move enormous quantities of sediment, gradually accumulated (stage II), over long periods. The sediment yield may consist of stored materials together with newly eroded material derived from stages I and II.

Recent research (McSaveney, 1978) suggests that rainfall (the specific parameters being storm frequency, intensity and duration) is the dominant determinant of the erosion rate and that the high rainfall (over 10 metres per annum in parts of the Southern Alps) provides the high energy required. He estimated that the erosion rate increases with approximately the cube of annual precipitation. Mosley (1978), and Howard (1978) note that this type of natural erosion is unaffected by vegetation and is unpreventable i.e. erosion which has already occurred provides a long term supply of sediment for movement through rivers. Therefore, even the best upper catchment conservation schemes may not solve the river sediment problem in the foreseeable future.

O'Loughlin and Pearce (1978) provide estimates of the age and magnitude of some of these stored deposits. As a corrollary, greatly increased slope erosion may only slightly increase sediment yields measured over the short term. Recent work (e.g. Howard, 1978; McSaveney, 1978; Adams, 1978) suggests that it is the high rainfall, high altitude and high energy situations which generate most of the erosion. Using McSaveney's estimated relationship between erosion and rainfall, it was shown that 1 km^2 in the main divide could produce 125 times the sediment with a rainfall event of 5,000 mm as it could with 100 mm. The implications for research and management effort are aptly summarized by Howard (1978): "...it is better to put the resources into 5% of the area which generates 95% of the problem".

Of course, 'the problem' may be that the processes which can be controlled or mitigated are the ones responsible for 5% of the problem; those processes responsible for 95% may be too big (i.e. involve too much energy) to handle. Mosley (1978) argues that control efforts should be concentrated, if possible, on those parts of problem areas where rates of dissipation of kinetic energy are low. Howard (1979) suggests that emphasis be placed on rehabilitating montane lands (below 1350 m). The economics of the problem remain to be worked out.

2.2 Transfer Mechanisms

The common explanation of erosion in stages I and II, and of storm flows of streams based on Horton's excess rainfall theories, is that they result primarily from the run-off of surface water. This view may not be valid for South Island mountain lands for several reasons. First, studies of soil frost (see O'Connor, 1976) suggest that frost heave plays a dominant role in detaching the soil; once detached it may be blown or washed off. Second, studies in some high country areas (e.g. Soons, 1970; Hayward, 1977) have shown that it is very rare for rainfall intensity to be such that rainfall exceeds soil infiltration capacity. In Hayward's study of a 385 ha catchment in the Craigieburn Range, it was found that the storm flows of streams were supplied by direct precipitation and by rapid sub-surface flow from adjacent riparian lands (riverbed gravel). Underground flows of water, travelling at rates of about 1m/day, did not affect storm flows. Thus the 'contributing area' responsible for storm flows is only a small proportion of the total catchment area. The bulk of precipitation (80-90 percent) leaves the catchment as stream flow and evapo-transpiration is low.

To the extent that these findings can be generalised to other high country sites (and this is a vital issue), storm flow and water yield may be less amenable to management than has been supposed in some quarters. Regarding storm flow, the major contributing areas are the stream channels and adjacent riparian lands. Therefore, retirement from grazing and revegetation of an entire catchment may have a limited effect for the purposes of controlling storm flow. Regarding water yield, the Torlesse data shows that 80-90 percent of precipitation appears as a stream flow and "(it) is difficult to conceive of any high country management practice which could significantly increase this yield" (Hayward, 1977).

2.3 Natural Erosion and Screes

Another basic issue concerns the implied assumption that man, being responsible for erosion, can and should work to repair his damage and prevent further accelerated or geological erosion. This fails to give emphasis to the fact that the high country, and New Zealand as a whole, is geographically youthful and the "erosion of mountains and production and fluvial transport of their sediments are geological norms in such a landscape" (O'Connor, 1976, p. 8). Man is certainly not entirely responsible for high country erosion and it is by no means clear what proportion of erosion is man-made compared with what would occur naturally. The long term sediment yield from the Lake Hawea (Little Hopwood Burn catchment) has been estimated at some 1,500 tonnes/km^2 of catchment per annum (McSaveney, 1978). The catchment is not grazed by domestic stock or burned and has low levels of feral stock; geological erosion rates in high rainfall alpine catchments are naturally high. Watt (1978, p. 3-4) also points out that natural erosion operates over a very large range of intensities; this makes the assessment of man's contribution to erosion even more difficult to identify.

This leads into the question of how much erosion might be preventable. The only study which provides some empirical estimates is that of the Shotover River catchment in Otago concerning the impact of alluvial and slope restoration over 20 years. This research suggests a 40 percent reduction in Shotover River sediment loads, made up of a 50 percent reduction in alluvial sediment (from river banks and bed) and a 33 percent reduction in slope erosion (mass movement, gully erosion and sheet and wind erosion). Slope erosion was estimated to be responsible for 62 percent of the sediment and alluvial reduction for 38 percent. The costs of achieving this 40 percent reduction were not estimated. The geology of this catchment is not typical of the South Island high country, consisting of highly fractured non-resistant schists.

Howard (1978) argues that high altitude screes and scree creep erosion have attained an unwarranted level of importance. He points out that they are not the result of man's malpractices, but are old features (1000-8000 years B.P.) predating human occupation, which have been without vegetation since their formation. They do not constitute severely eroding or erosion-prone land, do not choke river beds with gravel and the majority do not threaten any downstream interests. Thus Howard (1978, 1979) considers that the current concern to revegetate screes and to destock land simply because it includes screes is not justified.

In summary, it is important to emphasize the gaps in present knowledge about these physical processes. Any objective economic assessment of policy and management options, in terms of their relative costs and benefits for soil and water conservation, are difficult at best. Citing NWASCO (1978, p. 18), "First...we know little of the quantities of materials involved in the condition of our mountain catchments; second...our knowledge of the processes that change the condition of mountain catchments and determine their water and sediment yields is almost entirely descriptive".

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4 The report (NWASCO, 1977, p. 19) foreshadows a programme of research on both small and large catchments from within a broad transect across the Southern Alps at the Rakaia River. The main aim of the programme is to quantify what is at present known only in a qualitative sense. For some preliminary findings, see McSaveney (1978).

Policy and programme analyses are also made difficult by the diversity between catchments and between basins within catchments and between sites within basins. It is easy, notes Watt (1978, p. 45), "to extrapolate, to bestow on the unknown something of our knowledge from the known; to expect a catchment to behave similarly to another because superficially they look reasonably similar...Every catchment is different and...we need to be constantly reminding ourselves of this". Such local variation "calls into question the necessity of catchment-wide treatments...for the correction of what may be local phenomena". (O'Connor, 1976, p. 9).

2.4 The Influence of Grazing and Revegetation

The early official statements on high country erosion (e.g. DSIR, 1939, 1945) emphasised the maintenance and improvement of vegetative cover as protection against soil erosion. They saw a healthy vegetative cover as dependent upon 'correct land use' - a just compromise between the requirements for erosion control and the fullest economic use of the land. Reporting the situation as at 1942, DSIR (1945) classified some 78 percent of the high country as significantly eroded, including 25 percent with less than 50 percent of the topsoil remaining.

Overstocking and regular burning of tussock grasslands came under close scrutiny. Zotov (1939) noted that as early as 1965, Buchanan had warned against such practices especially the annual burning off of vegetation to encourage the growth of more palatable grasses and to allow sheep to penetrate dense tussock lands. Such practices continued almost unaltered until the late 1930's, and brought with them a progressive deterioration of carrying capacity. Zotov pointed out that tussocks were eventually destroyed by burning and that this resulted in the loss of other, more palatable species. Zotov criticised the view that removal of stock alone would result in rapid spontaneous re-vegatetion because in many areas there were virtually no desirable species remaining. This had already been demonstrated by Cockayne's research in Central Otago, reviewed by O'Connor (1979), in the 1920's at altitudes between 300 and 800 metres. He recommended the sowing back of snow tussocks first which would shelter the growth of palatable species (which would also have to be sown).

The early 1970's saw a developing concern as to what was happening to retired land (Ministry of Works, 1972). Connor (1974) reported that, as at August 1974, no rehabilitation measures had taken place and that no overall improvement in vegetative cover had occurred on retired class VIII lands. In fact, a progressive deterioration appeared more likely and this was supported by the research of Dunbar (1970), Wraight (1964) and Dick (1978).

Soil fertility is the dominant influence on plant growth up to 1500 m (Nordmeyer et al., 1974). The yellow-brown earths have a low level of essential nutrients (especially nitrogen, phosphorus, potassium and magnesium) for plant growth. These are generally adequate to support slow-growing native species, provided they are undisturbed. However, the top layers of soil contain most of the total plant nutrients. If vegetation is damaged (e.g. by fire or excessive grazing by animals) then climatic forces, particularly frost and wind, will work to remove the top layers of soil. Depending on the extent of vegetation damage, it may be extremely difficult for revegetation to occur on eroded soils in the absence of protection. Revegetation either needs the protection of an existing vegetative cover or fertiliser to allow it to grow sufficiently in the first season to be able to withstand frost heave during winter.

The importance of vegetative cover, which is fundamental to soil and water conservation, results from:

(i) Reduced soil erosion through interception of rainfall which reduces raindrop impact; vegetative litter retards surface flow and further reduces impact.

(ii) Reduced flooding downstream, especially from small catchments, by

- (a) moderation of storm peak flows;
- (b) reduced river bed aggradation because of reduced debris being carried by rivers.

(iii) Improved water quality.

The following questions provide a focus for the remainder of this discussion:

(i) Will eroded high country revegetate naturally if stock is removed or will it require assistance?

(ii) Should native species only be planted or should exotics be used?

(iii) Are woody species or grasses/legumes the most effective cover?

(iv) How should the vegetative cover be planted?

(v) What fertiliser requirements are necessary to assist the revegetative process?

(vi) How costly is revegetation?

These questions are discussed with the following altitude zones in mind (after Nordmeyer, 1978):

A.	1700 and above.	Altitude limit for vegetative cover growth.	Retire from grazing. Extremely slow revegetation.
B.	1700 down to tree line.	Considerable exposed soil between tussocks.	Treatments with legumes/grasses, well fertilised should improve soil cover and, later, increase tussock size. European green alder and mountain pine will grow steadily.
C.	Below tree line.	Few areas of eroded country have not been under forest in the past.	Various trees will establish and grow well on eroded sites. Legumes/grasses, well fertilised.
D.	Below 1000 M.		Production forest viable.

2.4.1 Unassisted Revegetation

Where the removal of stock (plus control of wild animals) will result in natural re-vegetation depends primarily on the inital condition of the vegetative cover, its palatability to animals, and the soil quality/ slope/aspect/altitude involved. In general, it seems that unless there is a favourable environment (i.e. altitude of approximately 1000 m or less, reasonable soil cover, good rainfall and gentle sunny slopes), and a reasonable vegetative cover to begin with to provide seed, spontaneous revegetation by natural species will be very slow (O'Connor, 1975; Dunbar and Adams, 1972; Wardle, 1972). This results from slow growth rates and limited seed production of tussock grasses and a soil cover where a high proportion of the available plant nutrients have been removed, and which is subject to frost heave and high winds. Kelland (1974) notes that the top 20 cm of soil contains 50 percent of the total nitrogen and phosphorus and up to 80 percent other elements. Wardle (1972) studies primary succession on bare surface gravel deposited on river bed flats at 1100 m in the Craigieburn Range between 1960 and 1968. He reports (Wardle, 1972 and pers. comm.) studies in Westland, with higher soil fertility and rainfall than is general in the South Island, on fresh, unweathered material. At 1000 m he estimates snow tussock would be fairy well established in 80-100 years and, on silted material between moraines, that a fairly complete cover could be expected in about 200 years. A well developed soil profile and dense Chionocholoa could occur in several thousand years time.

Dunbar et al. (1977) have plotted the course of revegetation on a number of highly eroded South Island high country sites between 1966 and 1976. Earlier research of TGMLI had shown that a first step in the re-establishment of a stable soil surface was via a well fertilised grass-cover mixture and it was hoped that this would encourage the growth of native species. Significant spontaneous re-establishment of native species has been noted at most plots. This suggests the possibility of a direct progression from well fertilised pasture species to slower growing native species. The progress will, however, be slow and requires the complete exclusion of grazing animals.

2.4.2 Native Vs Exotic

This is partly a matter of biologic conservation (e.g. Wardle, 1977). Given their relatively slow growth rates, native species are a distinct disadvantage in colonizing eroded subsoils. Nitrogen and phosphorus fertilisers are needed to give satisfactory growth but even so, planted native species do not grow sufficiently fast for even moderate numbers to be able to withstand frost heave. Legumes such as white clover and Lotus, and some woody species, raise nitrogen levels in soil but do not compete well. Whilst there are long term hopes (e.g. Benecke, 1974; Dunbar *et al.*, 1977) to revegatate with native species, initial stabilisation of the soil, it seems, will have to be achieved with exotics.

2.4.3 Woody Vs Herbaceous

A related question is whether to plant woody species or to rely on a herbaceous cover. If the former are chosen for any site, then the species used will almost certainly have to be exotic. In the case of herbaceous cover, initial stabilisation with exotic species is necessary but this may give way to natural species - spontaneously (Dunbar *et al.*, 1977) or sown by man.

In a convincing paper, Nordmeyer (1978) has argued that the high on-site biomass of forests makes them the most effective way of treating and, more importantly, preventing erosion or erosion-prone surfaces. He suggests that some of the protection forests may be able to be carefully logged thus recouping the high costs of revegetating. This is an area where economic considerations will be the major determinant.

There are encouraging indications that the direct seeding of some woody species can result in the revegetation of high country eroded slopes in zones B and C. Research carried out by the New Zealand Forest Service since 1954 (Ledgard, 1974, 1976; Benecke, 1974) has identified Pinus contorta, P. mugo and Alnus viridis as woody species which appear to be most well adapted to the soil and climatic conditions. In order to protect planting from frost heave, temporary herbaceous cover is essential for woody species to establish over 1000 m.

2.4.4 Fertiliser Requirements

The grass/legume cover typically requires fertiliser application for successful establishment (although too much fertiliser causes competition between grass/legumes and tree seedlings) plus innoculation of seed with mycorrhizal fungi to hasten growth. Research has been carried out (e.g. O'Connor and Lambrechtsen, 1967; Holloway, 1970; Dunbar, 1970, 1972; Dunbar and Adams, 1972) which indicates that exposed infertile subsoils can support some useful grass/legume species, provided sufficient fertiliser is applied. It is soil quality rather than climate (in other than zone A) which is the main limiting factor (Holloway, 1970). Phosphorus and nitrogen in particular are needed for the plants to grow sufficiently in the first season to withstand frost heave and wind.

2.4.5 Maintenance

Revegetation has several phases: first the establishment of cover on bare subsoil (which depends on heavy fertiliser applications) to counter ice-needle formation; and second, survival, either indefinitely or until trees or native grasses can become established. Grass/legume varieties with pioneering attributes (e.g. Yorkshire fog) may be replaced by colonizing types such as Chewing's fescue and browntop. Dunbar (1970, 1971) points out that maintenance fertiliser applications are essential for introduced vegetative cover on exposed surfaces to persist beyond three years. Some indication of the high expense of revegetation is indicated in Table 1.

2.5 Implications for Economic Analysis

A recent article by O'Connor (1979, p.28) has reviewed the major trends in mountain revegetation studies. His conclusion is worth reporting here:

> "The success of high altitude revegetation techniques has not been universal nor is it confined to primary recolonisation. As shown in this review, success in some situations extends to pasture rehabilitation, to forest establishment and to succession towards tall tussock grassland. The costs of such treatment are not low and there is need and opportunity for further economy. Only in some cases of riparian land is it likely that revegetation will be justified by its downstream benefits. In some circumstances there may be justification in offsite water yield. In many roading cases it may be justified as landscape cosmetics. Its most common justification, where justification is possible, is likely to

TABLE 1

Some Costs of High Country Revegetation

Activity			Costs ($/ha.)	Source
Hand planting of exotic trees			300-800	Ritchie and Davis (1974)
Oversowing legumes/ grasses/tree seeds/ fertiliser			200-300	Baker (1974)
Handplanting tree and shrub species, close planting			up to $2,000/ha.	Baker (1974)
Aerial Spreading				
	Seed	Fertiliser		
Helicopter	84	163	(gullies)	Ritchie and Davis (1974)
		84	(faces)	
Small fixed wing	19	15-54	(mixed seed and fertiliser)	
DC-3	7	21-24		

> be in its productive use of what was hitherto a wasting asset. Just as the montane tussock grasslands might be demonstrated to be a net cost to the nation unless we accelerate their development for primary production, recreation, nature conservation and other uses, so also the subalpine and alpine areas of the mountains may remain for us a net cost, unless we quickly develop ways of integrating on them the range of uses for which they can be demonstrated to be suitable. Revegetation in all its forms should be recognized as the technological key so such goals and objectives for high mountain land use."

From the foregoing selective review it will be clear that there is a good deal of uncertainty as to the precise nature of the erosive processes, stream flow and the course of revegetation. If, for example, it is randomly occurring extreme events which are responsible for most of the movement of sediment in streams, and most of the transported material derives from material already in storage, man may be powerless to prevent flooding and deposition of material lower down. The present rates of erosion may be the norm for mountains of this age and the influence of man on these rates may not be significant. Again, if the "contributing area" theory of stream flow, as proposed by Hayward, is generally relevant, then retirement of land and grazing and its revegetation may have no impact on stream flows. Furthermore, even if the knowledge necessary to control erosion became available, to effect a noticeable reduction in erosion losses could prove very costly.

CHAPTER 3

THE COST-BENEFIT FRAMEWORK

3.1 Introduction and Definition of Terms

Governments are basically concerned with maximising the present welfare of society with due consideration for the future. For any particular action, the government seeks to maximise the difference between social benefits and social costs. Cost-benefit analysis (CBA) is an aid to government decision making, being used to assess public projects where the market mechanism does not provide an adequate indication of the costs and benefits to society. The aim is to identify and measure the gains and losses in economic welfare of the project in question. This includes all benefits and costs, not only those involving cash flows nor only those accruing to the agency undertaking the project.

Stated simply, CBA has four aspects, viz.

(i) Identification of all relevant benefits and costs associated with the project.

(ii) Valuation of each of these benefits and costs, where possible.

(iii) Discounting the future stream of estimated net annual returns.

(iv) Calculating one or more appropriate measures; the internal rate of return, the net present value and the benefit:cost ratio.

The last two of these aspects are basically arithmetic but the first two may pose problems for the economist. This is not the place for a thorough consideration of CBA but certain important features are relevant to this study and need to be identified and considered.

The standard textbooks distinguish between two types of tangible (i.e. measurable) impacts - primary costs and benefits resulting from a government action (i.e. those occurring within the boundaries of the project with impacts on the cash flows of the sponsor(s) of the project) and externalities (i.e. impacts occurring outside the project boundaries or non-sponsors of the project, which may be measurable in money terms). An example of tangible externalities, cited by Pigou (1932, p. 185) were the additional costs of washing clothes in Manchester ("a smokey town") as compared with Harrowgate ("a clean town"). The extra costs (estimated at 7½d per household per week) of washing clothes in Manchester resulted from coal-burning factories but the costs were borne by households. Therefore the costs of the factories' operation to society were greater than they were to the firms operating the factories.

On the other hand, the impacts may be intangible either because the market does not measure them at all or does not measure them adequately. Another example from Pigou concerns afforestation, where "the beneficial effect on climate extends beyond the borders of the estates owned by the person responsible for the forest". In such a case, social benefits exceed the private benefits accruing to the owner of the forest. Intangible costs and benefits should be mentioned in a CBA report. Sometimes they prove crucial and outweigh the net quantifiable impact.

3.2 Conceptual Limitations

There has been, in some quarters, an over-enthusiastic opinion of CBA as an objective value-free technique which greatly simplifies political decision-making as regards economic projects because the costs and benefits could be expressed in a common measure of exchange value. However, CBA has a number of limitations even assuming that the analysis has been carried out with a high degree of competence. The most important of these limitations, with respect to the present study, appear to be the following:

(i) Subjective valuations continue to form the basis of CBA so that economists can arrive at very different conclusions from the same basic set of data concerning some public expenditure decision. A good example of this is the re-evaluation by Hanke and Walker (1974) of the multi-purpose Mid-State Water Project in the United States. The comment that "Basic disagreements (between analysts on such matters as predictions about the future, evaluations of the performance of markets, beliefs about the economic role of the state etc.) cannot be avoided, regardless of the degree of technical refinement" (Hanke and Walker, 1974, p. 899). Another example concerns the evaluation of the Ord River scheme in Western Australia (Cannegieter, 1964, 1965a, 1965b; Bowen, 1964, 1965a, 1965b; Campbell, 1964, 1965; Musgrave and Lewis, 1965a and 1965b).

(ii) Not all the consequences of public decisions may be amenable to economic evaluation. Often, in fact, economic considerations are relatively minor in the eyes of the decision makers. CBA may be used to provide economic "justification" for decisions which have already been made. An important related point is that CBA is normally optional rather than mandatory (Parish, 1976) and hence is applied only in a limited number of cases.

(iii) Economists have generally accepted the view that "when evaluating the net benefits or costs of a given...project, the costs and benefits accruing to each member of the... nation...should normally be added without regard to the individuals to whom they accrue (Harberger, 1971, p. 785). In other words, that the distribution of benefits of costs from a project is irrelevant because distribution is assumed to have been taken care of, independent of CBA criteria. This view has been strongly challenged (e.g. Stewart, 1975). She contends (1975, p. 33) that "to select projects in such a way that net benefits are maximised is meaningless as a criterion of selection, until one has defined whose benefits one is talking about". It is possible to have projects which increase aggregate output and efficiency, and are judged highly successful by CBA, which nevertheless have clear negative impacts on the employment and incomes of the poorer sections of the population (e.g. Tyler, 1979).

(iv) There are specific problems in the use of CBA in the evaluation of environmental policies. The major problem resolves around the identification and measurement of benefits, especially externalities (Unger _et al_., 1973; White, 1978).

There are some means of dealing, at least in part, with some of these limitations. For example, in the case of the subjectivity of analysts, ranges can be identified within which the estimated impact is considered likely to fall and estimates made of the sensitivity of the measures to changes in these impacts. Mishan comments that even where the items are not sold in markets and therefore cannot be valued, the economist can still make some contribution:

> The least he can do is to reveal clearly the area of ignorance. After measuring all that can be measured with honesty, he can provide a physical description of the spillovers and some idea of their significance. Secondly, he may offer a guess, or a range of guesses, of the value of damage to be expected...Thirdly, he can have recourse to contingency calculations, these being the estimates of a critical magnitude for the spillovers which will just offset the excess benefits of a project that is calculated in disregard of the spillovers.(Mishan, 1972, p. 175-7).

3.3 Measurement Problems

The benefits of soil conservation and water management activities may be on-site or off-site (sometimes termed upstream and downstream effects respectively). If has been usual to consider in any detail only the off-site benefits of conservation work in the high country (e.g. Poole, 1973). For example, production and population are typically concentrated on a limited area backed by a large area of steep, erosion-prone mountain country, in order to provide adequate flood protection to the lower area (i.e. an off-site benefit), careful management of the watershed is required, or alternatively, river control works. There are a number of on-site benefits (e.g. recreation, tourism, conservation of native flora) which are more difficult to quantify and which, in monetary terms, could be more or less important than the off-site benefits. For the purposes of this study the on-site benefit of the increase in stock units attributable to a SWCP is used as the benefit measure.

The following tables present a listing of the possible off-site and on-site benefits of SWCP's from a national and occupier viewpoint.

Costs, as reported in Tables 2 and 3, are generally straight forward to measure. It is the benefits which cause problems for analysts. The benefits which may be derived from soil conservation and water management programmes on any piece of land may be further classified as follows:

(i)	On-site benefits	a.	With production implications.
		b.	With no production implications.
(ii)	Off-site benefits	a.	With production implications on the same property.
		b.	With production implications elsewhere.
		c.	With no production implications.

TABLE 2

Benefits and Costs of SWCP's - National Viewpoint

Benefits	Costs
1. Increased net income (weighted for foreign exchange content).	1. Total works costs include: a. Government grant. b. Local share (weighted for foreign exchange content).
2. Soil and Water Conservation. a. In hill and high country. b. On productive land lower down.	2. Extra on-farm costs not eligible for government grant.
3. Saved damages to public. a. Reduced flooding. b. Improved water quality.	3. Operation and maintenance.
4. Alternative uses of destocked land (eg. recreation).	

TABLE 3

Benefits and Costs of SWCP's - Occupier Viewpoint

Benefits	Costs
1. Increased net income.	1. Private share of total works.
2. Reduced costs of flooding.	2. Extra on-farm costs not eligible for government grant.
3. Saved rantal rates and dues on surrendered land.	3. Maintenance costs of on-farm works.

Category (i)a. benefits are fairly straight forward. For example, Howard (1979, p. 35) notes as a proof of the value of soil conservation work by Catchment Authorities in co-operation with runholders, that "a large area of well vegetated lower and mid-altitude land (has been) restored to enhanced levels of production". Category (i)b. benefits may occur where land is destocked and retired from grazing. As a result, vegetative cover may improve which has no on-site implications for production. Two types of (i)b. benefits may occur where land is destocked and retired from grazing. As a result, vegetative cover may improve which has no on-site implications for production. Two types of (i)b. benefits may be identified: there may be aesthetic and related values of improved vegetative cover, and there may be non-production effects which nonetheless have value such as increased leisure time.

As regards off-site benefits, category (ii)a., benefits commonly occur where destocking is agreed to under a soil and water conservation plan. Other land on the property is improved in order to accommodate the stock previously grazed on the destocked land. Category (ii)b. benefits may occur where the productive potential downstream land or other assets is enhanced, e.g. if pastoral or agricultural lands are made less prone to flooding. Category (ii)c. benefits may occur, for example, when the downstream assets protected are not productive units, although they may have productive implications, e.g. roads, bridges, and houses. Commonly, there will be combinations of benefits, especially (i)b. with (ii)a. and (ii)b. It is possible to estimate these mangitudes, although the accuracy may not be high.

The author's judgement as to the feasibility of measuring each category of benefits is summarised in Table 4.

TABLE 4

Relative Ease of Measuring Benefits

		Relative Measurability
(i)a.	On-site, with production implications	Easy
(i)b.	On-site, without production implications	Difficult
(ii)a.	Off-site, with production implications	Easy
(ii)b.	Off-site, without production implications	Difficult
(ii)c.	Off-site, no production implications	Difficult

The benefits under categories (i)a. and (ii)a. can be expressed in stock unit terms and therefore, given appropriate gross margins, are relatively easy to value. Category (i)b. benefits are, by definition, intangible. The measurement of category (ii)b. and (ii)c. benefits has two related problems: firstly, the nature of the casual link between soil conservation and water management works and production has not been clearly established, and secondly, the precise extent of the impact has to be measured.

In rare instances it is possible to say that a certain amount of land would be lost to production in the absence of soil conservation measures. As one OCB SWCP for a downland farm comments:

> "The national contribution (grant) can be justified on soil loss only...It is difficult to equate the $4,384 national contribution with inches of topsoil saved, but it can be certain that at least 79 acres of land will go out of farm production if the gullies are not treated."

In virtually all cases, however, the SWCP's involve a mixture of practices spread over the whole property. Some are specifically designed to conserve soil through tree planting, tunnel gully treatment and retirement of land. Others are attempting to conserve soil by relating land use more closely to land capability, for example, conservation fencing, cattle proofing and aerial oversowing, and top-dressing. The latter are normally much more important than the former. The case quoted above was the only example found of an amount of land actually saved for production which could be directly attributed to the grant expended.

Of these cases where soil conservation aims are specifically mentioned, the following is a typical statement of aims:

> "From the national viewpoint, the expenditure (grant) is justified because (1) the improvement works will speed up the rate of restoration of severely depleted country (2) the promotion of management around land use capability ensures permanent, safe production (3) the revegetation of exposed soil areas will lead to no further soil losses."

Some progress towards the value of soil conservation activities might be expected from studies of the rate of revegetation on destocked areas. That is, an area may have lost vegetative cover to such an extent that soil conservation considerations require destocking of the land. If revegetation occurs, whether naturally or assisted, and the land is able to be returned to partial or complete grazing, then the value of this grazing could be regarded as a return on the investment in soil conservation practices. A summary of studies relating to revegetation is reported in Table 5. The studies primarily concern destocking land on high country properties.

Unfortunately, only a few of the OCBSWCP's (9 out of the 66 which have completed stage I) involve land retirement, and only 3 of these have had assessments made of the impact of destocking on revegetation. The measurements indicating improvement or otherwise are generally imprecise. More important is the fact that class VIIe and VIII land which has been destocked is unlikely to be returned to grazing. This is both the intention of the SWCP and the logical result of more intensive use of better quality land elsewhere.

On those properties where revegetation studies have been made of non-retired land, there is more prospect of measuring improvement of vegetative cover (as in the case of Bendigo Station) and it may be feasible to estimate

TABLE 5

Results from Studies of the Effects of Destocking under SWCP's, OCB

Location of Property	Dates of Assessment	Major SWCP Activities	Conclusions
Lindis Valley (Forest Range Stn)	1970,1975	a. Conservation fencing AOSTD (on-site) b. Set stocking replaced by mob or rotational grazing. c. Spelling of depleted land d. Stock units increased by over 100%.	Vegetation trend study: Annual grasses, weeds etc. increased slightly on all mid-altitude blocks (below 1000 m) and markedly on AOSTD blocks. Response to AOSTD on shady faces was far greater than on sunny faces. Temporary retirement of severely depleted sunny country, without AOSTD, for 3 years resulted in negligible natural revegetation.
Cromwell (Bendigo Stn)	1959,1971	a. Conservation fencing	Significant improvement in cover, especially on depleted tussock areas below 800 m, via spelling/ reduced grazing pressure. In 1959 51 percent property was classified as severely or extremely depleted or with no vegetation. In 1971, the figure was 29 percent.

Table 5 (Cont...)

Table 5 (Cont...)

Location of Property	Dates of Assessment	Major SWCP Activities	Conclusions
Mt Nicholas Stn	1961,1966, 1974		Line transects on Class VIII Land showed little recovery of tussock 10 years after stock removal. Fertiliser necessary to bolster native vegetation.

SOURCE: Otago Catchment Board.

returns which could be expected from areas with different degrees of vegetative cover.

3.4 Application and Usefulness

It has been shown that the scientific grounds upon which current destocking policy is based can be challenged. Most recently, Howard (1979) has presented an array of evidence which indicates that most alpine screes are relatively stable and are not therefore in need of remedial treatment. He considers that class VIIe montane zone land is by definition capable of long term primary production and that the permanent destocking of class VIIe land should not be generally undertaken. He considers that remedial work on vegetated class VIII alpine zone land can be justified in terms of on-site values as protection of existing vegetation; but he recommends greater attention to class VII montane zone land (900-1350 m) where severe erosion is common and where both soil protection and enhancement of production can occur via the strengthening of vegetative cover.

The fact that such important aspects of the foundation of current soil conservation and water management policy in the high country are currently being reconsidered means that attempts at identification and measurement of benefits of present and past policies may not be particularly illuminating from a policy viewpoint. For this, and practical reasons associated with administering soil and water conservation plans, the approach taken in this investigation has been to study the impact on production on the properties concerned, i.e. to concentrate on category (i)a. and (ii)a. benefits only. Such benefits are somewhat incidental to the main aims of soil conservation and water management policy. In the case of (ii)a. benefits, these derive from the public policy measures used to encourage occupiers to destock and give up control of severely eroded class VIIe and VIII lands. Yet they do have an important national benefit in the sense of increasing stock units and therefore foreign exchange earnings. Hence, the question to be answered by this study is: To what extent are stock numbers and performance different to what they otherwise would have been as a result of soil conservation and water management policy? In monetary terms, this involves a comparison of increased net income and a comparison of this with the three cost items listed in Table 2.

The main objectives of soil conservation and water management policy are benefits (i)b., (ii)b. and (ii)c. Benefits (i)a and (ii)a. are incidental, but they do form the means by which society encourages individual occupiers to act so as to achieve (i)b., (ii)b. and (ii)c. benefits. In other words, this last group of benefits are externalities as far as the occupier is concerned. Because of the difficulties involved in measuring benefits (i)b., (ii)b. and (ii)c., this study approaches the evaluation of soil conservation and water management policy from a reverse position, i.e. it treats (i)b, (ii)b. and (ii)c. benefits as externalities and measures (i)a. and (ii)a. benefits.

Assuming that the (i)a. and (ii)a. benefits accruing to the occupier are sufficient to make him adopt a SWCP (and thereby result, as externalities, in (i)b., (ii)b. and (ii)c. benefits), it may be asked why occupiers are subsidised at all? This question will be discussed in more detail later, but the short answer is that society presumably sees the need for swifter action than would be likely to result from the occupier, who considers only (i)a. and (ii)a. benefits, plus any intangibles which are important to him. In fact, the extent to which subsidies are preferred, over say, extension emphasising improved land management practices, (or to which compulsion is preferred over subsidies) depends on the extent of divergence between the interests of the occupier and society.

CHAPTER 4

DESCRIPTION OF PLANS UNDER STUDY

4.1 Introduction and Methodological Considerations

A SWCP is a document of about 120 pages describing the property's characteristics in terms of soil, vegetation and land capability classes, stock numbers and stock management practices, and its proposals for the improvement of soil conservation and for the use of the property according to its capability. SWCP's are drawn up in stages, a stage commonly lasting six years. Further stages beyond stage I may be undertaken according to the extent of the soil conservation problem on the property. As a result, SWCP's are individual documents, bear the mark of the soil conservator who drew them up and the year in which they were prepared, and take into account progressive policy changes or emphases.

It was initially intended to take a random sample of the 200 odd properties for which the SWCP's have been prepared, stratified by type of property.[5] The treatment of plans in an aggregated approach was impractical for several reasons:

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5 There have been evaluations of returns of SWCP's to individual properties (e.g. Johnson (1967, 1970), Ramsay and Diver (1971), Otago Catchment Board (1972), Johnson (1975)). To the author's knowledge there has been only one previous study which has attempted to evaluate a number of plans, that by Whitby (1979) for the Lower Waitaki.

(i) Within the main categories of properties in the OCB region (viz. high country, hill country and downland) there is great diversity as to size, physical conditions, the extent of the work required under the plan, and the stage of development of different properties. Some plans, for example, deal with the retirement from grazing of 60 percent and more of the property's area; other properties have no class VII or VIII land.

(ii) Different properties show very different rates of progress with their plans. For example, some plans were approved by the OCB but have not been taken up by the owners; other properties have been sold and the plan has not been carried on by the new owner; some plans have completed their first stage (commonly five years) and have stopped formal soil and water conservation work; others have begun a second stage plan.

(iii) The procedures used by the OCB in drawing up the plan, and in attempting to monitor its progress, have changed through time. For example, brief annual reports to the Board as to the progress of the various elements of the plan were introduced in 1972; the precise content of these annual reports has also varied over time. Another example concerns the fees charged by the OCB to property owners which have changed several times since 1970.

One other important constraint on the project has been the data limitations imposed as a result of the understandable desire of TGMLI not to subject occupiers to too many demands by researchers. For this reason, individual property holders were not questioned about their property or the operation of their SWCP. Consequently, a good deal of the data used in the study was from secondary sources. Given these difficulties it was decided that a more appropriate approach would be to study only those properties which had actually completed stage I of their plan, some 66 properties in all.

4.2 Basic Features of Otago SWCP's

Stage I SWCP's prepared between 1959 and 1978 number 202, and their status as at 31 October 1978 is summarised in Table 6. In addition, 47 stage II and four stage III plans have been prepared. These 207 plans cover about 26 percent of the total area of the OCB district. In addition, there were 34 plans under preparation and 13 applications for plans awaiting attention.

TABLE 6

Status of SWCP's Prepared by OCB, 1957-78

Status	Stage I Plan	Stage II Plan	Stage III Plan
Completed	66	8	0
Operative buy not yet completed	82	30	4
Started, stopped before completion*	33	1	0
Not taken up	21	8	0
TOTAL PREPARED:	202	47	4

* In most cases only a minor part of SWCP work was carried out.

Table 7 shows the distribution of completed plans between property types as classified by the Soil Conservation Planning Officer of the OCB. Most plans have been completed for the "hill country dry", and "high country dry" and "moist" categories. The years in which the plans commenced, classified by property type, are shown in Table 8. The commencement of plans was particularly concentrated in the 1965 to 1969 period. Property type by size is shown in Table 9. High country properties were normally in the 5000 to 6999 hectare size group, except for high country wet properties which were all above 9000 hectares. Hill country dry properties were concentrated in the 2000 to 2999 hectare range, but most of the hill country moist properties were below 2000 hectares. Downland properties were almost all below 1000 hectares.

Table 10 presents data on the composition of different land capability classes by property type. The median values calculated for the proportion of each broad property type belonging to each land capability class shows that high country properties had, on average, small percentages of class I-III and class VIII land, and roughly equal proportions of class IV-VI and class VII land. On hill country properties, class I-III land made up about 10 percent, class IV-VI about 60 percent and class VII about 30 percent. For downland properties, two thirds were made up of class IV-VI land, 16 percent by class I-III and 21 percent by class VII land.

TABLE 7

Completed OCB SWCP's 1957-78 by

Type of Property

		Frequency	Percent
High Country	dry	11	16.7
	moist	10	15.2
	wet	6	9.1
Hill Country	dry	22	33.3
	moist	7	10.6
	wet	2	3.0
Downland	dry	4	6.1
	moist	3	4.5
	wet	1	1.5
		66	100.0

TABLE 8

Completed OCB SWCP's 1957-78 - Type of Property by Year of Plan Commencement

Property Type		Year of Commencement 1957-59	1960-64	1965-69	1970-74	1975-77	Total
High Country	dry	2	1	7	1	0	11
	moist	0	2	4	2	2	10
	wet	0	2	3	1	0	6
Hill Country	dry	1	4	14	2	1	22
	moist	0	2	4	0	0	7
	wet	0	0	1	1	0	2
Downland	dry	0	2	2	0	0	4
	moist	1	0	0	2	0	3
	wet	0	0	1	0	0	1
		4	14	36	9	3	66

TABLE 9

Completed OCB SWCP's 1957-78 - Type of Property by Size

	Beginning Size of Holdings in Hectares[a]							
	Less than 1000	1000-1999	2000-2999	3000-4999	5000-6999	7000-8999	9000+	Total
High Country:								
dry	0	1	1	2	4	0	3	11
moist	1	0	1	2	4	1	1	10
wet	0	0	0	0	0	0	6	6
Hill Country:								
dry	4	7	10	1	0	0	0	22
moist	3	2	0	1	0	1	0	7
wet	0	1	0	1	0	0	0	2
Downlands:								
dry	3	1	0	0	0	0	0	4
moist	3	0	0	0	0	0	0	3
wet	1	0	0	0	0	0	0	1
	14	12	12	7	8	2	10	66

[a] These figures refer to property size at the start of the SWCP. Where retirement of land is involved, and this involves surrender from the Pastoral Lease, property sizes at the end of the plan were smaller.

TABLE 10

Completed OCB SWCP's 1957-78 - Type of Property by Land Capability Composition

Percent of Property Area	Land Capability Class			
	I-III	IV-VI	VII	VIII
High Country Properties				
0	6	0	0	7
1-20	20	5	2	17
21-40	1	7	7	3
41-60	0	12	11	0
61-80	0	2	5	0
81-100	0	0	0	0
Median Percent	4.6	44.0	48.5	5.6
Hill Country Properties				
0	1	0	2	25
1-20	23	0	8	6
21-40	7	4	14	0
41-60	0	13	6	0
61-80	0	11	1	0
81-100	0	3	0	0
Median Percent	10.7	58.5	27.9	0
Downland Properties				
0	0	0	1	4
1-20	5	0	3	4
21-40	3	1	4	0
41-60	0	2	0	0
61-80	0	3	0	0
81-100	0	2	0	0
Median Percent	16.0	66.0	21.0	0

Table 10 (Cont...)

Table 10 (Cont...)

* Recall that land use capability classes are defined by Soil Conservation and Rivers Control Council (1971) as follows:

Classes I to IV are considered capable of arable, pastoral or forestry use, with respective limitations classified as none, slight, moderate and severe; classes V to VII are considered capable of pastoral or forestry use only, with respective limitations classified as slight, moderate and severe; class VIII is defined as "protection land" and is considered totally and permanently unsuitable for production use; it is either eroded or liable to erosion if the cover is disturbed.

4.3 Planned Expenditures[6]

The planned expenditures on individual SWCP's, and their allocation between occupier and the state, are summarised in Tables 11 and 12. These show that an average plan costs (1978 prices) $33,000, two thirds of which is met by the occupier. Of the works eligible for subsidy, 40 percent were paid for by the state. Works not eligible for grant (and therefore fully paid for by the occupier) comprised one quarter of the total cost to the occupier and 17 percent of the total cost of the plan.

In addition to his share of the actual "costs of construction" of SWCP works, the occupier pays a "soil conservation fee" to the catchment board to cover the costs of drawing up the SWCP. The grant actually paid to the occupier is net of these fees. The way in which this fee has been charged to the occupier, and its magnitude, has varied a number of times over the period of the study. For convenience, and without significant loss of accuracy, this study assumes the preparation fee is included in the occupier's expenditures (as part of his share of works eligible for grant) and in the total expenditure on a plan.

---

6 The previous chapter presented physical data on 66 SWCP's; however, some data gaps led to the omission of four of these from the analysis.

TABLE 11

Planned Allocation of Expenditure for 62 SWCP's

(median values in 1978 prices)

		$
Occupier expenditure:		
Share of works eligible for grant	16,200	
Works not eligible for grant	5,600	
Total		21,800
State expenditure:		
Share of works eligible for grant		11,500
Total costs:		33,300

TABLE 12

Planned Relationships for 62 SWCP's, 1957-78

		Percent
Total cost of SWCP	- proportion to be met by occupiers	65.5
	- proportion to be met by state	34.4
Works eligible for grant	- proportion to be met occupiers	58.5
	- proportion to be met by state	41.5
Works not eligible for grant	- proportion of total cost	16.9
	- proportion of total costs to occupiers	25.7
Occupiers contribution to works eligible for grant as proportion of total cost		48.6

Destocking and retirement from grazing of class VIIe and VIII land was involved in nine of the 66 plans; the median area destocked was 1830 hectares.

4.4 Actual Expenditure and Cost Shares

Tables 13, 14 and 15 present data on actual expenditures made on SWCP's. Table 13 indicates a total expenditure of $1.67m on the plans, with 71 percent being made on high country properties, 25 percent on hill country properties and 5 percent on downland properties. Table 14 shows that of this $1.67m occupiers met 62 percent and the state met 38 percent. Of the expenditure on works eligible for grant, occupiers met 57.5 percent and the state the remaining 42.5 percent. Table 14 also shows that differences in the breakup of expenditure occurred between broad property types. In particular, the state met a considerably high proportion of the cost of works eligible for grant (and total costs) for high country properties than for hill and downland properties. High country wet properties received a much higher proportion of state assistance than did any other property type.

The data presented in Table 14 on the breakup of actual expenditure may be compared with the planned breakdown presented in Table 12. The allocations differ in only minor respects, although no data are available on farmers' actual expenditure on works not eligible

TABLE 13

Total Stage I Expenditure Shares on SWCP's by Property Type, 1957-78 (in 1978$)

Property Type	No. of Properties	Occupier Costs: Share of Grant Works	Occupier Costs: Non-Grant Works[a]	State Grant	Total
High Country					
dry	11	239,039	59,759	152,151	450,949
moist	10	227,250	56,812	148,826	432,888
wet	6	79,038	19,759	201,658	300,455
Subtotal:		545,327	136,330	502,635	1,184,292
Hill Country					
dry	20	183,776	45,944	81,396	311,116
moist	7	49,135	12,283	23,524	84,942
wet	2	16,530	4,132	7,361	28,023
Subtotal:		249,441	62,359	112,281	424,081
Downland					
dry	4	25,040	6,260	13,768	45,068
moist	1	8,585	2,146	5,432	16,162
wet	1	4,268	1,067	1,534	6,869
Subtotal:		37,892	9,473	20,734	68,099
Total:	62	832,660	208,162	635,650	1,676,472

[a] Estimated to be 25 percent of total occupier costs, as indicated in Table 12.

TABLE 14

Percentage Shares of Average Stage I Expenditure by Property Type, 1957-78

	High Country			Hill Country			Downland			Total
	d	m	w	d	m	w	d	m	w	
Total SWCP cost										
- proportion met by occupiers[a]	66.3	65.7	32.9	73.9	72.4	73.7	69.5	66.4	77.7	62.1
- proportion met by state	33.7	34.3	67.1	26.1	27.6	26.3	30.5	33.6	22.3	37.9
Works eligible for grant										
- proportion met by occupiers	61.1	60.4	28.2	69.3	67.6	69.1	64.5	61.2	73.6	57.5
- proportion met by state	38.9	39.6	71.7	30.7	32.4	30.9	35.5	38.8	26.4	42.5
Works not eligible for grant[a]										
- proportion of total cost	13.2	13.1	6.6	14.7	14.4	14.7	13.9	13.3	15.5	12.4

[a] Assumes works required to be carried out by occupier but not eligible for grant, were 25 percent of the value of works eligible for grant assistance.

TABLE 15

Stage I Median Expenditure Shares on SWCP's by Property Type, 1957-78 (in 1978$)

Property Type	No. of Properties	Occupier Costs: Share of Grant Works	Occupier Costs: Non-Grant Works[a]	State Grant	Total
High Country					
dry	11	12,618	3,154	12,388	28,160
moist	10	22,019	5,504	13,177	40,700
wet	6	7,802	1,950	19,735	29,488
Hill Country					
dry	20	8,380	2,095	3,706	14,181
moist	7	6,793	1,698	2,483	10,974
wet	2	8,265	2,066	3,680	14,011
Downland					
dry	4	6,516	1,629	3,517	11,662
moist	1	2,146	5,432	5,432	16,162
wet	1	4,268	1,067	1,534	6,869

[a] Estimated to be 25 percent of median occupier costs, as indicated in Table 12.

for grants. Table 15 shows typical expenditures on plans on properties for each property type. Medians are used rather than means to account for the effect of a typically skewed distribution of expenditures. Several general conclusions can be made.

Firstly, high country properties have had three times the total expenditure as have hill and downland properties. Secondly, high country properties have had four times the level of state grants as have hill and downland properties. Thirdly, the proportion of state grant to total cost is particularly high for high country wet properties. Table 16 shows the main types of works carried out under SWCP's, and the proportion borne by the state, through grants, and the occupiers. Conservation fencing and on-site aerial oversowing and topdressing were the major items, and for both, occupiers paid two thirds of the total costs and the state one third. In the case of retirement fencing, over 90 percent of total costs were met by the state.

Table 17 shows that stock units increased by an average of 35.6 percent for all properties between the start and end of the plan (a median time of six years).

TABLE 16

Cost of Main Types of Work Completed for 66 SWCP's, Stage I (in 1978$)

	Total Cost	State Grant	% of Total	Occupier Share	$ of total
Retirement fencing	232,056	213,355	91.9	18,701	8.1
Conservation fencing	539,856	171,927	31.8	367,929	68.2
Cattle Proofing	106,798	32,738	30.7	75,060	69.3
AOSTD (offsite)	134,259	47,812	35.6	86,446	64.4
AOSTD (onsite)	361,312	121,343	33.6	239,969	66.3
All other	186,584	71,804	38.5	114,779	61.5
TOTAL	1,560,865	657,979	42.2	902,884	57.8

TABLE 17

Stock Unit Changes on OCB Region Properties with SWCP's

	No. of Properties	Median Years to Complete SWCP	Sheep (su)			Cattle (su)			Total (su)		
			Start of SWCP	End of SWCP	% change	Start of SWCP	End of SWCP	% change	Start of SWCP	End of SWCP	% change
High Country											
dry	11	6	50,765	72,488	48.2	5,377	14,737	358.1	56,142	87,225	55.4
moist	9	6	45,374	57,180	26.0	5,640	7,519	33.3	51,014	64,699	26.8
wet	6	6	43,393	48,663	12.1	10,970	13,604	24.0	54,363	62,267	14.5
			139,532	178,331	27.8	21,987	35,860	63.1	161,519	214,191	32.6
Hill Country											
dry	20	6	51,611	67,957	31.7	8,211	19,663	139.5	59,822	87,110	45.6
moist	7	6	19,295	25,332	31.3	3,333	6,160	84.8	22,628	31,492	39.2
wet	2	5	11,950	14,397	20.4	4,670	6,035	29.2	16,620	20,432	22.9
			82,856	107,686	30.0	16,214	31,858	96.5	99,070	139,034	40.3
Downland											
dry	4	7	5,728	7,756	35.4	75	352	369.3	5,803	8,108	39.7
moist	1	3	1,400	1,557	11.2	245	335	36.7	1,645	1,892	15.0
wet	1	9	1,683	1,975	17.3	56	500	792.8	1,739	2,475	42.3
			8,811	11,288	28.1	376	1,187	215.7	9,187	12,475	35.8
			231,199	297,305	28.6	38,577	68,905	78.6	269,776	365,700	35.6

CHAPTER 5

EVALUATION

5.1 Interpretation of the Data

Although the data used in this study are drawn from completed SWCP's, there are reasons for not attempting a rigid *ex post* evaluation. Firstly, there are some unfortunate gaps in the data on production levels, e.g. stock numbers at the start and at the end of the plan are known, but the SWCP records do not reveal whether changes resulted from market transactions or breeding, nor do they contain a complete record of sale/purchase patterns during the plan's operation. As other government policy influences during the period of the plan are included, it would not be appropriate to attribute the total change in stock numbers to the SWCP.

Secondly, since gross margins depend on relative prices and costs, differences in price levels over time mean different rates of return to SWCP's operating over different time periods. Therefore, the approach adopted was to use prices prevailing at a single point in time and project income on that basis.

Thirdly, the analysis assumes the experience of completed SWCP's will be useful to predict the likely course of SWCP's in the early 1980's. Owing to the difficulties of separating out the influence of other policies, and for many other reasons already discussed with regard to data quality, the results reported in this chapter are subject to considerable margins of error.

5.1.1 Changes in Stock Units

As noted earlier, the measurable benefits of SWCP's were confined to increases in stock units. There have been impressive increases in stock numbers on almost all properties during the course of their SWCP. Besides the SWCP, these increases could also be attributed to:

(i) The owner may have made other changes or carried out other projects which may have added to the capacity of his property, prior to or at the same time as the plan was operating. However, it is probably reasonable to assume that the subsidised plan works represent the main development effort during the period in which the plan was operating.

(ii) The property may have been originally operating below its stock carrying capacity, and increased stock numbers may reflect an increase towards this limit rather than representing an increase in capacity as a result of the plan.

(iii) Stock numbers *per se* may vary because of the changing composition of flocks and herds. For example, an important change in the 1970's has been a move away from wethers into all ewe flocks. Insofar as carrying capacity rather than simply stock numbers is being evaluated, this will not be misleading.

(iv) The full impact of the scheme in terms of stock numbers may be felt some time after the completion of the SWCP.

In the present study, there is little doubt that without a SWCP some development would have occurred on some of the properties. One indication of this is the extent of stock unit increases on high country properties which are available for the period 1965/7 to 1976/8 from the Tussock Grasslands and Mountain Lands Institute

High Country Production Surveys (Kerr _et_ _al_., 1979). These are presented in Table 18 for high country dry, moist and wet properties in the OCB region, classified by whether or not the property had a SWCP in operation or had completed a SWCP.

This table shows several interesting points. Firstly, it confirms that properties with SWCP's are larger, in terms of stock units, than those without, and almost certainly were larger before their plans began. Secondly, it reveals different rates of growth of stock units over the eleven year period. The rates of growth are compared in Table 19. These data provide information which helps ascertain what the situation would have been in the absence of SWCP's, and therefore what benefits can be attributed to them.

The ratios of the rates of increase of cattle and sheep stock units on properties without SWCP's are shown in the bottom rows of Table 19. Between 1965/7 and 1971/3, sheep stock units on properties without SWCP's increased by 10.6 percent compared with a 12.6 percent increase for properties with SWCP's, i.e. properties without SWCP's had 86 percent of the increase of those with SWCP's. The comparative figure for the period between 1971/3 and 1976/8 was much lower at 11 percent. This suggests that the longer term impact of SWCP's on stock units may be more important than the immediate impact occurring during the course of the SWCP.

TABLE 18

Stock Units for High Country Properties With and Without SWCP's, OCB Region, 1965/7-76/8

		1965/7		1971/3		1976/8	
	No.	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle
High Country Dry							
Without SWCP	11	38,244 (3,477)	3,080 (280)	40,831 (3,712)	5,702 (518)	43,770 (3,979)	5,475 (498)
With SWCP	22	87,295 (3,968)	9,514 (432)	104,084 (4,731)	22,139 (1,006)	119,381 (5,426)	20,326 (924)
High Country Moist							
Without SWCP	29	99,800 (3,441)	13,436 (463)	119,395 (4,117)	36,103 (1,245)	115,995 (4,000)	39,558 (1,364)
With SWCP	28	100,860 (3,602)	13,380 (478)	123,478 (4,410)	37,495 (1,339)	148,430 (5,301)	39,163 (1,399)
High Country Wet							
Without SWCP	14	43,920 (3,137)	19,213	40,981 (2,927)	35,608 (2,543)	45,955 (3,064)	31,700 (2,113)
With SWCP	17	90,725 (5,337)	29,277 (1,722)	85,660 (5,039)	61,546 (3,620)	106,398 (6,259)	68,815 (4,048)
All Otago OCB High Country							
Without SWCP	54	181,961	35,729	201,207	77,413	205,720	76,733
With SWCP	67	278,800	52,171	313,222	121,180	374,209	128,304

SOURCE: Derived from Kerr et al. (1979)

Note: Bracketed figures refer to mean stock units per property.

TABLE 19

Median Percentage Growth Rates in Stock Unit Numbers for High Country Properties With and Without SWCP's, OCB Region 1965/7 - 76/8

	1965/7 - 71/3		1971/3 - 76/8	
	Sheep	Cattle	Sheep	Cattle
High Country Dry				
Without SWCP	6.8	85.1	7.2	-4.0
With SWCP	19.2	132.7	14.7	-8.2
High Country Moist				
Without SWCP	19.6	168.7	-2.8	9.6
With SWCP	22.4	180.2	20.2	4.5
High Country Wet				
Without SWCP	-6.7	85.3	12.1	-11.0
With SWCP	-5.6	110.2	24.2	11.8
All OCB High Country				
Without SWCP	10.6	116.7	2.2	-0.9
With SWCP	12.3	132.2	19.4	5.9
Without as a Proportion of With	0.86	0.88	0.11	0.15

SOURCE: Derived from Kerr *et al.* (1979)

There was an absolute fall in cattle numbers on Otago high country non-SWCP properties between 1971/3 and 1976/8. Excluding the SWCP properties, stock unit figures for the region would have remained virtually constant between 1971/3 and 1976/8. Because of the variation between years, Table 19 does not provide a clear answer to the question of what impact SWCP's had on stock numbers. Furthermore, no data are available on stock unit increases on non-SWCP hill and downland properties, hence whether a similar trend holds is not known. This implication is considered further in Section 5.4

5.1.2 Other Impacts

The production impacts of SWCP's can also be inferred from changes in the numbers of stock purchased and sold. Table 20 shows the number of sheep traded for three periods, 1976/7, 1971/3 and 1976/8. It is apparent from these data that properties with SWCP's initially purchased and sold many more sheep than those without (except for high country moist in 1965/7), and that trading of those with SWCP's grew relatively more rapidly, especially between 1971/3 and 1976/8. Sales of sheep grew by 41.9 percent between 1965/7 and 1971/3 for properties with SWCP's, and 36.5 percent for those without plans. The respective figures for 1971/3 to 1976/8 were 23.0 and 4.3 percent.

TABLE 20

Sheep Sold and Purchased on OCB High Country Properties

With and Without SWCP's, 1965/67 - 1976/78

	1965/67		1971/73		1976/78	
	Sold	Purchased	Sold	Purchased	Sold	Purchased
High Country Dry						
Without SWCP	17,346	491	20,321	667	23,154	275
With SWCP	41,166	1,862	58,964	1,834	70,219	2,704
High Country Moist						
Without SWCP	40,667	7,529	56,174	7,389	57,889	10,286
With SWCP	36,177	2,662	58,560	5,504	70,873	3,335
High Country Wet						
Without SWCP	9,416	1,354	15,563	2,332	15,009	4,926
With SWCP	20,175	3,435	30,596	4,469	41,063	10,007
All OCB High Country Properties						
Without SWCP	67,429	9,374	92,058	10,388	96,052	15,487
With SWCP	97,518	7,959	148,120	11,807	182,155	16,046

SOURCE: Derived from Kerr *et al.* (1979)

Another aspect of a possible influence of the SWCP's is stock performance. Data regarding performance on properties with and without SWCP's are presented in Tables 21 and 22. Regarding lambing percentages, properties with SWCP's appear to have begun with a better initial figure and, with the exception of the high country moist category, appear to have improved more rapidly than properties without plans. As regards wool weights, despite a better initial position, properties with SWCP's appear to have been overtaken by properties without plans. This is possibly due to greater emphasis on the growing of sheep for sale amongst properties with SWCP's, or as a result of higher stocking rates.

5.1.3 Gross Margins

Gross margins were calculated for downland, hill and high country properties, with mid-1978 as the base period. The calculations were derived from 1979/80 gross margins for Central Otago, presented in Appendices 1 and 2. Prices paid and received were indexed to the base period using the Meat and Wool Board's Economic Service Annual Review of the Sheep and Beef Industry and the MAF Farm Costs and Prices publication series. The resulting mid-1978 gross margins are reported in Table 23. These estimates represent an average for the range of properties within each land classification.

TABLE 21

Wool Weights for OCB High Country Properties With and Without SWCP's, 1965/67 - 1976/78 (kg/head)

	1965/67		1971/73		1976/78	
	Without SWCP	With SWCP	Without SWCP	With SWCP	Without SWCP	With SWCP
High Country:						
dry	4.4	4.4	4.7	4.2	4.8	4.2
moist	3.9	4.1	3.9	3.9	3.8	3.6
wet	3.2	3.9	3.5	3.9	3.4	3.5

SOURCE: Derived from Kerr *et al.* (1979)

TABLE 22

Lambing Percentages for OCB High Country Properties With and Without SWCP's, 1965/67 - 1976/78

	1965/67		1971/73		1976/78	
	Without SWCP	With SWCP	Without SWCP	With SWCP	Without SWCP	With SWCP
High Country:						
dry	87.8	87.2	90.6	93.7	89.1	91.9
moist	83.9	86.2	91.3	87.9	88.8	87.5
wet	65.9	68.9	73.2	80.3	82.3	88.6

SOURCE: Derived from Kerr *et al.* (1979)

TABLE 23

Gross Margins ($/Ewe Equivalent), OCB Region Properties, mid-1978

Property Class	Sheep
	($/EE)
Downland	13.60
Hill Country	11.10
High Country	8.80

5.2 Calculation of Net Benefits

The procedure for estimating the monetary benefits and costs was as follows:

(i) The median number of stock units before any SWCP was ascertained for each broad property type.

(ii) To this figure was applied the percentage increase in stock units which occurred between the start and finish of stage I of the SWCP's, adjusted by subtracting the proportional increase which occurred on properties "without" SWCP's.

(iii) This incremental increase in stock units was valued at the gross margin calculated for each broad property type for mid-1978, representing an estimate of additional income attributed to the SWCP's.

(iv) From this income figure was subtracted the cost (both capital and recurring) to the occupier, and to the nation; and internal rates of return were calculated for each accounting perspective.

Table 24 presents data covering steps (i) to (iii) above. The resulting increase in income which was attributed to SWCP's is shown in the last two columns. For high country properties the increase in income per annum as a result of the plan is estimated at $3,000 to $7,500; for hill and downland properties, the respective figures are $3,700 to $9,300 and $1,950 to $4,900.

A comment is necessary on the three sets of figures in column 3 - the proportion of the percentage increase in stock units attributable to the plans. From Table 19, a figure of 0.14 was derived from the experience of high country properties between 1965/7 and 1971/3, when rapid increases in stock units occurred as a result of favourable prices, especially for beef. However, to attribute 14 percent of increases in stock units to SWCP's in this study would be a gross under-estimate. It will be remembered that in the 1971/3 - 76/8 period, when prices were low and stock unit increases were modest, the proportion attributable to SWCP's was 89 percent. The true figure for "normal periods" lies somewhere between these two and in subsequent calculations, this report uses 0.20, 0.33 and 0.50 as pessimistic (I), middle (II) and optimistic (III) estimates respectively (Table 24).

TABLE 24

Calculation of Increased Income to Occupier Attributable to SWCP's After First Six Years by Broad Property Type (1978 Prices)

Broad property type	Mean stock units before SWCP[a]	Estimated % increase in stock units under SWCP[b]	% of increase attributable SWCP[c]			Increase in stock units attributable to SWCP[d]			Gross Margin[e]	Increase in annual income attributable to SWCP		
			I	II	III	I	II	III		I	II	III
High	5,230	32.6	20	33	50	341	563	853	8.80	3,000	4,955	7,506
Hill	4,150	40.3	20	33	50	335	552	836	11.10	3,719	6,127	9,280
Downland	2,004	35.8	20	33	50	144	237	359	13.60	1,958	3,223	4,882

a Based on TGMLI HCPS data for high country properties, 1976/78 (Kerr _et al_., 1979). The ratio of stock units on properties with plans to those without plans (1.3) was applied to hill and downland property mean figures for 1977/78 as reported in the Meat and Wool Boards' Economic Service _Sheep and Beef Farm Survey 1977/78_.

b Derived from Tables 18 and 19.

c Based on sections 5.1 and 5.4, with assumption I attributing 20% of the increase to the SWCP and assumptions II and III attributing 33% and 50% respectively.

d i.e. the result of multiplying columns 1 and 2 by 3I, 3II and 3III respectively.

e From Table 23.

Internal rates of return were calculated by relating the increased income to capital and recurrent costs. The latter are maintenance costs which begin after the completion of capital works. These are estimated, for the occupier, at 5 percent per annum of total plan costs, and for the State at 1 percent per annum. For the State, most of this is made up of subsidies on the purchase, transport and spreading of superphosphate (Johnson, 1975).

As was noted in section 5.1, the full impact of SWCP's would only be expected after the completion of the plan. Therefore, SWCP's are evaluated over a 20 year time horizon.

5.2.1 Return to Occupiers

The steps involved in estimating the return to occupiers over a 20 year period were as follows:

(i) Calculate benefits by multiplying the mean increase in stock units for each property type by the appropriate gross margin, with adjustments for the proportion of the stock unit increase attributable to the SWCP.

(ii) Calculate capital cost, comprising on-farm, off-farm and livestock costs, which are assumed to occur within the first six years.

(iii) Calculate maintenance costs, which are estimated at 5 percent of the on-farm and off-farm capital costs.

The results are presented, for each main property type, in Tables 25-27, and the respective internal rates of return in Table 28. In brief, the

TABLE 25

Calculation of Net Income of SWCP to Occupier, High Country Property, Over a 20 Year Period

(1978 $)

Year(s)	Capital Costs[a]	Maintenance costs[b]	Annual Income from Increased s.u.'s[c]	Total Net Income
0	18,786	0	0	-18,786
			I 1,500	4,032
1-6	0	828	II 2,473	9,870
			III 3,753	17,550
			I 3,000	18,830
7-20	0	1,655	II 4,955	46,200
			III 7,506	81,914

[a] Includes occupier's share of grant works, soil conservation fee charged by the OCB and non-grant works.

[b] Estimated to be 5 percent of the total cost of capital works undertaken under the SWCP. Maintenance costs in years 1-6 are calculated as an average of 2.5 percent of the total cost of capital works.

[c] I, II and III refer, as previously, to different assumptions regarding the proportion of increased stock units attributable to the SWCP. An average of half of the total increase in stock units is assumed to exist in years 1-6.

TABLE 26

Calculation of Net Income of SWCP to Occupier, Hill Country Property, Over a 20 Year Period

(1978 $)

Year(s)	Capital Costs[a]	Maintenance Costs[b]	Annual Income from Increased s.u.'s[c]	Total Net Income
0	9,986	0	0	-9,986
			I 1,859	9,144
1-6	0	335	II 3,064	16,374
			III 4,640	25,830
			I 3,719	42,686
7-20	0	670	II 6,127	76,398
			III 9,280	120,540

a,b,c As for Table 25.

TABLE 27

Calculation of Net Income of SWCP to Occupier, Downland Property, Over a 20 Year Period

(1978 $)

Year(s)	Capital Costs[a]	Maintenance Costs[b]	Annual Income from Increased s.u.'s[c]		Total Net Income
0	8,108	0		0	-8,108
			I	979	4,128
1-6	0	291	II	1,612	7,926
			III	2,441	12,900
			I	1,958	19,278
7-20	0	581	II	3,223	36,988
			III	4,882	60,214

[a,b,c] As for Table 25.

TABLE 28

Internal Rates of Return to Occupier by Property Type

Property Type	Assumption[a]	Internal rate of return (%)
High Country	I	1.0
	II	5.6
	III	8.6
Hill Country	I	8.2
	II	11.6
	III	14.2
Downland	I	5.4
	II	8.9
	III	11.6

a Assumption regarding the proportion of stock unit increases attributable to the SWCP. (Refer to Table 24).

internal rates of return to occupiers are all positive, but not particularly high. They are distinctly lower for high country properties, the range being from 1.0 to 8.6 percent. The alternative method of evaluating net returns, namely the net present value (NPV) technique using a ten percent discount rate, yields negative net present values for those SWCP's which have an IRR of about 5.5 or less.

It is important to be clear on what the IRR's represent. For an average property of each type, for price and cost conditions prevailing in mid 1978, they give the expected rate of return to new SWCP's over the next 20 years, based on the experience of previously-adopted SWCP's. In accordance with standard cost benefit procedure, inflation is not accounted for in this calculation.

5.2.2 <u>Sensitivity Analysis on Occupier's Return</u>

It is clear from Table 28 that the IRR to occupiers is sensitive to different assumptions regarding the proportion of stock unit increases. The results are particularly sensitive to change for high country properties.

The other main variable which might be expected to influence IRR levels is the gross margin. Table 29 presents IRR values calculated on the same assumptions as Tables 24 to 28 inclusive, except that gross margins are varied 25 percent below and above the previously used figures. The results indicate considerable

TABLE 29

Sensitivity of IRR Values to Changes in Gross Margins

Property Type	Assumption[a]	Internal Rate of Return[b]			
		Gross margin -25%		Gross margin +25%	
High Country	I	negative		2.4	(+140)
	II	3.1	(-45)	6.9	(+23)
	III	6.6	(-23)	9.6	(+12)
Hill Country	I	6.2	(-24)	9.8	(+20)
	II	9.7	(-16)	13.1	(+13)
	III	12.4	(-13)	15.6	(+10)
Downland	I	3.1	(-42)	7.0	(+29)
	II	6.9	(-22)	10.4	(+17)
	III	9.6	(-17)	13.0	(+12)

[a] Assumptions regarding the proportion of stock unit increases attributable to SWCP's (refer to Table 24).

[b] i.e. gross margins as estimated in section 5.1.3 above. Bracketed figures refer to the percentage decrease or increase on those values presented in Table 28.

sensitivity to change in gross margins also. Sensitivity proved greatest under assumption I (the lowest proportion of stock increase attributed to the SWCP), and for high country properties in general. For example, an increase of 25 percent in the gross margin increases the IRR to high country occupiers by 140 percent, assuming that 20 percent of the stock unit increase was attributable to SWCP's. The bracketed figures indicate the percentage increase or decrease from the IRR values presented in Table 28.

5.2.3 Return to the Nation

A similar procedure was followed to calculate the rate of return to the nation for different property types. There were three main differences. Firstly, capital costs included the state grant component. Secondly, maintenance was calculated at 6 percent of the total cost of capital works to allow, in particular, for the government subsidy on the cost, transport and spreading of superphosphate. Thirdly, each cash flow item was adjusted by an appropriate "composite coefficient" to allow for their foreign exchange content; the coefficients were derived from MAF (1977). The results are presented in Tables 30 to 32 and the resulting internal rates of return in Table 33.

TABLE 30

Calculation of Net Benefits of SWCP to Nation, High Country Property, Over a 20 Year Period

Adjusted for Foreign Exchange Content

(1978 $)

Year(s)	Capital Costs[a]	Maintenance Costs[b]	Adjusted Annual Income[c,d]		Total Net Benefits
0	34,421	0			-34,421
			I	1,635	3,612
1-6	0	1,033	II	2,597	9,384
			III	4,091	18,348
			I	3,270	16,870
7-20	0	2,065	II	5,401	46,704
			III	8,182	85,638

[a] Includes state grant, fees charged by OCB, occupiers' share of grant works and non grant works.

[b] Estimated to be 6 percent of the total cost of capital works in years 7-20; 3 percent of total cost of capital works in years 1-6.

[c] I, II and III refer, as previously, to different assumptions regarding the proportion of increased stock units attributable to the SWCP. An average of half of the total increase in stock units are assumed to exist in years 1-6.

[d] The composite coefficients used to adjust cash flows for their foreign exchange content were derived from MAF (1977): capital costs, 1.04; maintenance, 1.04; income, 1.09.

TABLE 31

Calculation of Net Benefits of SWCP to Nation, Hill Country Property Over a 20 Year Period, Adjusted for Foreign Exchange Content

(1978 $)

Year(s)	Capital Costs[a]	Maintenance Cost[b]	Adjusted Annual Income[c,d]		Total Net Benefits
0	13,931	0			-13,931
			I	2,026	14,664
1-6	0	418	II	3,340	17,532
			III	5,058	27,840
			I	4,054	45,052
7-20	0	836	II	6,678	81,788
			III	10,115	129,906

a,b,c,d As for Table 30.

TABLE 32

Calculation of Net Benefits of SWCP to Nation, Downland Property Over a 20 Year Period, Adjusted for Foreign Exchange Content

(1978 $)

Year(s)	Capital Costs[a]	Maintenance Costs[b]	Adjusted Annual Income[c,d]		Total Net Benefits
0	12,079	0		0	-12,079
			I	1,067	4,230
1-6	0	362	II	1,757	8,370
			III	2,661	13,794
			I	2,134	19,726
7-20	0	725	II	3,513	39,032
			III	5,321	64,344

a,b,c,d As for Table 30.

TABLE 33

Internal Rate of Return to Nation, by Property Type

Property Type	Assumption[a]	Internal Rate of Return (%)
High Country	I	0
	II	2.4
	III	5.7
Hill Country	I	7.5
	II	10.4
	III	12.8
Downland	I	3.5
	II	7.0
	III	9.7

a i.e. assumption regarding the proportion of stock unit increases attributable to the SWCP.

Due to the cost of subsidies included, the internal rates of return to the nation are lower than those to the occupier. All are positive, except for the high country property when the lowest estimate of the proportion of s.u. increase attributable to the SWCP was used.

CHAPTER 6

CONCLUSIONS AND POLICY CONSIDERATIONS

6.1 Summary

The IRR calculations of the previous chapter indicate that the return for SWCP's in Otago to occupiers are modest, and that those to the nation are low. However, it must be remembered that the benefit included in this calculation was only one of a number of other possible benefits, especially when considering the national viewpoint.[7] It is in fact the soil and water conservation benefits, so far not measurable, which provide the raison-d'etre of SWCP's.

One way of viewing these calculated rates of return to the nation is that they give an indication of the minimum value which government policy is currently placing on these other benefits in Otago. That is, if the government desires a rate of return (to the nation) of 10 percent for any expenditure which it undertakes, and SWCP's return something less than 10 percent, then the difference indicates the minimum value of the other unquantified benefits. Clearly, it is beyond the scope of the present study to determine whether the costs involved are justified. That decision rests in the hands of policymakers and their advisers.

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[7] See Tables 2, 3 and 4 above.

The study results need to be considered within the context that New Zealand has adopted a "carrot" approach to soil conservation by encouraging farmers to adopt desired measures. Australia, in contrast, has adopted the "stick" approach, with farmer adoption of the equivalent of SWCP's mandatory (e.g. De Boer and Gaffney, 1976; Knowles, 1978). It is assumed that the current New Zealand approach will be maintained.

The question was posed earlier as to why occupiers are subsidised at all, given that they receive increased income from the SWCP. In other words, should not occupiers be required to undertake SWCP activities without subsidies? The indication from this study is that the expected annual returns to the occupier are modest and below the rate of inflation experienced in the late 1970's/early 1980's. These returns are also generally less than the interest rate paid on secured savings in commercial banks during the same period. Under these circumstances it would not be expected that many farmers would undertake such works without some form of monetary incentive.

The time factor is particularly relevant here.[8] It may be that a well organised extension programme (involving, for example, the preparation of SWCP's and follow-up support) could encourage occupiers to make the necessary land management changes deemed to be in the national interest. However, the rate at which occupiers adopt these changes may be considered too

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8 This is discussed by White (1978).

slow; hence, the need for either subsidies or long term, low interest loans, in order for the nation to achieve (or achieve more quickly) its desired objectives which are externalities to the occupier.

As an aside, it is interesting to note that loan funds are available from, for example, the Rural Bank's Land Development Encouragement Loan Scheme.[9] Thus an occupier could have a SWCP prepared and, if not satisfied with some aspects, decline to accept it. He could then borrow funds to undertake those aspects which he finds attractive.

Finally, it can also be argued that the annual income which accrues from the SWCP does not necessarily represent the entire benefit to the occupier. If the increased stock units are capitalised into land values, then the capital gains to privately owned land should be included in the rate of return calculation. Since the method used does not include this aspect of private benefit, the estimated rates of return may actually be less than the true rates for some occupiers.

In considering policy options there are two extremes. One is that the government should bear all the costs associated with destocking and associated

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9 Under this scheme, provided development is carried out and maintained satisfactorily, the mortgagor is not required to pay interest and half the loan is written off.

activities; the other is that all costs should be met by the occupier. The present policy lies somewhere between these, with government and occupier sharing costs based on the principle that the occupier will be no worse off, in terms of net income and carrying capacity, as a result of acceptance of the SWCP. In considering some alternate policies, it should be noted that this principle is intended as a minimum standard. On most runs, income-earning capacity has been enhanced as a result of soil and water conservation plans.

6.2 Policy Implications

The aim of this report was to assess the costs and returns under present policy. In the course of this work some alternative policies have become apparent. Properties vary substantially with respect to percentage of total area comprised in class VIII and VIIe land, and with respect to potential for improving lower altitude lands. This means, given set rates of subsidy, that occupiers may receive quite unequal windfall benefits from SWCP's.

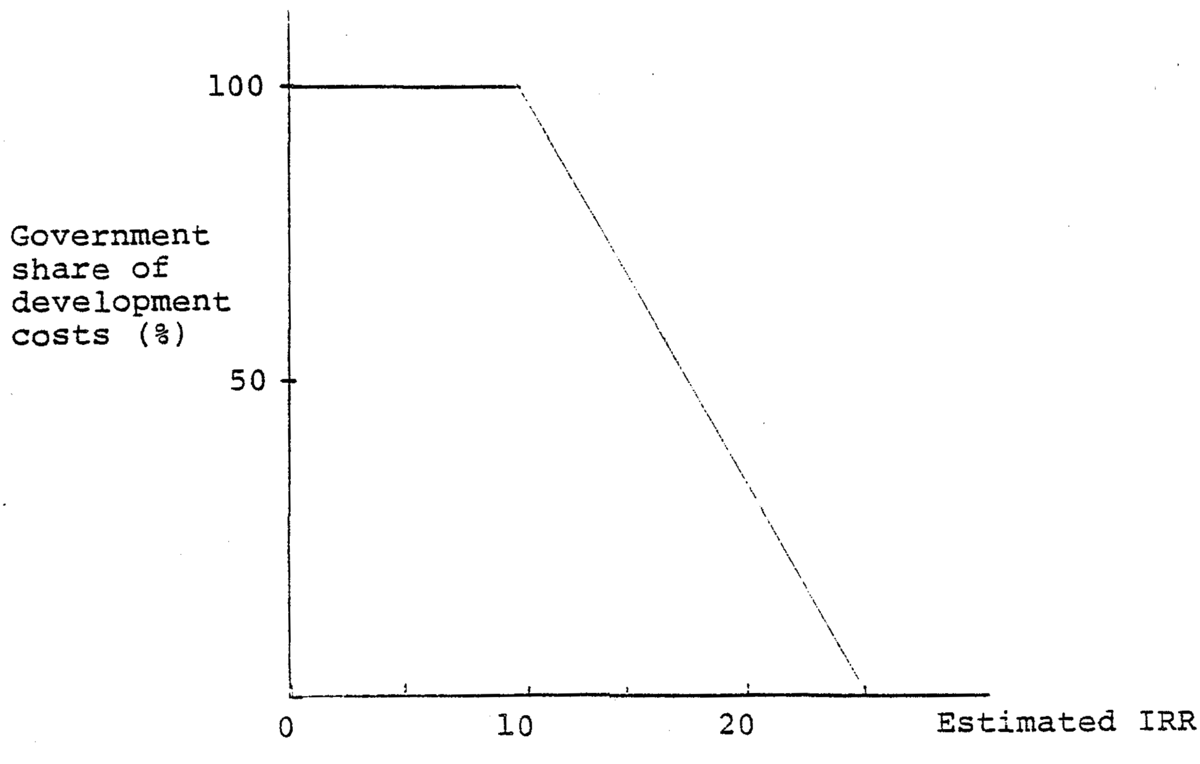
A possible policy alternative, outlined below, would involve a lower financial input by government, limit the extent of windfall gains in absolute terms, and reduce the unequal distribution of programme benefits. The proposal involves the following:

(i) Destocking of class VIII and VIIe lands and their compulsory removal from pastoral leases. This may involve changes to present land legislation.

(ii) Government should be entirely responsible for the costs of this destocking and removal from pastoral leaseholdings.

(iii) That soil and water conservation plans be drawn up, as at present, for individual properties, and that an overall internal rate of return for each plan be calculated. This IRR would include returns accruing from any government-provided works, such as a retirement fence.

(iv) This anticipated internal rate of return should form the basis of the cost sharing between the occupier and the government. That is, government should bear 100 percent of the costs where the expected internal rate of return is below some minimum (say 10 percent); a declining percentage as the anticipated rate is above the minimum; and a zero percentage above some specified "maximum" rate (say 25 percent). The precise figures are negotiable and could be varied if, for example, wool or meat prices changed substantially. This idea is illustrated in the following diagram:



(v) Occupiers should not derive windfall gains, based on the injection of public funds; nor should they suffer losses from it. For example, farm income may decline as a result of destocking if it is not possible to relocate displaced stock units on lower altitude land elsewhere on the property.

(vi) The occupier should have easy access to loan funds at the current rate of bank lending, to finance his share of development works.

(vii) The occupier may choose, within some specified period, whether or not to accept the proposed SWCP.

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APPENDICES

APPENDIX 1

Abbreviated Gross Margin Data, 1979/80 Season, Central Otago

	Lambing Percentage	Wool Weight Per Head	Wool Price (¢/kg)	Animal Health ($/head)	Shearing ($/head)	Rams ($/ewe)	Gross Margins ($/ewe equivalent)
Lowland valley, with hill run off (2,840 sheep, including 2,350 ewes; halfbreed)	115	4.87	242	0.43	1.32	0.19	16.02
Low hill country (2,550 sheep, including 2,050 ewes)	82	3.2	240	0.17	1.26	0.18	12.27
Hill country to 3000' relatively undeveloped (3,200 sheep, including 2,650 ewes; halfbreed)	115	4.1	244	0.75	1.37	0.27	16.30
High country runs (merino)	87	3.2	250	0.77	1.44	0.26	12.95

SOURCE: Personal communication, M.A.F., Alexandra, March 1980.

APPENDIX 2

Example of Otago Hill Country Property Gross Margin Calculation (early 1979)

GROSS MARGIN BREEDING EWE

Production parameters:

Lambing % 100

Wool weights 3.9 kg/head

100 ewes 24 hoggets

GROSS REVENUE

Wool	
100 x 3.9 kg/head x 237¢/kg	925
24 x 4 kg/head x 237¢/kg	228
Sheep Sales	
Lambs 76 @ $14.50/head	1,102
Cull ewes 21 @ $7/head	147
	$2,402

DIRECT COSTS

Shearing $91/100 x 124	113
Crutching $26 x 124	32
Animal Health 45¢/head x 124	56
Rams $17/annum/45 ($100/ram, serving 45 ewes for 4 years)	38
Wintering Cost 2 bales/head = 248 @ 70¢/bale	174
Interest $16 @ 12½%	250
	663
GROSS MARGIN per 100 ewes + 24 hoggets	$1,739
Stock Units 100 + 17 = 117	
Gross Margin/Stock Unit	$14.86

(Cont...)

GROSS MARGIN WETHERS

100 wethers + 20 wether hoggets

GROSS REVENUE		
Wool		
Wethers	- 100 x 5.45 kg/hd at 237¢/kg	1,292
Hoggets	- 20 x 4 x 237	190
Cull wethers	19 @ $15/hd	285
		$1,767
DIRECT COSTS		
Shearing	$106/100	106
	$91/100 for 20	18
Animal Health	7¢/head	7
Replacements	20 @ $16/head	320
Interest	$15 @ 12½%	188
		639
GROSS MARGIN		
100 wethers + 20 hoggets		$1,128
Stock Units	70 + 14 = 84	
Gross Margin/Stock Unit		$13.42

SOURCE: M.A.F., Alexandra.

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