Sustainable Land Use on the East Coast - A case study of land use change in the Upper-Hikuwai Catchment

A thesis presented in partial fulfilment of the requirements

for the degree

of Master of Philosopy in Development Studies at Massey University

Peter Zwart

1996

Abstract

This thesis explores the principles of sustainability and applies them to the issue of land use on severely erosion-prone hill country in the East Coast region of the North Island of New Zealand. Sustainability is found to require a biophysical bottom line, implying a need for planning to establish threshold levels of protection for particular classes of land. The study uses a locally developed system of land classification which takes into account the physical causes and remedies of soil erosion as the basis for such a plan. This sets the biophysical bottom line to which land use and management must seek to conform, but above which, remain flexible, according to other societal objectives such as equity or efficiency. The history of land use change, and the policy response to the issue is reviewed for the region, and compared with this plan. The plan is then applied to one catchment subject to severe soil erosion, and where changes in land use are in process and the changes assessed and compared with the attitudes of the landowners and the context in which they have made their decisions. It was found that considerable progress had been made recently towards greater compliance with this plan and toward a pattern of land use more diverse and more consistent with the varying physical capacity of the area. This has been particularly facilitated by assistance from central and local government between 1988 and 1993. The study concludes, however, by highlighting the degree of favour shown to forestry interests over those of farming interests in current method of public support for erosion control. The study anticipates the eventual blanket afforestation of the catchment under this scheme.

Acknowledgments

No research is ever a product of the labours of one person. It rests on the cooperation, support and encouragement of a host of people.

My gratitude goes firstly to the people of Tokomaru Bay and the Upper-Hikuwai Catchment who so willingly shared their experiences and choices with me. Their generosity and interest were perhaps the most important element and the highlight of the study.

Essential too, was the immense support received from Bob Miller, Trevor Freeman, Paul Williams and staff of the Conservation Division of the Gisborne District Council. Their assistance, advice and generous supply of information and planning documents provided the foundation to my work.

I owe much to my Heads of Department, Croz Walsh, Brian Ponter and John Overton who have all fostered the development of a vibrant and enquiring environment at the Institute of Development Studies. Each have provided much needed direction at crucial stages of this work.

To Anton Meister who supervised this project from its inception, belongs the credit for wading through ponderous drafts and distilling from them the crux of an argument.

To my flatmates in Palmerston North and Wellington, to all the past and present staff and students of Development Studies, and to my colleagues at Caritas Aotearoa New Zealand, who all gave freely and generously the moral support and caffeine needed to see this project to its conclusion, I offer my sincerest gratitude.

Finally and most importantly to my family who, throughout their own trials of recent years, have been unceasing in their steady support for my efforts and who, as always, have bolstered my efforts with regular parcels of greatly welcomed Gisborne fruit and vegetables.

Table of Contents

CHAPTER FIVE

CHAPTER SIX

CHAPTER SEVEN

List of Tables

List of Figures

CHAPTER ONE

Introduction

> "The primary social adjustment is the adjustment of society to the land. Upon the soundness and stability of this basic relationship depend the harmony and security of all the relationships within the social order. For national survival we must retain and develop an enlightened rural people who find satisfaction in their way of life, are proud of their calling, are wise rather than clever, are industrious and efficient, and whose creed is to cherish the soil and husband its resources" (Lance McCaskill quoted in *Conservation Quorum*, June 1990).

1.1 Introduction

The issue of severe soil erosion on pastoral hill country in the East Coast Region of the North Island of New Zealand has been a long and protracted one. In the past 50 years, numerous initiatives have sought to arrest the movement of land and to establish a pattern of land use more consistent with the unstable nature of these hills and one which does not consistently degrade the resource and contribute to severe river aggradation and flooding downstream.

Despite these initiatives, changes in land use have not been easy to effect. Expansionary policies for pastoral farming have in the past been counter productive to soil conservation, while farming communities have frequently opposed the encroachment of forestry into their districts. As a consequence, severe erosion remains a problem whose solution continues to lie beyond the capacity of the region to redress. In 1988, the arrival of Cyclone Bola renewed public concern over the degradation of the hill country resource and the dangers it posed for those living on the flats.

In the period since Cyclone Bola, the policy surrounding resource use and management has been characterised by immense upheaval which has changed the whole environment in which land use decisions are taken. The restructuring of the New Zealand Forest Service and of Local Government profoundly affected the implementation and encouragement of soil conservation in New Zealand. The 20 year old East Coast Project of state afforestation of eroding lands was abandoned. It was to be replaced after much lobbying, by a temporary scheme conducted in the wake of the cyclone, and then by an

entirely new scheme in which responsibility for reforestation was moved to the private sector, with tendered assistance available from the state to provide an incentive.

In the meantime long-standing Central Government subsidies available for the implementation of on-farm soil conservation works were slowly phased out, and responsibility for this area was devolved to the resources of local authorities.

In 1991, the introduction of the Resource Management Act was also to profoundly shift the ground for resource users. The principle of sustainability, and the responsibility for its achievement shifted, leaving resource owners faced with an externally imposed shift in property rights.

The objectives for this thesis are as follows:

- to explore the meaning of the terms *sustainable development* and *sustainable land use*, and their relevance to resource allocation and land use decisions;
- to explore the implications of sustainable land use to the erosion prone pastoral hill country on the East Coast of the North Island, New Zealand;
- to propose a sustainable pattern of land use for the region, and to apply this pattern to the land in one case study catchment, subject to severe soil erosion;
- to assess the process of land use change occurring in this catchment in the light of the changing economic and policy environment.

1.2 The Case Study Approach

In the light of the dramatic changes in policy and economic environment which affect land use decisions, and the on-going problem of soil erosion in the region, it was felt that a review which highlighted these changes, and examined the implications they have for land users, would be useful at this time. A case study analysis was chosen rather than a region wide survey or statistical study for a number of reasons.

Firstly, there have been produced over the past 25 years a steady stream of reports and evaluations based around the East Coast Project, the majority of which were conducted as regional studies. These are reviewed in Chapter Four, and together form a relatively

clear picture of the planning and implementation of the project. The number of such reports led Eyles and Newsome (1991: 219) to declare that:

> "by 1988, the Gisborne-East Coast Region was one of the most studied and 'planned' areas in New Zealand with the most known about options for its sustainable development".

Yet, they went on to comment that:

> "despite two major planning exercises, there has been little action to even begin to implement a regional sustainable land use pattern".

Although there remains evidence of strong current local concern over the extent of forestry development in the region[1], there appeared to be little need for a further regional analysis. Given the central role of land managers in the implementation of such a land use pattern, it was felt that a study which illuminated the decisions taken by this group would prove more valuable at this stage.

Secondly, the literature on sustainable land use emphasises the specificity of any sustainable outcome to the particular locality. A case study highlights problems and solutions arising from the particular physical and social conditions that exist in that area, and allows their exploration often in more detail than would be possible in a statistical analysis.

Thirdly, application of sustainability must address the question of scale. Limiting the scope of the analysis to one defined area, in which the on- and off-site effects of soil erosion could be readily identified, provided a natural boundary for the study. The boundary used - a watershed or catchment for one stream - would not be suitable if the study were to incorporate other issues of sustainability such as the use of non-renewable resources through fertiliser use, or the environmental effects of timber treatment, for these involve both inputs and outputs which extend well beyond the boundaries of the catchment in which they occur.

Finally, a case study format has much to commend it in the more complete picture it may offer of the situation in one area. It does undoubtedly introduce a considerable element of subjectivity into the analysis, and this will likely limit both the strength of conclusions

that can be drawn, and the relevance of those conclusions to other areas. Nevertheless, as is argued by Hillway (1965), such a format draws attention to information that may not otherwise be discovered. In this case it is the actions and attitudes of individual land managers in relation to the particular management situations that they face, which would be less evident in a broader or more statistically based study.

1.3 Direction and Layout

This study is divided into seven chapters. Following this introductory chapter, Chapter Two explores the economics of natural resource allocation in society and the limitations of the market as a resource allocator. It then looks at the developments within economic theory which have sought to address this problem, and to its own limitations. It then proposes a constraint on the application of economic rules as required by the principle of sustainability.

Chapter Three takes these findings, and questions raised, and applies them to the issue of soil erosion on New Zealand pastoral hill country, looking specifically at the property rights implications of the new principle of sustainability. Chapter Four backgrounds the issue and history of soil erosion in the East Coast region of the North Island. It then recounts the history of land use policy affecting the area, and the extent of land use change which has occurred.

This is followed in Chapter Five by an introduction to the case study undertaken, the reasons for its choice, and the manner in which data was collected and analysed. This leads into the main results chapter, Chapter Six, in which the changes in land use, tenure and vegetation are analysed for the upper-Hikuwai catchment on the East Coast. These changes are discussed in the light of the proposed pattern of land use and the changing policy and economic context discussed in Chapter Four.

---

[1] Concerns have been expressed by many local groups and individuals, including: the Federated Farmers; the Women's Division of the Federated Farmers; Weddel Crown; the local freezing works; the Maruia and Forest & Bird Societies; the Department of Conservation; and the Conservation Division of the Regional Council.

The study ends with the concluding chapter which draws together the main findings of the study and highlights some of the shortcomings of the exercise attempted here.

CHAPTER TWO

Natural Resource Allocation and Sustainability

2.1 Introduction

In recent years, most notably since the 1980 publication of the World Conservation Strategy, and in 1987 the report of the World Commission on the Environment and Development, the term sustainability has risen to prominence in a wide array of literature. The emphasis of these two documents and particularly the latter was on 'sustainable development' which may be seen as an attempt to integrate environmental concerns into mainstream decision-making on human social and economic activity. The latter document advanced a broad and widely accepted definition for this concept, defining it as development which "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987: 8).

Sustainable development has been adopted in principle by a range of national and international environment and development agencies including the United Nations Environment Programme (UNEP), the International Union for the Conservation of Nature (IUCN), World Wildlife Fund (WWF), and the World Bank (IRBD), as well as research organisations such as the World Resources Institute (WRI) and Worldwatch Institute (Lélé, 1991). In New Zealand the derivative concept of sustainable resource management has been adopted as the basic principle governing environment and natural resource management legislation in the Resource Management Act 1991. Statements on the interpretation of sustainability have been prompted from the New Zealand Ecological Society (1990), the Association of Soil Science, and the National Water and Soil Conservation Authority (Cuff, 1988), and sustainable agriculture has been cited as a main objective in the mission statement of the NZ Ministry of Agriculture and Fisheries (MAF, 1991). The very popularity of the term has led to the claim that sustainability stands "poised to become the development paradigm of the 1990s" (Lélé, 1991:607).

Yet despite this rapid rise in importance, a clear and unambiguous definition for the term remains elusive. Indeed many of its adjectival applications are seen to be in conflict. Positive connotations associated with the word combined with its non-specific nature

have allowed it to be used in a wide variety of often contradictory contexts. As a consequence, its value has been questioned (Hayward, 1991; Rees, 1990; Barbier, 1987) and it stands accused of having become an environmental cliche, with few implications beyond "political rhetoric" (Caldwell, 1990:177).

This chapter looks at the principles of resource allocation in society, the reasons for the emergence of sustainability, the implications it has for the management of particularly natural resources, and the manner in which this has been implemented in New Zealand.

It will be argued that sustainability has emerged due to the inability of current economic theory to adequately place economic activity in its environmental context, or to provide for an optimal solution either in terms of society's *social welfare function*, or to achieve an overall scale and nature of economic activity which remains compatible with long term maintenance of the resource. As such the goal of sustainability demands that a constraint be placed on economic activity which takes primacy over other decisions and which is determined by natural and physical criteria, rather than economic efficiency.

2.2 Resource Allocation

Economics at its heart is the study of the way in which people produce or obtain the physical things which they either require or desire in their lives and livelihoods[2]. Through cultivation, direct harvest or mining, societies are able to obtain things that their members find useful or desirable from the natural (non-human) world. Since the sources of those goods (resources), are ultimately derived from the non-human environment, the way in which these resources are allocated in any society must be viewed as an economic problem.

Throughout history, societies have evolved many diverse structures and institutions[3] to allocate their available resources among their various members and uses. These vary

---

[2] A definition offered by Samuelson and Nordhaus (1985:4) is "Economics is the study of how men [sic] and society end up choosing, with or without money, to employ scarce resources which could have alternative uses, to produce various commodities and distribute them for consumption, now or in the future, among various people and groups in society".

[3] An institution in this context may be defined as "a persistent pattern of social interaction with associated statuses, roles, norms of behaviour and social sanctions". It is an agreement system that organises some general aspects of group life" (Hayami and Rattan 1988: 100). In this case the market is one of a number of institutions that organise the production and distribution of goods and services.

with the resource, the particular circumstances of the society, and the goals of the society.

Despite this diversity, for modern states the two means which have emerged to dominate debate as to the most appropriate way to achieve the goals of societies are *allocation directed by the state* and *allocation left to the market*.

Simplistically these are sometimes seen as a dichotomy of the state versus the market. A simple choice is presented between state control or ownership of resources and planning of the way they are allocated, and the unhindered operation of markets in a climate of private ownership, and an absence of regulation. This is an inadequate picture of the true situation, since in all countries there exists some combination of the two. Differences tend to be more in degree or in the particular combination, than in absolute terms.

2.2.1 The Market as Resource Allocator

Contemporary economic theory and many of the tools of economic analysis rest heavily on the role of the institution of the market in the allocation of resources in society. Such is the centrality of this institution that its relevance as the framework for analysis is often taken as given, yet O'Connor (1989:32), among others, notes that "in historical and cross cultural perspective it [the market] is better viewed as a quite particular institutional arrangement" (see also Bromley, 1988 and Dragun, 1983). In his paper, O'Connor concludes that "the pertinence - or not - of economic analysis is itself a function of prevailing social institutions and conditions".

In developed market economies, where the market is the primary institution for exchange, the tools of market analysis *are* pertinent, but this pertinence may be substantially less for many developing countries with large subsistence sectors. Even where the market is well developed, one must remember that the market does not account for a significant proportion of welfare enhancing activities[4]. While the influence of the market may be widespread and important, it should not be regarded as a "general or universal" situation, nor should it be considered "immutable in its essence" (O'Connor, 1989:32).

---

[4] Waring (1988:225-229) lists estimates of the value of non-market activity such as household work and child rearing, that would add from 25 to over 50 percent to existing GDP figures in industrialised countries.

With this in mind, economic analysis does, however, shed much light on resource allocation as it occurs in a market-based economy such as New Zealand. It was the classical economic theories of Adam Smith (1723-1790) that popularised the concept of the *invisible hand* of the market, whereby the separate rational[5] actions of all individuals in an economy are believed to lead to the most *efficient* allocation of resources. This invisible hand corresponds more precisely to the phenomenon known as market forces, or the interplay of supply and demand which determines the price and quantity of individual goods. By assuming the free and rational participation of individual self-interested economic agents in the market, the resulting allocation can be regarded as reflecting the preferences of all.

While often glowing in support for the institution of the market, much classical economic thought was somewhat more pessimistic with regard to the long-run potential for economic growth. This was due to a belief in the ultimate scarcity of natural resources which would limit the extent of growth in the world (Pearce and Turner, 1990).

It was, however, precisely the concept of scarcity which became the basis of a much more optimistic *neo-classical* brand of economic theory. Contrary to earlier theories which had attributed the economic value of a good to its labour content, theorists from about the 1870's introduced the concept of economic scarcity as expressed in the market as the principle determinant of value. In this way, scarcity was seen to be a relative concept, dependent on the supply and demand for a commodity and for its constituent factors of production. As the supply of one input into a productive process decreased, its price would rise accordingly and producers would implement changes so as to minimise the need for that resource. All resources would be used in such quantities that their *marginal* rates of substitution were equal. If the supply of a particular good declined, its market price would rise. Demand would fall, and a new *equilibrium* between the two variables would be established at a new price. *Marginal* analyses such as these, whether at the economy (macro) or individual (micro) level, are the mainstay of neo-classical economics.

[5] The adjective "rational" is used in the economic sense to indicate that the individual seeks to maximise utility or profit through his/her actions in the market.

In the same way that Smith's *invisible hand* linked the pursuit of self-interest to the collective good, the market is also viewed by neo-classicists as providing the link between the preferences of the individual, and the collective welfare of society. Individuals are assumed to wish to maximise their *utility*, and to act accordingly in the market. They are also assumed to be *sovereign* in their consumption decisions. The allocation of resources resulting from a free market system will then reflect the preferences of all.

Clearly this needs some qualification. Apart from the doubt which surrounds the validity of the above two assumptions[6], the total demand expressed by an individual through the market must be seen as a function of that individual's capacity for participation in the market. Such capacity is never distributed evenly throughout an economy, since participation will be limited by one's income, and hence, one's spending power. It follows, then, that while the preferences of all may be represented in the resulting allocation, the preferences of some will be of rather more significance than those of others. The resulting societal allocation of resources will be heavily weighted toward the preferences of the wealthy, whether these be individuals, social classes, or countries. Such a situation tends innately to favour the *status quo*, in terms of the distribution of wealth and income.

2.2.2 Economic Efficiency

This discussion leads inevitably to the field of welfare economics and to the concept of economic efficiency which underlies neo-classical economics. It can be demonstrated that a perfectly efficient market situation - one based on the pursuit of individual self-interest and consumer sovereignty, in which there are no monopolies or externalities, and all welfare enhancing goods are freely traded in the market - will result in a *Pareto efficient* solution, ie. one in which no individual can be made better off without decreasing the welfare of another (Mishan, 1981). In such a situation, no new changes or exchanges can be made for any further gain in efficiency. In order to come closer to this ideal market situation, areas of imperfection were targeted in the hope that their

---

[6] The sovereignty of the utility-maximising consumer has been attacked perhaps most vigorously by economist John Kenneth Galbraith. In his book *The Affluent Society* (1958) and later in *The New Industrial State* (1967), Galbraith argues that large corporations rather than serving the innate desires of consumers, in fact *create* and manipulate demand for their products through advertising.

correction would lead to a more efficient outcome, and hence to an improvement in social well-being.

This theory appears to justify a universal quest for efficient solutions in order to maximise social well-being while maintaining a facade of moral neutrality. There are an infinite number of Pareto efficient outcomes, each depending on the initial distribution of resources and wealth in the economy. It is assumed that economics need not concern itself with the ethical considerations involved in this distribution, but may confine itself to an uncritical search for efficiency. Very importantly, it is an argument based on a utilitarian conception of social well-being, and on the assumption that money is an acceptable and a comparable indicator of individual well-being or utility.

There are several serious failings in this thesis, arising from the above assumptions. Firstly, while money may be accepted as having a relationship to ordinal utility, this is not a unique relationship, and the value measured cannot be assumed to be cardinal and thus comparable across individuals. The calculation of a net benefit or net cost in cardinal monetary terms, such as is done in cost-benefit analyses, cannot be taken to *necessarily* imply a corresponding net gain or loss in aggregate utility.

Secondly, in the absence of a perfect market, it must be accepted that a more efficient solution, or one which moves closer to the efficiency frontier, does not exclude the possibility of both relative and absolute injury to individuals. While a Pareto improvement may lay some claim to moral neutrality if no one individual were made worse off while some were made better off, the real situation is such that individual injury can (and frequently does) occur. Economics cannot divorce itself from the ethical issues raised by such injury. Even the Kaldor-Hicks *compensation criterion*[7] simply attempts to avoid the issue by declaring a solution acceptable if those who stand to gain *could potentially* compensate those who lose, and still be better off, *irrespective of whether such compensation does in fact take place*. This utilitarian position involves a clear moral judgement, that such injury is acceptable, that it is not necessary to consider who is injured, and that the compensation need not be made.

[7] This principle is discussed comprehensively by Ritson (1977).

2.2.3 Limitations of the Market

As has been mentioned above, real markets do not approach the perfection required for a Pareto efficient solution[8]. In fact markets as a means to allocate resources in a socially optimal way, suffer from a number of other well documented problems, popularly referred to as *market failures*.

Market failures occur where there exists a divergence in the private and social benefits or costs of resource use. *Monopolies* which prevent full and fair competition, *externalities*[9] in which certain costs remain external to the market, *public goods* which are socially desirable but privately not profitable, and *open access resources* which by their very nature cannot be privately owned, are all examples of market failure. The full range of these sources of market inefficiency is covered by Randall (1987:164-195).

These limitations are of particular importance to the environment, since all of these sources of inefficiency are prevalent for natural resources (Randall, 1987). Bromley (1988:40) points out that the realm of natural resources, and land use matters in particular, tends to be more frequently characterised by:

1. unclear property rights;
2. indivisibilities;
3. non-rivalrous use;
4. contemporary or inter-temporal externalities;
5. irreversibilities.

---

[8] One further shortcoming of the Pareto Efficiency thesis is that first postulated by Lipsey and Lancaster (1957) in their 'General Theory of Second Best'. Since real markets do not approach the idealized perfection assumed in economic models, a truly efficient solution can never be obtained. Any change thought to advance efficiency will therefore be a 'second best' solution. The theory of second best argues that while imperfections exist in an economy, a change which can be demonstrated to promote greater efficiency in one sector cannot be assumed to promote the overall efficiency of the economy. While this does not necessarily apply to all sources of inefficiency, it is particularly relevant to "monopolies, uncorrected externalities, and non-optimal policies" (Randall 1987: 114), all of which frequently characterise markets for natural resources. This argument does not rule out the search for optimal solutions entirely. Ritson (1977: 249) illustrates that the second best rule need not entail a "universal departure from familiar optimising rules" and depending of the size and nature of the imperfections, a "rule of thumb" may often be used. It does however, along with the other shortcomings mentioned, rule out an uncritical or universal application of such efficiency 'filters' as cost-benefit analysis, especially in the name of greater social well-being.

[9] An externality may be defined as a cost or benefit affecting an individual economic agent that is not caused by their own actions. It is in this sense *external* to the market process of exchange.

That this is the case means that resource allocations resulting from the uninhibited action of the market can have no claim to be efficient. Economic development can clearly be obtained at the expense of resource and environmental degradation, and this degradation, while representing a real loss to an economy, is frequently neither valued nor incorporated into statistical measures of growth.

To counter this criticism, two new strands of neo-classical economics - those of natural resource economics and environmental economics - arose to devote themselves to the correction of these shortcomings. This involved particularly the development of a range of innovative techniques whereby environmental values could be measured and incorporated into economic analyses, externalities could be identified and quantified, and optimal levels of public good provision calculated. With regard to non-renewable resources, economists concerned themselves with dynamically efficient rates of resource depletion, such that the discounted price of one unit of a resource remains constant over time. Common to all these attempts was the need to quantify the value of the environment and natural resources.

2.2.4 Environmental Values

There are a number of distinct types of value that the environment is often accorded (Pearce and Turner, 1990:129-140). The most basic division made is between *instrumental* value which is derived from some benefit which accrues to people through its use (*use* value) or potential for use (*option* value), and *intrinsic* value which rests on the assumption that environmental features have value of and in themselves, which is *wholly unrelated to their utility to human beings.*

On this latter point, there is as yet no clear consensus. Intrinsic values appear to be conceived of in two ways: (i) to refer to a value which, while being unrelated to human use or potential use of a resource, may still be measured by a person's *willingness to pay* for its continued existence (this is sometimes termed *existence* value); or (ii) to refer to a value which bears no relation to human preferences. Rather, species or ecosystems would continue to have value, were there no human population at all. Intrinsic values of the latter view are not economic values and can not therefore be measured or compared in economic terms. Both use and option values and existence values are economic in nature and can therefore all be measured, at least theoretically. It needs to be stated that

Pearce and Turner (*ibid*) list a number of possible sources of option value. The option value of a resource is related to the possibility of its future use and may be precluded by its current use. The potential benefit from future use comprises the value to the individual concerned, the value to future individuals (both direct descendants and future generations in general), and the value to other individuals. Private owners acting in a dynamically efficient manner, will take account only of the first and partially the second, as they provide for their own well-being and that of their immediate descendants. They cannot be expected to consider the value of the resource to the wider or, as yet, unborn society.

Option values are a difficult commodity. Future technological development or economic conditions can conceivably create new, previously unthought of or uneconomic uses for resources. This would involve an additional and unknown opportunity cost of their use now, often termed a *quasi-option* value. Alternatively, a resource that is productive and valuable now, may conceivably not be required by future societies. In the case of marginal land, it is by no means certain that increases in productivity on better classes of land will not reduce the total amount of land required for food or primary product production. This uncertainty means that a definitive value of the option of a resource or environmental feature, is unobtainable. One may speculate on future trends, but it is difficult to go beyond such speculation.

The case for intrinsic values which exist quite apart from socially derived economic values is even less clear. Since they are not values which are derived from supply and demand, it does not appear possible to assign them monetary values - even assuming they could be measured or accurately estimated - nor to compare them with values that are market based. If they are taken as existence values, these in part depend on human knowledge, not to the poorly understood ecological relationships that interlock and maintain the stability and function of global biophysical[10] systems. Nevertheless, the acceptance of intrinsic value could be regarded as the flagship of the *ecocentric*

[10] The term biophysical sustainability is use here rather than ecological sustainability, since ecosystems and physical systems are interdependent, and the long term functioning and "health" of both is essential.

positions[11], as these argue that "the welfare and flourishing of human and non-human living beings has value in itself" (Engel, 1990:17).

2.2.5 Dynamic Efficiency

With regard to allocation of resources over time, the response of natural resource and environmental economics has been to promote *dynamic efficiency* in both the protection and provision of environmental resources, and the depletion of non-renewable natural resources. Dynamic efficiency, or *efficiency over time*, is related to the option value of resources. By using resources now, the option of their future use is foregone which will involve an opportunity cost. Since benefits and costs occurring in the future are for a number of reasons, less valued than immediate ones, they are *discounted*. This process is essential to a dynamically efficient outcome. Justification for discounting includes arguments such as time preference in favour of the present, the productivity of capital and therefore its opportunity cost, risk and uncertainty associated with the future, and the historic trend toward higher incomes.[12] As an evaluation technique, discounting is widely used both for private investment decisions and in such public evaluative techniques as cost benefit analysis.

The effect of discounting is to lessen the value of both costs and benefits occurring in the future. The further in the future that they occur, the more they are discounted. For example, a cost of $1 million occurring 50 years from now, if discounted at 10%[13] would be worth just $8,519 in the present. The same cost occurring 100 years from now would discount to a mere $73. Costs or benefits occurring beyond such time frames are effectively negligible, even at quite low discount rates. Environmental costs, however, are typically long lasting and may occur far in the future. Similarly the stream of benefits of environmental protection now, may not be realised for many years. A common example is the storage of hazardous waste, which may remain toxic for many thousands of years. The costs of such storage are only of importance to the current generation for 50 to 100 years, yet the ongoing burden will be essentially the same for all generations. In the case of soil conservation, the costs incurred in planting trees are all borne by the

---

[11] Ecocentric refers broadly to the "communalist" and "deep ecology" points of view discussed by Pearce and Turner (1990:14).

[12] A good account of the time value of money is contained in Pearce and Turner (1990:211-225).

[13] 10% is the rate of return demanded of soil conservation projects by the New Zealand treasury.

current generation, and will be included at their full value. The benefits of such work, or alternatively the cost of allowing ongoing degradation, will be borne by many generations to come, but will be discounted heavily in any economic analysis.

The obvious anomaly of discounting the future while trying to protect it, has led to much debate as to the role of discounting, and to the appropriate rate which should be used.[14] Environmentalists have argued rightly that the higher the discount rate, the less weight that future costs and benefits will carry. They argue that rates should be adjusted towards zero. Pearce and Turner (1991:224) note however that there is no such unique relationship between discount rates and environmental degradation. A lower discount rate would also mean that a greater overall number of projects would be judged attractive, and so tend to increase economic throughput.

If the problem arises due to the non-representation of the preferences of future generations in current markets, adjustment of the discount rate would not alter this situation, especially when there is no clear consensus as to what adjustment should be made. Given the profound effect that varying discount rates have on project favourability, arguments in favour of an adjusted discount rate without such consensus opens the path to both individual manipulation of the discount rate and a lack of comparability between projects. Moreover it is doubtful whether a large difference could exist between the discount rate for public projects and the cost of capital faced. Governments must still choose between alternative uses for a limited revenue and projects in excess of this must be financed at available rates. Private investment will continue to be guided by the appropriate cost of capital.

2.3 Efficiency versus Optimality

At this point it may be useful to break down the steps which lead from resource allocation in markets to the goal of a socially optimal allocation of resources. First, it has been shown that if a Pareto efficient outcome is to be had, conditions of market perfection must rule. Second, it has also been noted, that there exist an infinite number of potentially efficient solutions, and that these will depend on the initial distribution of

[14] Refer to Pearce and Turner (1990:217-225), and to the opposing views of Birdsall and Steer (1993) and Cline (1993).

resources. Thus while a market induced outcome may well be efficient, this does not indicate that it is a socially optimal outcome. This would require knowledge of a *social welfare function* for that society, in order to locate the point of tangency between this and the *efficiency frontier*.[15]

Howarth and Norgaard (1990), using simple economic models, illustrate that a dynamically efficient outcome does not equate to either an inter-generationally equitable one, nor to an optimal one (one that maximises social welfare, and which would require knowledge of, in this case, an *intergenerational* social welfare function). In the same way that a situation may be statically efficient but not optimal if it does not coincide with society's social welfare function, a situation can be dynamically efficient, yet not equitable to future generations. This is because although current generations do consider the future in their dealings in the market, such consideration is derived from their own preferences, not from those of future generations. The market in question is the current one, and the time preference expressed is that of current individuals.[16] There is no ability for future generations to express their preferences today. Neither is it possible for the current generation to know what such future preferences will be.

2.3.1 Optimal Scale

Of equal importance to the question of optimality according to society's social welfare function, is the question of what is the optimal scale of economic activity? This is a question which is simply not addressed by conventional neo-classical economic theory. At no point does the concept of economic efficiency consider the ecological effects of the size and form of an "efficient" economy. This has been described as the lack of an "*existence theorem* that relates the scale and configuration of an economy to the set of environment-economy interrelationships underlying that economy" (Pearce and Turner, 1990:42). Economic development cannot be assumed to be able to be supported by the

---

[15] *Pareto Efficiency* is often used interchangeably with *Pareto Optimality*, however Howarth and Norgaard (1990) take issue with this use of the word *optimal*. There are in fact any number of possible Pareto Efficient outcomes, only one of which will be optimal. A truly optimal outcome would maximise social welfare and would require knowledge of a social welfare function, so as to enable choice between the infinite number of possible efficient outcomes.

[16] It is important that the distinction is made between individual time preference and social rates of time preference. For the individual, inter-temporal decisions are made in the light of their own mortality and personal preference for current as opposed to future consumption. For society however, which innately assumes for itself eternal life, there appears little justification for inter-temporal allocations made according to the individual "impatience" (Pearce and Turner 1990:223) of those currently living.

surrounding ecosystems, either through their ability to supply renewable or non-renewable resources, their capacity for waste absorption and assimilation, or through the wider global regulation functions which they perform[17]. This inconsistency is valid both for small areas and for the biosphere as a whole.

Human activity can (and does) bring about *irreversible* losses, such as occur through species or ecosystem extinction. Such losses may not have a readily identifiable or foreseeable economic value, or alternatively they may have an instrumental or existence value, but this may not be considered sufficiently large to warrant their protection on the grounds of economic efficiency.

The dilemma of such irreversibility is linked also to the problem of *uncertainty* surrounding the workings of the global ecosystem. The complexity of ecological interrelationships between species in an ecosystem which together form an integrated and self-regulating whole, is such that human attempts to manage changes is dominated by a lack of knowledge. In this context an ecosystem has been compared to a complex tapestry from which human activity is removing individual threads (Jacobs, 1991:10). Each one unwoven reduces something of the richness of the whole but that is not the most serious point. Our own lack of knowledge means that we have no way of knowing when the tapestry will simply fall apart for want of a crucial thread.

2.3.2 Thresholds

This discussion is linked to the ecological notion of thresholds. Thresholds are important for the maintenance of biodiversity, since there exist critical species numbers, or levels of ecosystem processes below which they may not recover. One response to this is the use of Safe Minimum Standards (SMSs), which is a "risk-averse conservative criterion that states society should assure the survival of species, habitats, and ecosystems unless the costs of so doing are 'unacceptably large'" (Batie, 1989:1097). The adoption of safe minimum standards places the existence of species and ecosystems above economic activity, and would ideally provide sufficient protection for their survival.[18]

---

[17] These are the three functions that economists traditionally accord the environment.

[18] Batie's definition does, however, leave room for wide divergence on the appropriate interpretation of "unnacceptably large".

This is especially difficult when the degradation will be irreversible, such as in the case of species loss. It is not reasonable to propose that no species extinctions should be allowed since there occurs in the course of evolution a regular process of species attrition. As species lose their particular ecological niche, either through changes in climatic conditions or competition from another better adapted species, no amount of intrinsic value will preserve them. Nor is it reasonable to suggest that the era of human-induced species extinctions can be stopped simply through the introduction of a SMS[19]. While economic valuation may not provide a theoretically sound level of protection for biodiversity, it is not evident exactly how far the human species should be allowed to usurp or demolish the intricately evolved niches of other species, thereby diminishing the diversity and stability of the ecological system.

This has profound implications for the fields of natural resource and environmental economics. The theory and empirical research conducted in these two overlapping areas has concentrated on the identification of efficient solutions to environmental and resource depletion problems. Such solutions, while having done much to rectify the often flagrant disregard of the value of the environment, cannot ultimately determine whether or not the overall system will meet either goal of intergenerational equity or maintenance of ecological integrity.

2.3.3 Economic Growth and Limits

The unresolved question of scale also has important implications for the phenomenon of economic growth, or increased economic output, as measured by annual changes in the Gross National Product or Gross Domestic Product[20] of an economy. After a long period when the earlier concern of classical economists with long term growth patterns was largely "sidelined" (Pearce and Turner, 1990:10), economic growth has taken on and held a leading role in what is conceived to be a nation's development. In the period since World War II, "economists and politicians from all nations, rich and poor,

---

[19] Loss of biodiversity is not a phenomenon of importance only in the great centres of diversity, such as tropical rainforests, or coral reefs. McGlone, (1989: 166) makes reference to the major extinction period which began in New Zealand approximately 1000 years ago and continues to the present. Over 30 species and subspecies have been eliminated from the main islands and many others are now rare and uncommon. These extinctions McGlone ascribes primarily to human fires, introduced mammals, and human predation. He discounts past climatic changes as a significant contributing factor since these began several millennia earlier, and were not sufficiently large to cause such a loss.

[20] The distinction between these two measures arises from whether profits accruing from foreign investments are counted as production in the host (GDP) or the investing (GNP) nation.

capitalist, socialist and mixed, have worshipped at the shrine of economic growth" (Todaro, 1992:114).

While during the 1950s and 60s the foremost tool for stimulating such economic growth and industrial activity was considered to be national economic planning by the state, this has altered. The growing dominance of neo-classical economic theory, has given new strength to the argument that reduced state involvement in the economy, along with increases in economic efficiency, provide the most favourable conditions for long-term economic growth. In both cases, however, deterioration of environmental quality if considered at all, has often been seen as something to be expected; a "necessary cost of rapid economic growth" (Hufschmidt *et al.*, 1983:1).

Criticism of development and economic theory that stresses economic growth became increasingly strong from elements of the modern environmental movement of the 1960s and 1970s. This movement, described by McCormick (1989:47) as an "environmental revolution", was "more dynamic, more broad-based, more responsive, and won much wider public support" than older *conservation* movements. "Its characteristic concern for the position and role of humanity in the environment and overt political agenda also set it apart from such older movements"[21].

Kenneth Boulding's essay in particular developed the idea of the finite and systemic nature of the globe, and questioned the premise of economic growth:

> "Throughput is by no means a deconsideratum, and is indeed to be regarded as something to be minimized rather than maximized. The essential measure of the success of the economy is not production and consumption at all but the nature, quality and complexity of the total capital stock" (Boulding, 1966, reprinted in Daly and Townsend 1993:304).

In 1970, the *Club of Rome* took this idea further, in the publication of the results from a series of global simulating computer models. In "The Limits to Growth" they predicted the likelihood of global catastrophe within the near future if current trends in resource use and pollution continued unchecked. The critical parameters behind these predictions were pollution; loss of agricultural land to soil erosion, degradation, and desertification;

---

[21] It was also distinctly different from the Progressive Conservation movement of the 1890s to the 1920's, as exemplified by the United States Forest Service. This movement had historically adopted an aim of technical efficiency (Batie 1989:1090) whereby resources should be developed, but with a minimum of waste, and the goal of long term productivity.

and the finitude to the Earth's resources, particularly non-renewable fossil fuels. Publications such as those of the Club of Rome quickly earned their authors the nicknames "Prophets of Doom" and "neo-Malthusians", drawing a comparison to the gloomy early nineteenth century predictions of Thomas Malthus (1766-1834). They were criticised in particular for the self-acknowledged over-simplicity and reductionism of their models, yet the publication served to provoke a string of reports and publications that sought to further examine the relationship between resource scarcity, economic activity, pollution, and land degradation.

2.3.4 The Entropic Debate

Central to the Club of Rome's thesis was an acceptance of limits, particularly limits to economic expansion. This acceptance echoed the earlier writings of Nicolas Georgescu-Roegen (see Daly and Townsend, 1993), an economist who had sought to place the field of economics in a more physical context. Georgescu-Roegen examined economic activity in the light of two fundamental laws of physics: the first and second laws of thermodynamics.

The first of these two laws deals simply with the finite nature of matter and energy. The sum total of matter and energy is constant. It was the second law concerning the availability of energy to produce useful work which had more revolutionary implications, particularly for the field of economics.

"All physical processes [of which economic processes are a subset], natural and technological, proceed in such a way that the availability of energy decreases" (Erlich, 1993:71). This is due to an increase in entropy which is essentially a decrease in order. Any process which lowers the entropy of a particular good, invariably requires an even larger input of low entropy, which in the process is converted to a higher entropic state. Thus Georgescu-Roegen found that all economic activity required sources of low entropy and ultimately converted these to higher entropic states.

Norgaard (1986:325) refers to this law as a "cumulative ... [constraint on the] ... amount of work possible in a closed system over all time". The earth, however, is not a closed system. If it were, this law would truly offer a gloomy outlook, the only issue at stake being how quickly we decide to burn up our available low entropy. The addition of four

and a half billion odd years of solar energy at an annual rate some 26,500 times the current total global consumption (Georgescu-Roegen 1975, reprinted in Daly and Townsend, 1993:100), instead offers an essentially infinite, if somewhat dilute, supply of energy. The cumulative constraint becomes instead a rate constraint, at least as far as energy *availability* is concerned. It is, however, by no means clear that there are not cumulative constraints on the increases in high entropy brought about by economic activity. Pollution and land degradation are but two prominent manifestations of increasing entropy brought about by economic activity.

The outcome of the entropy debate was perhaps not that some level of economic activity could not be sustained indefinitely, but rather that ultimately human survival would depend on external sources of low entropy - solar energy - both as an energy source and as a means to limit increasing entropy brought about by economic activity. It lent the environmental lobby a sound theoretical foothold in the natural sciences on which to found criticisms of the dominant economic philosophy. Economic activity could be clearly seen to have important entropic consequences which had not previously been acknowledged by economists. This foundation was crucial to the emergence of what may be termed an "ecological world view" (Engel, 1990:16), in which human activity was seen as taking place in both a physical and an ecological context and must ultimately conform to the laws of physics and ecology, rather than those of economics.

In 1980, in response to a US presidential request, a group of scientists produced the US Global 2000 Report (Barney, 1980) which examined the foundations of contemporary environmental concerns. This report confirmed the seriousness of these concerns, and in part supported the findings of 'The Limits to Growth'.

The decade which followed, however, brought a series of publications of a significantly different nature. Arising as a direct response to the above report, *was The Resourceful Earth* (Simon and Khan, 1984) which rejected totally the idea of physical limits to growth. This book concentrated on highlighting the shortcomings of studies such as those of the 'Club of Rome' and 'Global 2000'. In reply they laid particular emphasis on the ability of technology not only to mitigate scarcity but to cause resources to become less scarce. This was evidenced in the historical decline in economic scarcity and a corresponding increase in availability of most resources due to ongoing discoveries,

greater efficiency of recovery, and reductions in the cost of extraction. Economic growth was not challenged but advocated as the source of improved welfare and as being essential to technological advancement whereby environmental problems, where they occurred, could be overcome.

Following closely on the heels of *The Resourceful Earth* came *The Global Possible* (Repetto, 1986) which, while acknowledging the importance of global environmental problems, also rejected the physical limits to growth thesis and argued the positive role played by the market in both development and environmental protection. Turner (1988:4) finds that these two documents, as well as the Brundtland Report of 1987, accept in principle that:

> "... the Earth's resources are sufficient to meet long-term human needs. The critical issues under debate therefore, concern the uneven spatial distribution of population relative to natural carrying capacities, together with the extent and degree of inefficient and irrational uses of natural resources."

There also is to be seen in these documents increasing reference to interdependency among nations and to common interests held by both developed and developing nations in both environmental protection and global development. This theme was to be central to the *Brundtland Report* on sustainable development.

2.3.5 Ideological Diversity

From this general debate as to the relationship between the environment, growth and development, Pearce and Turner (1990:13) distil what they consider to be "four basic world views" or "environmental ideologies" within the broad environmental paradigm. These range from that termed "extreme cornucopian" whose adherents stress, as the name suggests, resource abundance and the potential of technology to overcome absolute or *physical scarcity*[22] as a limiting factor; to the "deep ecologists" who tend to advocate strict controls on economic activity and a system of "minimum resource take" (*ibid*:14). In the middle are the "accommodating" and "Communalist" positions, both taking a more moderate position, the former typically accepting the presence of environmental constraints, but arguing nevertheless that sustainable growth is possible and the latter, while questioning economic growth, tend to support decentralisation of

[22] This is in contrast to *economic* scarcity which is acknowledged and supported as the most efficient means of resource allocation.

resource control and communal ownership or access as a means to achieve equity and environmental protection. This classification reduces what is in reality a continuum of positions that ranges to the extremes of both optimism and pessimism. It is nevertheless useful to illustrate the divergence of opinion on this topic.

2.4 Emerging Themes

Despite the diversity of ideological positions the environment/economic development debate developed a number of important themes which were becoming more widely accepted:

- unspecified economic growth is not on its own a sufficient measure of development or well-being, and certainly not equity;
- dynamic economic efficiency, even in a perfectly efficient market, is not equivalent to intergenerational equity;
- adjustments to the discount rate do not offer a universal solution to the problem of environmental protection;
- scale and configuration of economic activity are not adequately placed in the ecological and entropic context in which they take place by the conventional (neo-classical) economic paradigm;
- environmental change is characterised by irreversibility and uncertainty, two concepts that are difficult to incorporate in mainstream economics which normally assumes full knowledge and the ability to substitute;
- the relationship between development and the environment is inescapably international, demanding attention to the respective roles of both poverty and affluence in resource use and environmental degradation, and to the distribution of resources nationally and internationally.

These were the issues with which an integrated approach to the environment and economic development would have to grapple in a climate of ideological diversity on both fronts. That which emerged and which attempted to deal with all of these issues was the call for a form of development which could be sustained indefinitely - sustainable development.

2.4.1 Sustainable Development

One of the documents most seminal to the emergence of sustainability (in the form of sustainable utilisation) as a clearly identified goal was the World Conservation Strategy (IUCN,1980), published by a coalition of international conservation organisations.

In this document, *sustainable utilisation* was advocated as one of three central objectives in this strategy, together with concepts of *eco-development* and the *basic needs approach*. Being a world strategy the publication dealt specifically with the environmental problems of Third World countries

O'Riordan (1988) describes the term "eco-development", as referring to a mode of development which took as its aim improving the welfare of the human population, while still preserving the *integrity* of natural ecosystems. This came in response to a perceived failure of conventional development theory to consider the ecological context in which development took place.

Eco-development also implied development of a location- and culture-specific nature, reflecting existing trends within development theory towards culture-oriented, participatory or grassroots approaches.[23]

The key concepts contained in current understandings of sustainable development, are identifiable in this report: that economic activity or economic development should be inter-generationally equitable and should maintain ecological integrity. Furthermore this strategy was immensely important in developing the idea that environmental protection and sustainability are cental to, rather than in conflict with, the provision of basic needs (O'Riordan, 1988:36). This has also become a central tenet of the mainstream sustainable development paradigm. Critics note that this earlier strategy was more restricted in its coverage. Its focus was directed toward issues of resource conservation, including: (i) maintenance of ecological processes and life support systems; (ii) preservation of genetic diversity; and (iii) ensuring the sustainable utilisation of species and ecosystems. The related but much more controversial issues of population, the international economic and political order, and levels of resource use by more developed countries, were largely left aside (Khosla, 1987).

---

[23] These trends are discussed by Maiava (1989), Long (1984), and Galjart (1981).

2.4.2 Our Common Future

Seven years later, sustainable development was to form the central theme of *Our Common Future* (the Brundtland Report), the report resulting from the World Commission on the Environment and Development (WCED, 1987). This report did much to popularise the concept of sustainability and it is the definition proffered by this report that may be considered the basis of the "mainstream sustainable development paradigm" (Lélé, 1991:611). This definition stated the goal of intergenerational equity as the prime motivator for sustainable development.

> Sustainable development must "meet the needs of the present while not compromising the ability of future generations to meet their own needs" (WCED 1987).

The Bruntland Report stressed the inseparability of economic development issues from environmental issues and, as is evidenced by the chosen title, the global interrelatedness of both. Sustainable development was to be "a goal not just for the developing nations but for industrial ones as well"(WCED, 1987:4).

It is however precisely the relationship between industrialised countries and sustainable development which has been the foundation of much criticism of the sustainability paradigm. This has been directed in particular at the Bruntland Report and at the outcome of the 1992 Earth Summit held in Rio de Janiero. Such criticism centres on the perceived failure of such global initiatives to address the issues of affluence and high consumption in the industrialised countries. The July/August 1992 (p.122) issue of the Ecologist questions why the UN Conference on the Environment and Development (UNCED) secretariat provided conference delegates "with materials for a convention on biodiversity but not on free trade; on forests but not on logging; on climate but not on automobiles".

The industrial revolutions and modernisation of Europe, North America, Japan, and the former Communist Bloc, were not constrained by sustainability requirements. Yet this is what is being asked of developing countries today, on the basis that it will benefit all. This runs the risk of appearing as environmental imperialism in which the aspirations of developing countries are subordinate to the fears of industrialised countries for their own safety. Notably, the sustainable development paradigm emerged in response to environmental movements primarily in industrialised countries and then only after a

realisation that environmental degradation may have profound effects beyond national boundaries.

It is therefore essential that if sustainability is indeed to emerge as "the paradigm for the '90s'", that OECD countries are seen also to be placing their own economic activity on a sustainable footing. These countries combined account for almost 80% of world resource consumption yet contain less than a quarter of the world population (Todaro 1992:203). They contribute disproportionately to global environmental problems, especially in the areas of ozone depletion and climate change.[24] Current rates of consumption, especially of non-renewable fossil fuels as is found in more developed nations (MDC's), imply that development has moved far from the "ecological roots" (as referred to in the Brundtland Report) of these countries, through the use of energy reserves from many other areas which have been built up over millions of years.

The stance taken by the Brundtland Report was strongly growth-oriented.

> "Policy makers guided by the concept of sustainable development will necessarily work to assure that growing economies remain firmly attached to their ecological roots and that these roots are protected and nurtured, *so that they may support growth over the long term*" (WCED, 1987:40, author's italics).

In this statement, it is assumed that not only will economies be growing, but that long term growth is the essential outcome of such ecological nurturing. Among the critical objectives for environment and development policies listed in the report were "reviving growth" and "changing the quality of growth". These two objectives are central to the overall position of the report since it argued both the possibility and the necessity to achieve ecologically sound forms of growth. The assumption is that "growth in economic activity can occur simultaneously with either an improvement or a deterioration in environmental quality" (Lélé, 1991:614), depending on the quality of that growth.

The long-term growth envisioned in the report involved a projected five to ten fold increase in the size of the global economy, prior to stabilisation of levels of population

---

[24] The burning of fossil fuels accounts, either directly or indirectly for some 48% of greenhouse gas emissions (Carley and Christie 1992:34). Given the high levels of consumption of such fuels in MDC's, it is not surprising that the United States, Canada, the former USSR, the European Community and Japan, together contribute 55% of total greenhouse gas emissions (ibid: 33).

and resource use. Such an increase was considered not only practicable but "essential to relieve the great poverty that is deepening in much of the developing world". There is in this argument an implicit acceptance that there is no contradiction between economic growth and sustainability.

While the growth envisioned in the Brundtland Report was not without limit, the five to ten fold increase has drawn strong criticism from those of a more ecocentric persuasion. Daly (1993:269) finds that "the present scale of the economy shows clear signs of unsustainability" and that "multiplying that scale by a factor of 5 to 10 would move us from unsustainability to imminent collapse". For Daly[25] the term *sustainable development*, as it is used in the Brundtland Report, is a synonym for "oxymoronic *sustainable growth*" (*ibid*:268). The latter, it is argued, can only be "logically self-contradictory in a finite non-growing ecosystem".

Daly's view of the impossibility of sustainable growth is not, however, one shared by Pearce *et al.* (1989). In 'Blueprint for a Green Economy' they offer a definition of sustainable economic growth and, in much the same vein as the Brundtland Report, consider that it is precisely making growth and development compatible that is "the challenge of sustainable development" (*ibid*:33). The debate between these two factions has characterised much of the work done on sustainable development, given their apparent irreconcilability.

2.4.3 Environmental Efficiency

Perhaps a mid-point in this debate is the elucidation offered by Jacobs (1991). Here he concurs firstly with the Brundtland argument that different forms of economic activity have very different environmental effects. With a change in the type of economic activity it is possible for GDP to rise while using the same or less resources. Growth may be possible, provided that *environmental efficiency* is also raised to offset the extra throughput (Jacobs, 1991:105). Environmental efficiency is presented as being the

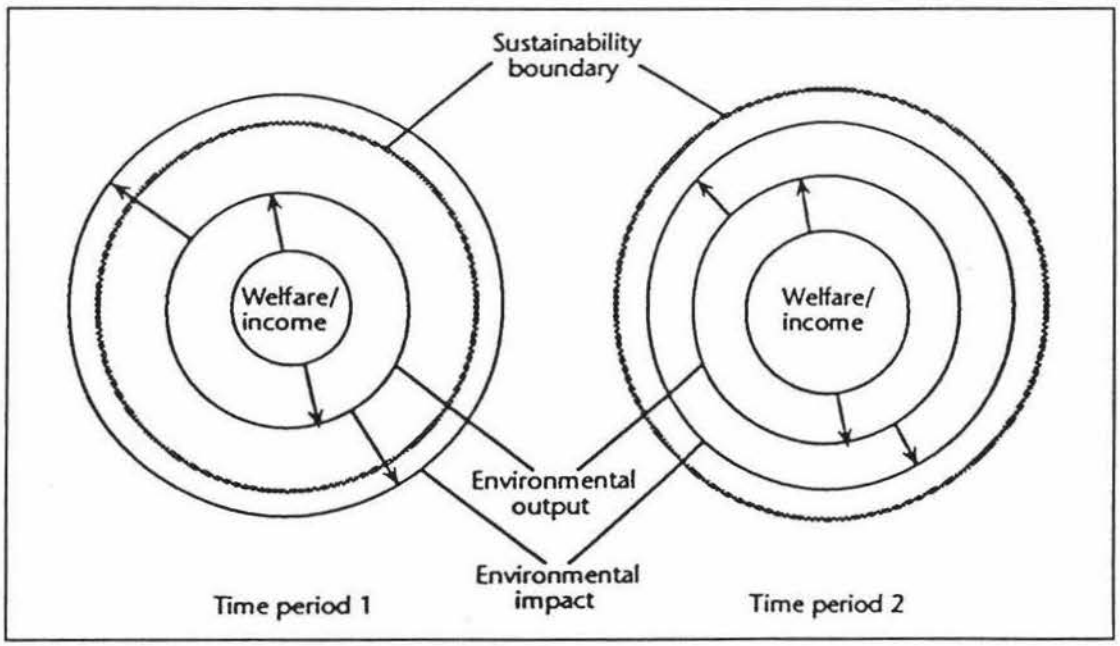
[25] Herman Daly has written extensively on what he terms a "steady-state economy", or one not based on ever-increasing throughput. Examples of these writings are found in Daly (1973a, 1973b, 1993a) and Daly and Townsend (1993). Daly is one of a number of authors of a deep-ecology persuasion who view growth and sustainability as completely incompatible (Townsend 1993). Drawing on Georgescu-Roegen's work on the Laws of Thermodynamics and the principles of ecology he argues that, ultimately, sustainability can only be achieved within a "steady state economy" stabilized at some acceptable level of economic throughput. Naturally this philosophy also implies both a rapid stabilisation of population and resource use per capita and an ultimate return to renewable sources of energy.

relationship between welfare and the environmental impact which the provision of that level of welfare causes. In this sense it is more akin to physical definitions of efficiency that relate output to input, rather than to the economic concept dealing with efficient markets.

Improvements in environmental efficiency can occur at three stages in the production/consumption process: "the amount of production required by a unit of GNP (or of welfare), the amount of environmental output required by a unit of production, and the degree of environmental impact caused by a unit of environmental output" (*ibid*:104). By improving the efficiency of any one of these transformations it is possible to increase the level of well-being through growth without increasing the total environmental effect. This is shown diagrammatically by Jacobs in the Figure 2.1.

This diagram illustrates the theoretical move from time period 1, in which the impact of economic activity exceeds the sustainability boundary, to time period 2, where the level of welfare has been increased significantly, yet environmental impact has been brought back to a level inside the sustainability boundary.

Figure 2.1 - Economic Output and Environmental Efficiency



Source: Jacobs (1991:105).

This diagram presupposes that the initial level of environmental impact falls outside some pre-existing "sustainability boundary", but can be brought back inside through raising the

environmental efficiency. Inevitably one is then led to the conclusion that, ultimately, it is not growth that is of primary concern but rather the current level of economic activity on which that growth is based and the environmental impact which that level of activity causes. This, even at its current level, may in itself be unsustainable.

Current levels of both natural capital and economic activity are the product of historical conditions and are, in that sense, arbitrary. There is no logic that either should automatically be held at the present level. Without disaggregation and analysis of the level, composition and effects of current economic activity, a goal of zero economic growth is no more helpful than is a positive rate. What matters is locating the optimal scale for economic activity and environmental quality. As we have seen, markets may in some cases do an admirable job in achieving an efficient solution but they are singularly inadequate at determining optima.

Whatever position held on the compatibility of the two concepts, growth must be seen as subordinate to the goal of sustainability. The goal set is the sustained well-being for both current and future generations. To this end Caldwell (1990:181) would recast not only *growth* but also *development* as a means toward this goal: development would be "no more be a major policy goal of government than would accounting", both being necessary but not primary objectives. Such a view appears to separate the two concepts. The theme of the Brundtland report was sustainable development and emphasis was laid on the inseparability of the two as a unified objective. If development is a means to achieve sustainability, then sustainability is also the means by which to achieve development.

2.4.4 Economic Efficiency and Equity

Under a guiding principle of sustainability economic efficiency, along with economic growth, takes on a somewhat reduced role. It must be regarded as a goal which may be pursued simultaneously with sustainability, but with full recognition that efficiency is not a purpose in itself, but a tool which society may use to achieve the goals it sets for itself. Efficient solutions need always to be seen as being efficient for a *particular pattern of resource distribution amongst the current generation*. A society which sees equity, the elimination of poverty, or sustainability as appropriate goals for public policy, must be aware that neither efficiency nor growth will lead automatically in those directions.

A maximal understanding of intergenerational equity demands that the activities of current generations do not diminish the capacity of future generations to provide for their welfare. Within the neoclassical approach this is problematic since the welfare of future generations would depend on their preferences which are as yet unborn and unexpressed in today's market. Current generations can in no way know what these preferences will be. Nor is it acceptable to assess the likely welfare of future generations in terms of the preferences exhibited by those currently alive.[26] While it has been shown that dynamic efficiency does not lead to intergenerational equity, this does not indicate what will. How do we determine the level or amount which should be sustained? Resources that are productive and economically viable now, may not be required in the future, particularly if technology were to raise productivity in other areas.

In addition to the uncertainty surrounding future preferences and requirements, lack of understanding of the workings of biophysical systems, combined with the irreversibility of many environmental changes, mean that it is impossible to fully determine the long term effects of such changes in the present, or to value these effects, even in terms of the preferences of today's population. Any attempt to achieve intergenerational equity must operate in this climate of uncertainty and will necessarily be risk averse. It the absence of full knowledge it must seek to *preserve the options* for future generations.

2.4.5 Sustainable Development - a Unifying Concept?

Despite diverging views and ideologies, sustainable development is seen by some as a bridge across the gulf between views at both extremes (Pearce *et al.*, 1989; O'Riordan, 1988; Lélé, 1991; Turner, 1988). The basic premise is that human activity must be compatible with the maintenance of long-term ecological carrying capacity, on which life depends. Both economic growth and development could then be acceptable, provided they were not in conflict with this principle. For Lélé (1991:607) it is the very "broad vagueness" of the term which gives it value as "it allows people with hitherto irreconcilable positions in the environment-development debate, to search for common ground without appearing to compromise their positions".

---

[26] In neo-classical theory, individual preferences are treated largely as an exogenous factor, that is culturally or socially determined, or simply "given". In sharp contrast, writers such as Norgaard (1992, 1994) consider that values and the preferences they cause to be expressed, coevolve with economic, social, and environmental systems, and reflect all of these. In both cases however, future preferences are equally uncertain.

Norgaard (1994:96) also makes a plea for "pluralism" in the approach to sustainable development, though less from an expectation that common ground will necessarily be found, than from an awareness that the perspectives of different writers are profoundly influenced by their own particular background, experiences and research. There is no overarching truth or rule that the individual can comprehend, but only a multiplicity of explanations and insights, each contributing a valid perspective to knowledge. This simply reflects the inherent diversity and contextual nature of biological, ecological, physical, or social systems.

O'Riordan (1988) stresses the tremendous political importance of the pluralism of sustainability as it absorbs the range of environmental ideologies discussed above. Development and the environment are portrain as potentially complementary. This is in marked contrast to the historical conservation and environment movements which took a regulatory approach to environmental protection and had been seen to be anti-development and anti-economic efficiency. While suggesting that such claims may "gloss over" the very real differences between the ends of the ideological spectrum, Caldwell agrees that sustainable development serves as a "conceptual halfway house, between an economistic and technocratic concept" (1990:181) indicating the possibility for reconciliation between traditional regulatory conservation movements and trends towards "market solutions".

Indeed, sustainable development is attractive precisely because it holds out the hope of the fulfilment of human aspirations both of the current generation, as well as those in the future, while maintaining the integrity, diversity and health of the global ecological systems. While not belying the seriousness of the issues, it does not adhere to environmental pessimism or preservation, but to the idea that these can be transformed to offer a positive alternative. (Colby, 1990; Norgaard, 1992).

2.4.6 Sustainability as an Environmental Ethic

Concern for the themes listed in section 2.3 above, can all be seen to be normative, involving value judgements as to the importance of the future state of the Earth. The ethics involved may be divided into two groups: *anthropocentric* and *ecocentric* (Frechette, 1988:114), the former ultimately oriented to human well-being, and the latter to a broader ecological well-being. By seeking to address these issues, sustainability

involves an ethic for the use of nature by humankind. It is not, however, entirely clear, and nor is there a great deal of consensus, as to whether this should be primarily *anthro-* or *eco*-centric.

To a certain extent, the case for eco-centric ethics runs parallel to that for intrinsic values, since both require some acceptance of values that go beyond human preferences. There is a logical difficulty in extending rights to members of other species since *rights* are a social construction and can be defined only by human society. The environment "concedes no rights, only opportunities and penalties" (Caldwell, 1990:177) in the evolutionary process. There is a good case that rights should be extended to sentient beings, since they can experience pain, and one might well argue that such pain should where possible be minimised. Such an extension would however give rise to the apparent arbitrariness of where (between which species or genera) to draw the line.

Frechette's pragmatic and more manageable response is the argument that "we should attempt to implement the radical consequences of accepted athropocentric (egalitarian and utilitarian) theories, before attempting to construct some new environmental ethic" (1988:123). It is felt that the more radical implications of the sustainable development paradigm, in terms of maintaining long term human well being, will achieve the concerns of ecocentrists, such as adequate protection of species and ecosystems, if somewhat by default. This position is also supported by Jacobs (1991:76) when he considers that the application of intra-generational equity principles, in their widest sense, necessitates the preservation of even such ill-defined, qualitative judgments as the "beauty" or "health" of nature for future generations. This must occur irrespective of economic values or the willingness of future generations to pay for such protection. In this sense, antropocentrically based ethic may achieve the same outcome as a much more philosophically complex ecocentric one. Such a position does not exclude the acceptance of intrinsic value of species and ecosystems but is consistent with the inability to compare or trade-off these values with other, socially derived ones. It is perhaps again a case for Norgaard's conceptual plurality.

The anthropocentric moral operative of sustainability has been seen to lend itself to either a *minimalistic* or a *maximalistic* understanding (Jacobs, 1991:72). The Brundtland Report states that "at a minimum, sustainable development must not endanger the natural

systems that support life on Earth. The atmosphere, the waters, the soils and the living beings" (WCED, 1987:45). Jacobs (1991:72) also sees a minimal approach as "the avoidance of environmental catastrophe". Thus under a minimalistic understanding, sustainability would allow the running down of resources, the extinction of species and the degradation of air and water, provided that this did not threaten the world with major environmental catastrophe!

An ethic more appropriate to intergenerational equity, and grounded in welfare economics would be to ensure that current economic activity did not diminish the capacity of future generations to achieve a per capita level of well-being at least equivalent to the level currently enjoyed. This corresponds to Jacobs' (*ibid*) *maximal* understanding that "future generations are left the opportunity to experience a level of environmental consumption at least equal to that of the present generation". It is an understanding encapsulated in the concept of *stewardship* whereby current users of a resource are seen to be stewards with a duty to pass on the resource in a healthy state. Future generations must be assured the same options for its use that current generations now enjoy.

It is argued here, that the only appropriate understanding of sustainability is this latter *maximal* definition, especially given the uncertainty of the effects of ecological change. Indeed only this definition would achieve the level of environmental protection required above. It is recognised that as environmental capacities are progressively reduced, as may occur through deforestation, soil erosion, overfishing, or pollution to a level that diminishes the assimilative capacity of environmental sinks, the difference between these two versions is narrowed.

Several authors consider that sustainability is a broad ethical guiding principle (Horsley, 1991:37; Peet, 1992:209), much akin to such concepts as "liberty, social justice, or democracy" (Jacobs, 1991:60). As such, attempts at definition are difficult. Peet (1992) maintains that, as an ethical guiding principle, sustainability need not be defined in anything other than general terms. Other principles of a similar ethical nature such as *equity*, are equally hard to define, but nevertheless acceptable goals for public policy.

In some cases, sustainable development is used erroneously to denote simply 'successful' or 'stable' development (Lélé, 1991:609). A 'successful' development project may be successful in that it is well designed, caters to the requirements of the beneficiaries, ensures their on-going participation and control, and persists after the removal of aid or external finance, but this does not imply that the project is a sustainable one. These may all be worthy objectives, but failure to examine the ecological implications to the project is to diverge from the crucial implications of the concept.

2.4.7 Biophysical Sustainability

To *preserve the options* for future generations, the capacity for the environment to perform each of the three economic functions it is accorded must be maintained. These are the capacity to: (i) supply resources; (ii) assimilate wastes; and (iii) provide wider environmental services.

For renewable resources maintenance of the capacity for supply means that their use must not exceed their natural regenerative capacity. For non-renewable resources, the corresponding maxim is that their non-recyclable use must be compensated for through the development of renewable substitutes.[27] Waste discharges should not exceed the assimilation capacities of the environment, and these capacities must be maintained or enhanced. Environmental services refers both to the global regulatory functions that are essential to life, as well as to the non-economic benefits that are derived from the environment such as aesthetic or spiritual benefits.

None of this maintenance, however, addresses Jacobs' (1991) concern for the existing capacity of the environment to perform these services. Existing capacity is entirely the product of particular historical conditions. Levels are arbitrary, determined by past actions or inactions, and may not be optimal. Their levels in the future, however, are not arbitrary, but will depend on decisions made today. While these levels may not be optimal, in order to preserve the options of future generations, they must at least be maintained at current levels.

---

[27] This assumes that there exist renewable or manufactured substitutes for such resources, on which to fall back on when scarcity renders them economically attractive.

2.5 Sustainability in New Zealand

In New Zealand, the principles of sustainable development have been incorporated into national legislation under the Resource Management Act (RMA) of 1991[28]. This Act succeeded in bringing together a large amount of separate legislation governing the environment and resource use repealing, in the process, over 60 Acts and amending more than 150 others. The Act took as its purpose: "to promote the sustainable management of natural and physical resources" (Part II, section 5(1)), going on in section 5(2) to define "sustainable management" as:

> "managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well-being and for their safety and health while:
> (a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
> (b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
> (c) Avoiding, remedying or mitigating any adverse effects of activities on the environment."

Thus while the international approach to sustainability has been toward sustainable development, the concept as it is incorporated into the 1991 RMA is the *sustainable management of natural and physical resources*[29]. Although sustainable resource management would have to be considered an integral part of any policy of sustainable development, it is notably more limited in scope. While the principles of intergenerational equity, and environmental protection are equally present in the two terms, the former does not carry the same connotation of an ethic of *intra*-generational equity. It is quite feasible to imagine a situation in which a natural resource such as land were used 'sustainably', such that the carrying capacity or integrity of ecosystems were not being degraded and the options preserved for future generations equalled those of the present, but that coexisted with a high degree of inequality amongst the population.

---

[28] The RMA was not the first piece of New Zealand legislation to espouse the principles of sustainability. The Environment Act 1986, mentions in its long title the "sustainability of natural and physical resources" with natural resources including water, air, soil, minerals and energy. This Act did not however give primacy to sustainability over other objectives.

[29] Initially this was intended to include all such natural and physical resources, whether renewable or non-renewable. For non-renewable mineral resources (such as coal, minerals, natural gas and petrol) however, the difficulties posed by such an approach, and the opposition that this invoked particularly from the mining lobby, led to the exclusion of minerals from the Act.

Thus, issues which under sustainable development are of primary importance, such as poverty, population growth, or the redistribution of wealth, are not necessarily key contributors to sustainable resource management. In the RMA 1991 it appears that sustainability has been adopted in a reduced capacity. While the two ethical aspects concerning future generations remain intact, ethics regarding current generations are excluded.

This was an important point to make since the adoption of sustainable resource management as the operative principle neatly avoids many of the more radical resource redistribution implications of sustainable development. The accepted moral responsibility for current generations to manage resources in such a way as not to disadvantage future generations, does not extend to the disadvantaged of the current generation. Popular ideas such as 'stewardship' or the indigenous concept of *kaitiakitanga*[30] can be incorporated, without questioning the status quo as far as the current distribution of wealth and resources is concerned. Implicitly it is a move back to the utilitarian assumptions underlying neoclassical economic theory. Horsley (1991:365) considers that the Act has imposed "ecological constraints on economic activity, but it has not dealt with wider equity issues or how economic, social, and environmental issues can be integrated or made mutually consistent".

Sustainable resource management also does not invoke the growth versus environment debate which has haunted sustainable development. Sustainable resource management can be seen as a foundation on which both growth and development must be based. Growth in productivity would be acceptable, provided that it did not undermine the productive potential of the resource. Equally, if a system is found to be unsustainable at its current level of production, it may require change, scaling down or redesign, such that it does not continue to degrade the land resource on which it is based. Sustainable growth is not the objective of a policy of sustainable resource management, even though it may be central to government economic policy.

---

[30] The Resource Management Act 1991 demands that persons having powers under the Act, must "have particular regard to" *kaitiakitanga*. This is defined in the Act as "the exercise of guardianship; and in relation to a resource, includes the ethic of stewardship based on the nature of the resource itself." This implies that the ethic is for the care and stewardship of the resource both in the interests of future generations, as well as *for its own sake*.

2.5.1 Primacy of Biophysical Sustainability

Ethically, the purpose of sustainable resource management in the Act, is to enable "people and communities to provide for their social, economic and cultural well-being and for their safety and health". This objective is clearly subject to the constraints listed, but these are means to an anthropocentric end. The Act does, however, accept that sustainability has a "biophysical bottom line" (Blaschke *et al.*, 1991:181) and that this takes primacy over socio-economic concerns (Gow, 1992:8; Fisher, 1991). The Act is about meeting long term human needs and, as such, short term human values become secondary to ecological essentials.

The RMA 1991 as well as the preceding Environment Act 1986, include an acceptance of the intrinsic values of ecosystems, which may be defined as "those aspects of ecosystems and their constituent parts which have value *in their own right*, including (a) their biological diversity; and (b) the essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience" (Forest and Bird 1992: 316, derived from Leopold's 'A Sand County Almanac', 1949).

This acceptance of intrinsic values also provides a stronger imperative to avoid irreversible changes than do intergenerational equity, uncertainty, and the maintenance of ecological integrity alone.

2.5.2 The Hierarchy of Considerations in the RMA

The remaining sections (6), (7), and (8) of Part II of the act "Purpose and Principles", introduce a number of other elements, using distinct phraseology for each. This phraseology indicates a degree of hierarchy among these elements (Milne, 1992:38). This begins with "matters of national importance" section 6 (a), (b), (c), (d), (e), including such items as the preservation of the natural character of the coastal environment , wetlands and lakes and rivers, the protection of outstanding natural features and landscapes, and significant indigenous vegetation and fauna, the maintenance of public access to natural areas, and the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga. Persons exercising functions and powers under the Act, must "recognise and provide for" these matters. Clearly none of these concerns requires an acceptance of intrinsic value in its deeper sense. They may all be shown to be derived from human

considerations of the value of the environment. It is not required, however, that such provision be dependent on the economic value of these matters. The implication of such terms as *preservation*, *protection* and *maintenance*, is rather that these are concerns which go beyond economic valuation.

The second level in this hierarchy (section 7) demands that such persons "have particular regard to ... other matters". This is a significantly lesser obligation than is required above by "to provide for". Notably, it is here that the Act refers specifically to intrinsic values, and to the ethic of *kaitiakitanga* which also assumes protection for nature, beyond its value to humankind. Also included here is "the efficient use and development of natural and physical resources". Its appearance here suggests that while such efficiency should be regarded as important, it is secondary to those matters included in Section 6. It is given the same weight as intrinsic values, kaitiakitanga, amenity values, heritage values, the quality of the environment, and finite characteristics of natural and physical resources, and, the protection of the habitat of trout and salmon. This last item is presumably included since these species are not indigenous, hence they are not provided for in the previous section, despite their importance to amateur fishermen.

Thirdly the Act demands in section 8 that such persons "shall take into account" the principles of the Treaty of Waitangi, an obligation still less demanding than section 7 (Milne, 1992:38).

The RMA 1991 demands that resource allocation decisions that have environmental consequences, be placed in their ecological context, in a manner far more theoretically sound than did environmental impact assessments. The latter were simply one contributing element in the decision making process, without a clear indication of their relative importance, rather than being seen as the bounds within which economic activity must operate.

2.5.3 Sustainable Land Management

In attempting research into sustainability Turner and Meyer (1991) suggest an appropriate division between human sources of environmental change as being those due to *industrial metabolism* and those due to *land use and cover*. The former relates to "the flow of energy and materials through the industrial production-to-consumption-to-

disposal chain of urban society" (*ibid*:669) and the latter to the more self-explanatory human modification of biophysical systems through changes in land use and cover.

While these categories are naturally overlapping, and both are relevant to land use and management in New Zealand, it is primarily the latter that is addressed in the RMA 1991. The exclusion of most non-renewable energy resources from the Act means that consideration of the impact that the use of these resources has on sustainability is limited to the environmental effects of the waste or by-products they produce. Ultimately the sustainability of land use systems, particularly in industrialised countries, will demand that attention be given to the high levels of energy and fertiliser inputs that energy intensive agricultural systems require. This is indicated in the example below which illustrates the importance of fertiliser in maintaining land cover on much of New Zealand's agricultural land.

Fertiliser applications are required to maintain the high chemical fertility in soils required by modern pasture species. All hill country areas that were previously in forest have a tendency toward reversion. It is primarily fertiliser and effective grazing management that minimises this tendency. This potential for reversion through scrub has been assessed by Eyles and Newsome (1987) based on a combination of personal knowledge and New Zealand Land Resource Inventory data. They found that if land in the North Island were destocked and fertiliser withheld, approximately 47% could be expected to revert from pasture to established scrub within 10 years, with another 34% in the following 10 years (See Table 2.1).

Table 2.1 - Potential for North Island Pasture to Revert to Natural Vegetation

Rate of reversion	*Area (ha)*	*% Total Area*
Within 5 years	778,700	12%
5 to 10 years	2,290,800	35%
10 to 20 years	2,206,100	34%
Over 20 years	1,248,200	19%
Total	***6,523,800***	***100%***

Source: Eyles and Newsome (1988)

While this data is far from definitive it does serve to indicate the dependence of current productive pastoral ecosystems, particularly in the North Island, on high-input management systems based on non-renewable resources, and their potential for rapid

reversion under a low-input system. To move away from fertiliser use may be very difficult on substantial areas on currently farmed land. The New Zealand Ecological Society also note (in an unpublished statement) that up to 30% of the nutrients in a New Zealand agro-ecosystem may be exported in any one year as produce. These ecosystems are only sustainable through the use of inorganic fertilisers whose use, as yet, incorporates no requirement for building up renewable resource capacities and can be shown to cause external effects downstream.

While such considerations as these will be critical to long-term sustainable land management in New Zealand this report confines itself to the more narrow implications of land use and vegetative change.

2.5.4 Sustainable Agriculture

In March 1993, the Ministry of Agriculture and Fisheries (MAF) released a policy position paper entitled *Sustainable Agriculture* based on a 1991 discussion paper on the topic (MAF, 1991) and 84 submissions thereon. The submission process appears to have brought about a substantial change in MAF's position from the original document in which it was considered that:

> "Most farming systems in New Zealand are sustainable ... therefore a policy of sustainable agriculture will mean *little change for the majority of farmers in most regions*" (p.10, author's italics).

Reference was made only to three major localised issues - erosion in the Gisborne region, and rabbits and Heiracium on South Island Hill Country - as being possibly unsustainable over time. The paper argued strongly in favour of an approach that integrated and balanced economic, social and environmental concerns into decision making. These assertions were supported by submissions from land owner groups and agribusiness, but strongly challenged by most others (MAF, 1993) as is evidenced by the response from environmental agency, Greenpeace (Watts, 1991).

The subsequent policy position paper included a substantially wider range of issues that required attention but retained its emphasis on integrating socio-economic concerns with environmental ones. Ideas were drawn from submissions and from an international conference on sustainable land management held in Napier in November 1991 (Henriques, 1991). This paper aimed at compliance with the RMA 1991 definition of

sustainable resource management, while proposing a definition of sustainable agriculture for New Zealand:

> "Sustainable agriculture is the use of practices and systems which maintain or enhance:
> • the ability of people and communities to provide for their social and cultural well-being;
> • the economic viability of agriculture;
> • the natural resource base of agriculture;
> • other ecosystems influenced by agricultural activities; and
> • the quality and safety of food and fibre."

As this definition implies, the document emphasises the importance of the economic and social well-being of the agricultural sector. While maintenance or enhancement of the natural resource base of agriculture and of other ecosystems are listed as objectives, these are not accorded a greater priority than the other objectives listed. The document also allows for some short term depletion of resources, such as soil fertility, "when economic survival necessitates" and provided that "such short term actions be undertaken with an awareness of the consequences". The maintenance or enhancement of productivity is a recurring theme in the document, with the aim of natural resource base management being "to maximise any beneficial effects [of management] and maintain the resource base at a level to ensure sustained or improved productivity" (p.6). Some allowance is made for land use change away from unsustainable practices. "Where productivity or viability cannot be maintained, options for diversification or transition to other uses need to be considered" (p.5), but here again it is productivity and viability which are the key motivations for change, not the ecological integrity or resilience of the resource base. The clear primacy given to biophysical sustainability in the RMA 1991 does not appear to be reflected in this document.

The approach of the paper to choices about alternative land use decisions assumes a cost-benefit approach with the aim of maximising the net social benefit. This is thought also to require a "consideration" of the needs of future generations, and a "balance sheet" approach to natural resource use. It is not stated whether such consideration would entail more than mere acknowledgment, nor does it outline what the policy would be for debits or deficits against such a balance sheet. This appears to leave considerable room for land degradation.

In local communities and catchments, the document does find that 'landcare' groups based on those which have achieved substantial success in Australia, may have great

potential for achieving community involvement and control to address issues of mutual concern to various groups.

One of the most recent and extensive attempts to apply the principle of sustainability to an evidently unsustainable system of land use, is that detailed in the South Island High Country Review, the final report arising from the Working Party on Sustainable Land Management (1994). This study also raised many of the difficulties surrounding the practical application of the term which have so far been alluded to here.

The authors recognised the complexity of deriving practical recommendations from the ethereal vagaries of the sustainability debate. Nevertheless, the authors of this study found that, based both on their understanding of environmental-economic interaction and on the interpretation of sustainability of the RMA 1991, the most appropriate conceptual framework was to define a hierarchy of considerations in which there was proposed a biophysical bottom line. The attainment of a system consistent with this bottom line would then require attention to the short and medium-term socio-economic issues. This framework gave rise to three "basic philosophies" on which the reports imperatives, objectives and recommendations were based. The precise wording was as follows:

1. In the long-term, economic and social needs are secondary to ecological sustainability.
2. In the short to medium-term, the economic and social considerations associated with the process of achieving ecological sustainability are fundamental.
3. Market distortion should be avoided where possible. (Working Party on Sustainable Land Management, 1994:9)

The third principle can be seen to be of significantly lesser importance than the first two, and is certainly not sought as a solution.

2.6 Conclusion

In the light of the above discussion, sustainability is best viewed as an ethical constraint on economic activity, such that it may *preserve the options* of future generations. The key reason for the emergence of the sustainability paradigm was the realisation that development, and economic systems in general were not consistent with their ecological or physical context. While the ethical motivation for the adoption of a sustainability principle may be either the more practical anthropocentric concern for intergenerational equity or for the long term survival of the human population, or the less definable

ecocentric concepts of a duty of stewardship or the rights of other species, the operational exigency is always that biophysical sustainability be achieved. This is a pre-requisite to all other aspects of sustainability, be they sustainable development, growth, or associated concepts such as social, economic, or political sustainability[31].

A similar approach to that used by the Working Party on Sustainable Land Management (1994) above, is thus also advocated in this study. It is accepted that biophysical constraints must define the limits of a sustainable system, but that the economic and social imperatives and their interaction with the environment, which have led to the current situation, will also affect, and be affected by, any attempts to meet biophysical constraints. This theme is developed in the following chapter.

[31] The perception of biophysical sustainability as a overriding constraint is also accepted by Gow (1992:8), the New Zealand Ecological Society (unpublished statement) and Daly (1991:35) when he draws an analogy to a plimsoll line of a ship, whereby the maximum weight of cargo which may be safely carried is regulated. This corresponds to the *carrying capacity* of the ecosystem in which economic activity takes place. Daly calls the workings of the market into question, not with regard to their role in resource allocation, which they do admirably, but in their inability to define an upper limit to the overall scale of economic activity. Only biophysical sustainability can address this concern, which is echoed by Pearce and Turner (1990: 42) in their reference to the absence of an *Existence Theorem* in conventional economics.

CHAPTER THREE

Sustainable Land Management on New Zealand Pastoral Hill Country

"There are generally sufficient physical data available to model sustainable land use patterns and there is an operational technique which has been used for this purpose in New Zealand by the soil conservation movement for more than thirty years." (Eyles and Trustrum, 1991:9).

3.1 Introduction

In the previous chapter, sustainability was argued to be a broad ethical goal, which when applied as sustainable development, requires attention to ethics of resource allocation both between generations, and within the current generation. Its incorporation in the RMA 1991, however, reduces its extent to distributional ethics involving future generations and ecosystems. Its application to land use[32] and the issue of soil erosion will therefore deal with the implications that particular land uses have regarding these two concerns.

It was also argued that sustainability has a biophysical bottom line which must set a constraint both on the level and manner in which resources are used. In the long run, it will be the integrity and resilience of ecosystems or more broadly biophysical systems, that will determine whether development, growth or resource management are sustainable. Before such a goal can be aspired to, there must be some identification of this biophysical bottom line, (if not what is sustainable, then at least what would be unsustainable) . The means of achieving biophysical sustainability however, will demand attention to social, economic and political considerations.

This chapter looks at the biophysical processes underlying soil erosion as a form of land degradation, the physical means for its control, and the role of planning and land classification in determining a practical plan of sustainable land management for pastoral hill country. This is followed by a discussion of the economic theory of land use and

[32] Land use here refers to the manner in which land is both used and managed.

degradation, the role of the land manager in the implementation of such a plan, and the appropriate role of policy in advancing sustainable land management.

3.2 Biophysical Sustainability and Soil Erosion

Maintenance of the biophysical sustainability of land will depend heavily on the soil. Since it is the soil which is the base for most terrestrial ecosystems, ecological carrying capacity is closely related to the depth, and fertility of the soil. For renewable resources, a suitable principle for biophysical sustainability, must be that the rate of harvest should not exceed the rate of regeneration (Carley and Christie, 1992:43) and, for soils, this means "the maintenance of soil volume and fertility" (Jacobs, 1991:89). "A land use is sustainable when a resource is consumed at a rate no greater than that at which it can be renewed by natural or other processes" (Shirley, 1989:11).

This represents essentially a stock approach to sustainability, in which practices should seek to maintain the existing stock, in both quantity and quality. The advantage of this approach is that these two aspects can both be measured, thereby providing a means of identifying non-sustainability of systems (Jacobs, 1991).

3.2.1 Land Degradation

The decline in the quantity and quality of agricultural land or 'land degradation', the "*quiet crisis*", is a world wide problem (Blaikie and Brookfield, 1987). In 1989, the Governing Council of the UN Environmental Programme cited "protection against deforestation" and "protection of land resources against desertification and other forms of land degradation" among its top eight global concerns. With specific reference to agriculture and global food security, the Brundtland Report stated that "agricultural production can only be sustained on a long term basis if the land, water, and forests on which it is based, are not degraded" (WCED, 1987:133).[33]

---

[33] History provides numerous examples of land use patterns which persisted for many thousands of years, and others which through the degradation of their land resource, ended in the collapse of the ecological system in which they evolved. In an early paper on soil erosion, Lowdermilk (1935) documents a progression of "man-made deserts" drawing examples from the Sahara, Central Asia, Palestine, the Gobi, Northern China, and South America. Lowdermilk maintains that there exists a direct link between the history of civilisation and the incidence of soil erosion. Two factors are highlighted: the delicately balanced semi-arid or semi-humid sites which were most favourable to early human development, and the subsequent exposure of the soil surface. It was Lowdermilk's thesis that vegetation loss and desertification were not primarily the result of climate change (increasing aridity), but of soil loss due to human agency, and an ensuing decrease in the ability of land to conserve moisture and

A decline in either quantity or quality of the stock of soil, such as occurs through soil erosion, is a major form of land degradation. It has been described as one of the three great dilemmas facing the Third World, along with desertification, and the destruction of tropical rainforest (O'Riordan, 1988), and is of equal concern to many developed countries[34].

Land degradation must be seen as the product of degradation and restorative processes, both of which may be of natural or human origin. Blaikie and Brookfield (1987) allow for both causes of degradation as well as for restorative processes in the following equation:

> *Net degradation = (natural + human induced degradation) - (natural restoration + restorative management).*

There exists for any area of land, subject to soil erosion, a natural rate which would occur in its unmodified natural state under cover of an evolutionary ecosystem. There exists also in this state, a natural rate of soil formation primarily brought about through weathering of parent material, and through the action of plant roots. These two processes combine to produce a net rate of soil degradation or formation that would occur naturally according to the particular combination of soil or rock type, slope, climate, and vegetation present. In the absence of major climatic changes, such a process will tend toward a stable or homeostatic, though evolving, state, at a particular depth of soil and level of fertility. This may be subject to periodic fluctuations associated with climate events, affecting both rates of soil formation and the incidence of erosion. Longer periods of climatic variation will also affect these processes directly, as well as influencing the dominant vegetation.

Grant (1989) in a study of alluvial soils in New Zealand finds that climatic variation accounts for an alternation between short periods of net erosion, and longer intervals of net soil formation. He notes that "in the last 1800 years seven periods of increased storminess, erosion, and alluviation have damaged or destroyed large areas of vegetation

---

support vegetation. In particular, he illustrates this point with the case of the Buddhist temple forests of the Weipei plain in Shensi, China. These forests were protected, while the land around them was cleared for agriculture. They appear now "as 'green emeralds' in an ugly setting of denuded mountains" as the surrounding lands eroded without protective cover.

[34] Soil erosion in developing and developed countries is discussed by Moldenhauer and Hudson (1988).

throughout New Zealand" (*ibid*:132). This finding is supported by McFadgen (1989:147), who notes also that historical depositional (erosion) periods have occurred "largely independent of forest clearance and other cultural influences". Depositional periods occurred between 1770-1800, A.D., again between 1870-1900 A.D., with the most recent beginning in 1950 and continuing through to the present (Grant, 1989:132).

Soils may be seen to be both influenced by, and to influence, the type of vegetation which they support (Park, 1991). Beneath forest, root systems tend to penetrate further into the soil and its parent material, and persist for the longevity of the tree. This increases soil shear strength and allows for longer periods of soil accumulation, producing generally deeper soils than would be found under pasture (O'Loughlin and Ziemer, 1982). Years of leaf-fall lead to the development of a prominent layer of humus, high in organic matter and microbial life, having a significant role in water absorption and retention, and contributing to the physical and chemical fertility of the soil.

When land is brought into production, this state is modified such that some of the biomass which may be produced is captured by the human economy. The ecological change wrought by large scale forest clearance, sowing of pasture, and the introduction of large grazing mammals, such as has occurred in New Zealand is a dramatic one. Relative to the quantity of biomass and genetic diversity which would have been supported by these same areas under natural indigenous forest, European settlers created what Eyles and Trustrum (1991:2) refer to as "a pastoral desert". The reduced bio-diversity which occurs above ground, is matched by a profound change within the soil itself. The maintenance of the micro-organism population and the physical and chemical fertility which supported the forest depended to a large extent on the forest cover itself. With clearance, the prior existing tendency towards homeostasis under a forest ecosystem is profoundly distorted.

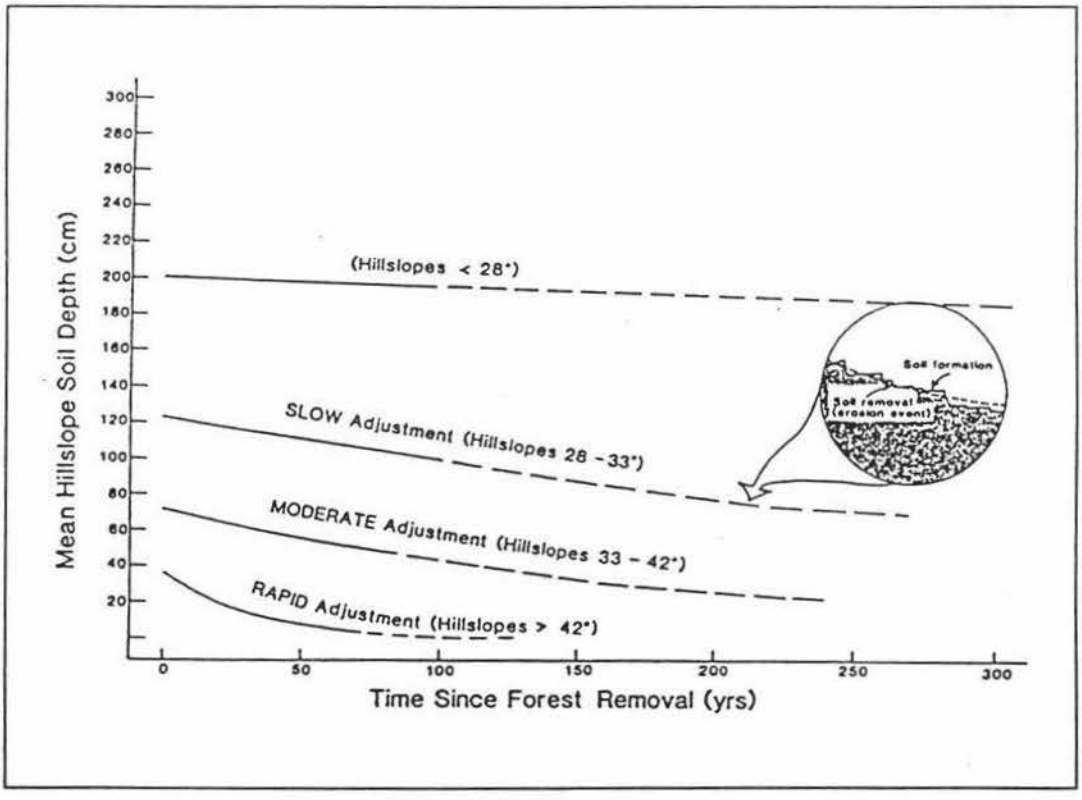
Under a pastoral grazing ecosystem, the system adjusts to re-establish a new homeostatic balance. Rates of erosion increase since the forest had also provided a level of protection from natural erosion, and had contributed to soil formation. Reduced structural support provided by pasture roots, a raised water table, and increased levels of run-off[35], lead to a net loss of soil and a reduction in mean soil depth. In this case

[35] Refer to Appendix III which reviews the literature on the relationship between vegetation and slope stability.

acceleration of the natural rate of erosion is not primarily brought about by climatic variation, though this may well influence the severity of erosion, but by the replacement of native forest with pasture via human action. Of all the depositional periods recorded by both Grant and McFadgen above, the rate of siltation of the Poverty Bay flats in the period since 1932 has been 5 to 10 times greater than for any other (Poole, 1983:68).

The degree to which erosion rates are increased is heavily influenced by slope angle, micro-topography and vegetative cover (DeRose *et al.*, 1991). Trustrum *et al.* (1990) illustrate the rates of decline in mean hillslope soil depth for Taranaki soils since forest clearance (Fig. 3.1). In each case the mean depth of soil under forest is greater on slopes of a lesser gradient while the rate of decline in soil depth following forest clearance increases with slope.

Figure 3.1 - Adjustment of Mean Hillslope Soil Depths following Deforestation.



Source: Trustrum et al. (1990:127).

Eventually the curves of declining soil depth shown will lead to a restored 'steady state' soil depth reflecting a balance between long run soil erosion and formation for the new vegetative cover (*ibid*:127), at a level dependent on slope.

The physical degradation caused by soil erosion also affects the chemical, and biological properties of the soil (Basher *et al.*, 1991:79). Lost soil generally involves a loss in organic matter, and chemical and biological fertility, and new soil formed will be based on lower strata. Fertility levels should eventually fall to a level supported by the action of pasture rooting systems and soil organisms, by the recycling and redispersal of nutrients through animal wastes, and through natural rates of weathering and soil formation.

These processes clearly represent a decline in the ecological carrying capacity of the land. In a pastoral context, declining soil depth is associated with declining pasture productivity (Lambert *et al.*, 1984; Douglas *et al.*, 1986; Hicks, 1993). Hicks (*ibid*:8) concludes from DSIR research into pasture productivity and soil erosion, that "pasture production does not decline indefinitely due to erosion. Eventually it stabilises". Since erosion is initiated by climatic events such as storms, the level at which it stabilises for any given slope and pasture cover will be dependent on the frequency of such storms.

Park (1991:334) notes that when we consider the sustainability of New Zealand soils, we must instinctively think of them as forest soils: "Our most valuable soils did not evolve their fertility in the 150 years they have been under grassland, but during the thousands of years they were under forest". Of themselves, changes in the chemical and biological fertility of a soil need not be irreversible. Any change in land use will involve a change in the homeostatic balance that the system tends towards, and it would be unreasonable to expect fertility levels to remain constant. Over the long run however, such levels should be seen to be able to be maintained, and that the conversion of land to one use should not lessen the capacity of that land to perform other uses.

3.2.2 Land Classification

The Brundtland Report (WCED, 1987:133) stressed the need to delineate "broad land categories" on which land use planning can be based.

In New Zealand, land is classified according to the Land Resource Inventory (NZLRI) into Land Use Capability (LUC) units, a system adopted by the Soil Conservation and Rivers Control Council in 1952. This system includes information on five physical factors of critical importance to long term land use decisions: rock type; soil; slope;

erosion type and severity; and vegetation cover. A breakdown of these units is provided in Appendix I. The system also provides recommendations of the long term potential for particular forms of land use (cropping, grazing, and forestry), and information on soil conservation and water management requirements among other things.

The term *capability* as Blaikie and Brookfield (1987) point out, is not one to be found in economic literature. It is however, one that has been very prominent in the fields of agronomy and soil science. By assessing all the factors listed above, the LUC system gives land use recommendations based on the capability of the land unit to support that particular use over the long term, and identifies the key management requirements that will be required. It does not specify particular recommended land uses on the basis of productivity, or profitability, but "provides the land manager with an assessment of the land's capability for sustained production" under different forms of land use (Eyles 1991:164). Thus it provides a recommendation of a physically determined minimum level of protection; a recommendation of *capability* rather than *suitability*, conceptually comparable to the sustainability constraint discussed earlier, and a valuable tool for land use management (Marden *et al.*, 1989).

While providing an excellent base for land use planning, the precise nature of these units also means that they often form a very complex mosaic when mapped on a detailed scale. This is especially true for East Cape hill country, given the extensive folding and faulting that has occurred there. For this reason, a new system was developed both in and for the East Coast Region, which simplified the basic LUC units into Land Use *Categories*.

3.2.3 Land Use Categories

This system was developed by the East Coast Land Use Planning and Development Study (PBCB, 1978), otherwise known as the "Red Report" to be discussed in greater detail in the following chapter. Land Use Categories were simply amalgamations of LUC units present in the region, having similar susceptibility to erosion, and recommended treatment. This classification divided land into four categories with several sub-categories. The basic descriptions of these categories, as well as their accompanying recommendations and relationship to LUC units are given in Table 3.1. It is these units which form the basis of land use planning in the region (MWD, 1987:Appendix II:4), and which are used in this study.

The reclassification of land carried out in the Red Report is shown below:

Table 3.1 - Land Use Categories

Category 1:	*"Land with a long term future in farming and requiring no erosion control work or only moderate remedial and preventative erosion control treatment"*
1a	River terraces and flood plains, suited to horticulture, cropping or pastoral farming (Classes II and III).
1b	Relatively stable hill country (Classes IV and VI).
Category 2:	*"Land with a long term future in pastoral farming only if intensive erosion control practices are carried out".*
2a	Erosion prone hill country, generally on silt stones and close jointed mudstones (Units VIIe1, 2, 5, 7 and VIIw).
2b	Less stable hill country, generally on loose jointed mudstones and argillites (Units VIIe3, 4, 6, 8, 19 and 21).
Category 3:	*"Land predominantly more suitable for afforestation" but including "some with a future for pastoral farming".*
3a	Steep infertile hill country on sandstones and silt stones, relatively stable (Units VIIe9, 10, 11 and 17).
3b	Undulating to steep hill country, predominantly on banded mudstones, close jointed mudstones, and argillites. Prone to severe earthflow and gully erosion (Units VIIe12, 14, 16 and 20).
3c	Undulating to steep argillites, prone to severe earthflow and gully erosion. Some fractured greywhackes, liable to severe gullying (Units VIIe13, 15 and 18).
Category 4:	*"Land with no potential for primary production". Generally steep hill country on soft fractured greywhackes, or small pockets of argillite. Such land should remain in protection forest. If left untreated, most Category 3c land will eventually deteriorate to Category 4 (Class VIII).*

Source: MoWD (1978:4).

Category 1 land being largely stable, generally requires little erosion control work. Category 2 land usually relates to areas underlain by Tertiary rocks subject to surface land slides and slumps, most of which can be treated either through on-farm conservation works, or afforestation. Category 3b and 3c land is generally located on Cretaceous rock types, and is thus more prone to deep seated earthflows, mass movements, and severe gullying. Land of these categories cannot generally be stabilised through on-farm conservation works.

It must be noted that while the primary basis for the new categories was related to the physical susceptibility of land to erosion, the nature of the predominant erosion, and the need for this to be mitigated, one recommendation, namely that for Category 3a land, appears to be more related to inherent fertility, than to erosion potential. Land in this category is described as being "relatively stable, but steep and infertile" (MWD,

1987:Appendix II:3) and of "low priority for protection" (PBCB, 1978:6). This category along with all Category 3 land, carries a recommendation for afforestation, but unlike Categories 3b and 3c, this is primarily because soils on Category 3a tend to be shallow, drought prone, and of low fertility, making pastoral production "technically possible ... but difficult to maintain without expert management" (*ibid*:22).

This category clearly differs from the others, since pastoral farming would not necessarily cause a decline in the carrying capacity of this land. Afforestation may well be warranted on productivity or profitability grounds, but not on those of biophysical sustainability. While it may be difficult to sustain pastoral farming on land in this category due to low fertility and scrub regeneration, the soil resource would not in fact being substantially degraded.

If the recommendations put forward in the Red Report are considered sufficient to ultimately reduce the rate of soil erosion to approximately that of soil formation, then they represent a plan of "minimum protection", such that land may be sustainably managed in any form of land use that provides at least as much protection against soil erosion as that afforded by the recommended use. This concurs with the position taken by the Inquiry into Planning for Flood Mitigation (Shirley, 1989:17), which found that a sustainable land use policy for the Gisborne District Council area would require an area wide planning scheme, based on land use categories. This would for example allow for Class 2 land "to be pastorally farmed *if erosion control measures are in place* or allow for production forestry on this land" (author's italics). For Classes 3b, 3c and 4 the scheme would allow for "production/protection forestry or for managed reversion of land".

It must of course be realised that Land Use Categories are a broad simplification, subject to considerable variation in individual situations. Thus, while Category 1 land is not deemed to require soil conservation works, some individual units within this category due to their location or proximity to other more erosion prone units may require protective works. Similarly while Category 2 land generally has the potential for long term pastoral use, individual areas may require afforestation, or may form part of a forestry block where existing fence lines or rational forest boundaries are made use of.

Equally, areas of Category 3b and 3c land may be sustainable in pasture if the most severely eroding areas are afforested.

Furthermore these categories cannot be wholly regarded as being based on principles of biophysical sustainability. LUC classifications incorporate information on the existing vegetation type and severity of erosion on any one unit. While factors such as slope, rock, soil or erosion type do not change rapidly, vegetation and erosion severity can. This is especially so where vegetation has been cleared or where there has occurred a severe erosion event in the period since the area was assessed. Thus LUC classifications are not immutable, but can change over time, changing also the recommended treatment. This is more likely to be the case where an area has not been treated according to the basic recommendation.

This ability of LUC classifications to alter should not however be seen as in direct conflict with the biophysical limit. Biophysical limits are themselves not unchanging, but more accurately seen as evolving. Moreover, to establish an unchanging classification would tend to push recommended land uses to the lowest common denominator, thereby understating the productive potential of land if it is properly stewarded. For example, while areas of Category 2 land can, if left untreated, degrade to Category 3, with proper protection, this could be avoided, and productive pasture maintained.

3.3 Methods of Erosion Control

The primary means of controlling pastoral hill country erosion in the East Coast is through re-vegetation, either through a change in land use such as afforestation, or through on-farm plantings which seek to maintain land in pasture. Afforestation has occurred primarily as blanket plantings of *Pinus radiata*, carried out by the New Zealand Forest Service, the local Catchment Board, and private afforesters.

On-farm soil conservation measures have concentrated on plantings of willow and poplar poles, though considerable numbers of debris dams have also been installed generally in conjunction with pole planting, to control individual gullies[36]. These have generally been installed with the assistance of the Catchment Board, though some farmers have

[36] The East Coast Project Review (MWD 1987:Appendix III, Table 1) records a total of almost 13,000 such dams installed between 1958 and 1986.

maintained their own planting operations. The history of progress and policy concerning both afforestation and on-farm soil conservation works in the region is given in Chapter Four.

In general, afforestation is most often used to control earthflows and deep-seated erosion where willow or poplar plantings are of little effect. This corresponds to the recommendations which apply to land use categories 3b and 3c. Luckman and Thompson (1990c:2) note, however, that while these two forms of erosion are distinct, and are generally prevalent on different rock types, they are nevertheless similarly distributed throughout the East Cape. In many areas they may be "associated or mutually dependent".

3.3.1 Effectiveness of Erosion Control Measures

> "When Cyclone Bola struck the East Coast in March 1989, early reports about the extent of damage were somewhat contradictory. Everybody agreed that damage to the hill country was massive. Some local body officials and politicians said that areas in pasture had fallen apart, but areas in bush or pine forest had stood up extremely well. Others claimed they had seen acres of flattened pine trees. Foresters said that native bush had suffered heavy damage, but their pine plantations had survived more or less intact except for local failures. Environmentalists claimed the reverse. It appeared to observers from outside the district, that local people's perceptions of where damage had occurred, depended as much on the organisations they worked for, as on what they had seen with their eyes" (Hicks, 1989b: 1)

Given the longstanding acknowledgment of the erosion prone nature of New Zealand steeplands, and its address primarily through tree planting, a significant amount of research has been conducted into the technical and physical effectiveness of such plantings. This body of research has grown considerably in recent years, as early conservation plantings have matured and, as in the case of forestry plantations, have reached a harvestable age. A clear understanding of the protection value of different forms of vegetation and erosion control measures is important to avoid the confusion and perceived vested interests suggested by the above quote.

In 1988, the arrival of Cyclone Bola caused severe and widespread soil erosion in the East Coast region, yet it also provided an opportunity for numerous studies to examine the effectiveness of forestry and other erosion control plantings and vegetation types following the impact of a severe cyclonic storm and associated flooding. It also produced a body of new research built on over 30 years of experience and

experimentation with erosion control in the region, and which was directly relevant and applicable to the region. The work of relevance to this issue is reviewed in Appendix III with a summary given below.

3.3.2 Pinus Radiata

Research into erosion control via afforestation using *P. radiata* indicates clear and rapid reduction in erosion susceptibility due to the structural support provided by root systems, and to reductions in soil water content. The effectiveness of both these functions is highly dependent on the attainment of site occupancy of both root system and canopy. Site occupancy of the root system could be achieved within 4 years of planting, and of the canopy, within 7 years at higher planting densities (1250-1500 stems per hectare.)

In the first 1-2 years after planting, pine plantations offer effectively no protection against erosion, though erosion incidence decreases rapidly over years 2 to 6. A critical age of 8 years has been established in the literature, beyond which little further gains in slope stability are evident, although this will vary according to the age at which site occupancy is achieved. The increase in protection offered by a pine forest over this age is in the order of 10 times that provided by unprotected pasture.

Post-harvest research indicates that pine roots decay rapidly after felling, though they will persist in the soil for 1-2 years, contributing to slope stability. This may reduce the length of time that an area of land is exposed during one rotation, although the effects of harvest and replanting on renewed erosion will not be known until detailed studies have been conducted of the first conservation forests to be harvested at Mangatu. Early monitoring has failed to record any increase in slope movement after harvest in this area.

3.3.3 Indigenous Forest

Stands of indigenous forest appear to offer a level of protection equal to that provided by established pine plantations over 8 years of age since they maintain near constant site occupancy of roots and canopy. The roots of native tree species tend to be considerably stronger than those of *P. radiata* (FRI, 1981). Research indicates that stands of Manuka/Kanuka offer an intermediate level of protection, and Herbert (1992:3) argues from unpublished data that in respect to the East Coast region "Manuka/Kanuka communities in excess of about 8 years old are as effective as fully stocked radiata

stands". No detailed study of this class of vegetation was found which relates the incidence of erosion with the age and density of the stand.

3.3.4 On-Farm Soil Conservation

Hick's study following the effects of Cyclone Bola on the East Coast, indicated that while failures occurred where on-farm conservation work had been carried out, provided treatment measures had been installed and maintained properly and that they were "appropriate, sufficient, mature and healthy" then erosion on these sites was scarcely greater that on stable hillsides which do not require plantings. This research, plus that of Luckman and Thompson which also found evidence of the effectiveness of on-farm conservation works if well constructed and targeted, affirms the value both of on-farm conservation work, and of the expertise and knowledge built up by the bodies responsible for carrying out these works during the past 40 years.

3.3.5 Towards Biophysically Sustainable Land Use

If the aim of sustainable land management is to maintain or enhance the well-being of the human population over the long term, in order to achieve this we must sustain the ultimate source of that well being - the environment (Gow *et al.*, 1992:8). A policy of sustainable land management therefore, seeks neither to perpetuate nor to prevent particular forms of land use for their own sake. Rather, it seeks to ensure that the use of land by the current generation does not diminish the options of future generations to provide for their welfare to a level at least as great as that enjoyed by the current one. Sustainable land management therefore requires the establishment of a *pattern* of land use and management which, while providing for human well-being, does not diminish the *biophysical* sustainability of the land.

For any area biophysical sustainability requires the maintenance of the ecological carrying capacity of both the land and water, as the basis for both natural and productive ecosystems; it also requires the maintenance of the biodiversity (of both species and ecosystems[37]); and it requires that essential ecological processes and functions are maintained. Each of these requirements is of course related to the others, but even taken together, they do not entail either preservation, or inflexibility of land use.

---

[37] Simpson (1991) discusses the importance from an ecological point of view of maintaining the diversity of both species, and ecosystems. They are in essence complementary, but subject to great interference by human activity.

It is acknowledged that while the issue of sustainability is much broader than soil conservation alone, the extent and severity of erosion in the East Coast region means that stabilising the soil is at least a prior condition to a sustainable system of land use. The recommendations which arise from the application of Land Use Categories represent therefore a "mimimum level of protection" which may provide a basis for the development of a sustainable system.

Sustainability considered as the dynamic, "coevolutionary" process, described by Norgaard (1992:97), would see land use as coevolving with the natural and social systems. The establishment of plantation forestry for eventual clearfelling in place of pasture, must then be regarded as simply one step toward the moving goal post that is a sustainable pattern of land use.

Since both the susceptibility of land to soil erosion, and the history of vegetation change vary widely between different localities, so will the patterns of land use which are both appropriate and sustainable. This was recognised early in the New Zealand soil conservation movement by Kenneth Cumberland (1944:7) when he noted that "soil conservation must be approached regionally and in full knowledge of the intricate interrelation of physical and cultural conditions under which soil wastage has been hastened in differentiated regions".

3.4 The Economics of Land as Property

Under conventional economic theory, land, along with labour and capital, is treated as a scarce (in the economic sense) resource. Its price therefore is determined by the interplay of supply, or the quantity and quality of available land; and demand, governed by alternative uses and their profitability. Land use patterns in a market led economy, are taken to be the result of rational allocation decisions made between alternative uses, be they productive or non-productive (conservation); private or public. In the absence of zoning regulations, the price of land should reflect the expected returns from the most profitable alternative.

Chapter Two outlined the limitations of the market if left to itself, in allocating resources such as land in either an efficient or a socially optimal way. While these limitations are considerable, markets are nonetheless exceedingly powerful institutions in the

distribution of resources . Where the goods and services in question are divisible, rivalrous, do not suffer from externalities or irreversibilities, and have clearly defined property rights, market failure is minimised. While the fulfillment of these conditions does not solve the more intractable problems of the lack of an "existence theorem", or the equity implications of market allocations, it does allow a stronger claim that the resultant distribution lies closer to the efficiency frontier.

In the case of land, however, we find a good which is frequently not easy to divide, which has incompletely defined property rights, and for which externalities and irreversibilities abound. It is not a good which can be left to the play of the market as it currently stands.

3.4.1 The Property Rights of Shifting Ground

The processes of production, consumption, and exchange which occur in a market economy, all depend on the existence of *well specified*, *exclusive*, *transferable*, and *enforceable* property rights (Randall, 1987: 157[38]; Tietenberg, 1992:45). Such rights enable individuals or organisations to exclude others from the benefits accruing from the production, sale or consumption of goods and services produced, thereby providing incentives for such production.

Property rights refer to the right to "use" a resource (Pearce and Turner, 1990:71) and may be either formally (in law) or informally (in practice or custom) defined, yet such rights as are conferred, are seldom absolute. Rather, ownership confers a bundle of rights to the property holder, but also defines limits to the manner or rate at which the resource may be used. In this way, property rights are said to be attenuated.

Property rights to be consistent with Pareto-efficiency must ideally meet all four requirements listed above. That is not to say that the resulting Pareto-efficient solution will be consistent with the moral and ethical norms of society. That will depend more on the initial distribution of property and property rights within the population, since this will ultimately determine society's position on the efficiency possibility frontier. Randall

[38] Randall notes however that in fact, since the specification, transfer and enforcement of property rights involve substantial transaction costs, this indicates that these characteristics of property rights will not be achieved to perfection, but ideally to an economically efficient level.

(*ibid*:160) labels the bias in favour of the existing specification of property rights "conservative reinforcement" since it generally reinforces the *status quo* distribution.

Where, however, property rights do not meet these four criteria, the market cannot be relied upon to result in even an efficient solution. One of the responses to this problem, was that first postulated by Ronald Coase. In his celebrated article, Coase (1960) argued that it matters not to whom property rights are assigned, so long as they are assigned to someone.

The central argument in Coase's theorem was that where no market existed (due to the poor specification of property rights) one should be created. The key lay in the specification and transferability of the rights, and in negotiation, through which an efficient solution could be expected to be induced. In true neo-classical form, such a standpoint regards the status quo situation with impunity, and to whom the rights are issued as irrelevant to the outcome. If however our interest lies not only with the demonstrably insufficient efficiency criterion, but also with that of equity, and how such changes might be equitably distributed, it is essential to remember that while Coase's theorem might arguably lead to numerous *efficient* solutions, it will not lead to *identical* solutions, nor will the distribution of costs and benefits be the same.

In reaction to this obvious shortcoming, Bromley (1988:34) suggests an alternative approach. Rather than simply attempting to establish a system of voluntary exchange, we must first ask:

- who is bearing unwanted costs?
- what is the prevailing institutional set-up that allows this situation to persist?
- who must bear the transaction costs necessary to resolve the situation?
- who gains and who loses by this resolution?

The first question is easily answered even if quantification of such costs is not so simple. In as much as the ecological carrying capacity of the land is degraded, it is future generations who will bear unwanted costs, either of land restoration, of the opportunity cost of lost land, or the less tangible, but irreversible losses of ecosystems or biodiversity.

Land users or dwellers downstream also bear the costs of increased risk of flooding as well as poor water quality and siltation of the marine environment.

The landowner may bear a portion of the cost, but only to the extent that the carrying capacity or value of the land is reduced in his or her lifetime. Even here, if the landowner were able to assess the extent and the cost of this degradation in terms of lost productivity or asset value, then he or she would be able to account for this in their own erosion control measures. The ability of landowners to accurately assess productivity losses due to erosion must however be subject to some uncertainty.

In the case of erosion-prone hill country, the prevailing institutional set-up did not fully define or specify property rights with regard to the right to allow land to erode. In the absence of such definition, simple ownership or title to land conferred what Reeve and Kaine (1991:228) refer to as "*de facto*" rights.

Thus ownership of a hill country property which confers the right to maintain the land in pasture for the purpose of production of meat and wool, may not confer the right to construct buildings without prior permission or apply certain chemical or hormonal pesticides. These rights are formally attenuated through the institutional framework of national and local government. However, the right to maintain areas of land in pasture that are subject to severe erosion susceptibility (such as Categories 3b and 3c, and Category 2 without on-farm soil conservation works), confers the *de facto* right to reduce average soil cover of the land (to all intents and purposes irreversibly), to thereby reduce long term carrying capacity of the land, to contribute to aggradation of local stream and river beds, to increase the risk of flooding with its associated costs downstream, and to deposit sediment over the marine bed in the adjacent bay.

In this case, the owner of the property is not exposed to the full costs of such *de facto* rights. Instead, the process of accelerated soil erosion as is induced when previously bush clad hills are converted to pasture, creates costs (negative externalities) for others downstream and in the future. This is one manifestation of market failure. If, at the time of purchase, prospective buyers were aware that accelerated erosion would result in a steady decline in the productivity of the land, they would adjust their willingness to pay accordingly to ensure a dynamically efficient solution. This however only incorporates

the private cost of land degradation, and the externality experienced by others precludes the possibility of a dynamically efficient outcome for society. Neither would it result in an intergenerationally equitable outcome since future generations will also experience an externality where the resource is degraded. Given that land markets are not always efficient, there is also evidence that the long-run effects of soil erosion, or the value of soil conservation measures are in fact taken into account in land transactions.

In order to clarify the status quo situation, Bromley (1988:36) uses a classification of legal right, which requires analysis of the existing rights. He asks whether such de-facto rights are indeed justifiable rights, or merely privileges. In this situation, since the landowner is imposing unwanted and unwarranted costs on other parties, as well as unquantifiable damage to local ecosystems, the right to erode can only be regarded as a privilege under the prevailing institutional set-up.

The privilege remains in part because unwanted costs currently borne in the present generation, can only be effectively expressed indirectly by moving out of the region. Those who stand to bear costs in the future, are not able to bargain in either the political process, or the economic process of the market, since their interests are not represented in the current market. That is not to say that markets take no account of the future. Clearly they do, as this is the basis of discounting, but analyses are always done on the value of benefits or costs occurring in the future, to those living today. This then is the primary aspect of intergenerational equity which must by addressed in the issue of sustainability.

3.4.2 The Shifting Ground of Property Rights

The introduction of sustainability into both this country's legislation, and into the consciousness of the New Zealand public, has brought with it a changing perception of both the de-facto and formal rights inherent in property ownership, particularly of natural resources such as land, waters, fisheries and forests. Particularly rights which were not formerly legislated, have now been formalised through the political and legal processes as they operate in New Zealand.

Through the new institutional arrangements ushered in by the RMA 1991, New Zealand has moved from a situation in which the future was accorded no rights, to one in which

the future is assigned the right to the bequeathal of a resource endowment that is "not diminished in quantity or quality from that which we inherited" (Bromley, 1988:19). The present generation has then moved from a situation of privilege, to one of duty or obligation. Rather than continuing to degrade land under such arguments as "it may not be needed in the future", or that capital wealth created now will substitute for natural wealth lost, we are charged with ensuring that future generations enjoy access to that land undegraded regardless, so that they may retain the option of using it.

This point is also emphasised by Jacobs (1991) when he argues that while the current stock of natural capital may be arbitrary, and somewhat reduced by the actions of previous generations, this no longer accords the present the right to further wear them down at the expense of the future.

For those who then enjoyed this privilege, the altered situation creates a substantial problem. Local councils are charged with the task of ensuring that resource users meet the principles and requirements of the RMA 1991.

Thus it is when we arrive at Bromley's third question that the debate becomes more intense. Who must bear the transaction costs of changing the situation, has far reaching implications for all concerned. It is also a question which cannot be separated from the fourth question of: who will benefit and who will lose; nor, for that matter, from the first question of: who currently bears the unwanted costs. That which the RMA 1991 does not specify, is who is economically responsible for remedying the situation. For currently severely eroding land, the cost of treatment will be large. All alternatives of production afforestation on land where forestry is not commercially viable, on-farm soil conservation measures, reforestation with permanent forest or even fencing to allow regeneration are expensive, and will not be carried out by the private sector without a large stick or carrot. In many cases it may be prohibitively large for either landowner, or local council to undertake on their own as is argued by Miller (1990).

In implementing erosion control measures on this land, those who will benefit, will primarily be downstream users and future generations. Yet for these, the change would simply be to remedy the undesirable situation of imposed costs or risks which they had been bearing under the status quo.

Setting aside the cost of implementing erosion control measures, existing landowners would also stand to benefit directly, through improved land values, and through the maintenance of the productivity of their land.

By contrast, the wider community of the region, and the country as a whole stand to gain only indirectly. The region may benefit substantially in the long-term, through decreased risk of flooding, and through improved or maintained productivity and rate-value of both the erosion-prone land, and lands and waters downstream.

Under an eroder pays principle, the responsibility for bearing costs of sustainable agriculture should be borne by the land user, as the person who benefits from the land use which causes the erosion. This appears to ensure that the situation of de-facto rights to erode no longer apply, and the eroder bears the full cost of the effects of land use. While in the long-term, this principle has much merit, in the case of a dramatic change in land use, or in the transition from a situation of unsustainable land use to a more sustainable system, it does not follow that the land user should absorb the costs of the transition. Where the erosion problems are serious, these will almost certainly be large capital costs, beyond the capacity of the individual to cover.

That the "eroders" may have benefited from de-facto rights for up to a hundred years on an area of land, does not mean that they will possess the means to effect such change, nor that they were the only party to benefit from their use of the land. The current generation of society as a whole both sanctioned and benefited from the unsustainable land use.

Similarly central government and the country as a whole, it can be argued, stand to gain from long-term tax revenues and from a decreased risk of disastrous flooding, especially if the politically and electorally popular tradition of government relief assistance and compensation in times of great disaster were to continue. On a less tangible level, it is the democratic process - and therefore by extrapolation, the New Zealand population - which has defined sustainability as a worthy and necessary goal for society. The implementation of this principle, is therefore an intangible benefit to the country as a whole, moving it closer to achieving an objective to which it has itself ascribed great value.

The Report of the Inquiry into Planning for Flood Mitigation (Shirley, 1989:19) stresses a need for policy to ensure that rates of soil erosion do not greatly exceed rates of soil formation. This report recommends that "government [central] continue to fund part of the cost of water and soil resource management in the context of a sustainable land use policy in recognition of the off-site benefits and the benefits to future generations".

The collective responsibility of the current generation for rectifying the situation cannot be avoided, due both to the benefits it has accorded us in the past, and from our collective decision to seek and implement change.

3.5 Land Use Change

While legislation and planning may alter the environment in which land use decisions are made, and can advance the cause and motivation for sustainability, ultimately, the responsibility for actual implementation of a more sustainable pattern of land use and management, will fall to individual landowners and managers. It is they who respond to the physical, economic, social, and political environment in the decisions they make.

Despite the confidence which Eyles and Trustrum express in the quote which led this Chapter, data-modelling, planning and technical ability do not in themselves realise what is perhaps the more intractable problem of land use change - that of how to realise a more appropriate pattern of land use. There are many impediments to this change. Swaffield (1991:318) lists several:

- biophysical constraints;
- inadequate capital resources;
- risk aversion;
- lack of information;
- incompatible attitudes;

Of the five impediments listed, two appear to be predominantly personal or psychological in nature, concerning an individual's attitudes or behaviour.

Historically in theories of land use change and innovation, explanations have centred on the values and behaviour of individuals, and their particular personal or psychological traits. The classification of farmers into either "early" or "late" adopters, according to how quickly they adapted to a new innovation, was taken to be determined by such factors as entrepreneurial spirit or traditional conservatism. These notions were applied particularly to rural areas in the Third World, within the theory of modernisation. Explanations sought tended to look to the background, psychology or education of the land manager, their particular attitude to risk, or to the land use or management system in question.

3.5.1 Risk Aversion

McLean (1978) argues that farmers throughout the world are risk averters, concerned as much with risk aversion as with profit maximisation. Traditionally these two objectives are treated in economic theory as being traded off against each other.

Soil erosion and hence sustainability on pastoral hill country is closely associated with extreme climatic events. Molloy *et al.* (1980:139) argue that the long term viability of an agricultural unit "may depend strongly on management which allows for periodic extreme climatic events", and point to "technological optimism" among scientists and planners, who plan for the average rather than the extreme event.

Where, however, government policy insulates the farmer from the effects of extreme events, measures that would otherwise be taken to mitigate or avoid risk may be ignored. This point will be taken up again in Chapter Four with specific regard to the compensation paid out by central government at the time of Cyclone Bola.

In either case, personal perception of the severity of degradation problems[39] could also be important to the willingness to take measures to control them.

3.5.2 Personal Attitudes

Swaffield's reference to incompatible attitudes strikes a chord with much of the literature which attaches importance of the attitudes of land users to sustainability. There have

[39] Rickson *et al.* (1987) found a strong link between farmers' perceptions of both erosion severity on their own farms, and the relationship between soil erosion and declining crop yields, and their adoption of soil conservation measures.

been a number of calls for an accommodating shift in values (Meister and Weber, 1991:4). Eyles and Trustrum (1991:2), speaking from a background on resource planning and management consider that for soil conservation in New Zealand, "those who wish to, will, and those who are not interested are very difficult to involve".

The reasons for such observations could well lie in the particular background of the land-holder. Attitudes to such subjective issues as the desirability of certain types of land use over others, or the importance of land productivity may well arise from a person's background and experience. While calls for a shift in values have their place, the planning process needs still to take account of attitudes which resist change.

3.5.3 Context of Land Management Decisions

This, however, must be regarded as but one side to the story. In 1957, research by a United States economist indicated that such responses were far more readily explained by the relative increase in net income available through the change to different farmers (Griliches, 1957, 1960). Smaller farmers or farmers in different regions faced variable economic circumstances and the value of the innovation (in this case, a new hybrid corn variety) varied accordingly.

Thus, in Swaffield's list of impediments, three out of five relate to the particular context of the land manager, in this case the biophysical, the financial, and the informational. Neither of these examples are meant to be exhaustive in their identification of causative variables. They simply make the point that it is not only attitudes which determine decisions, but also the particular context of the decision maker. This means not simply the economic context, but also the biophysical, social, cultural, and policy context. All can provide potential barriers or impediments to change in land use and management. Moreover, since these areas are closely interrelated. Swaffield (1991:319) goes on to argue that their combined effect may provide a cumulative resistance to change that "greatly exceeds the significance of any individual issue".

The framework in which land use change is viewed here is one which focuses on the land manager as the implementer of change, but in a context shaped by particular economic, social and political context operative on that farm.

3.6 Micro-Economic Context

At the local level a number of contextual factors may strongly influence land use decisions. Land tenure, the type of land-holder, the size and nature of the property, and the financial situation of the land holder will all impact on these decisions.

3.6.1 Land Tenure

Land tenure systems are the institutional rules which define the property rights pertaining to land. Different forms of tenure involve different distributions and specifications of property rights. Land may be held privately, communally, or by the local authority or state. It may be freehold, leasehold, under trusteeship, or company ownership, or any combination of the above. In each case, the tenure of the land will influence land use decisions, some which may be explained in economic terms, but others which derive from different motivations.

In general, the four requirements of non-attenuated property rights will be fulfilled within any of these ownership structures[40], however the individual incentives created by each will vary substantially, as will the efficient solution implied.

This can be clearly demonstrated in the case of leasehold cf. freehold land. In the latter situation, the on-site value of all legal improvements such as fencing or soil conservation measures, will accrue to the land-holder. Should the land be sold, the economic value of these improvements will theoretically be reflected in the price received. In an environment of perfect information and perception, the economically rational response to this situation would be to carry out soil conservation measures up to the point where the marginal private cost equals the marginal private benefit. This would not be a socially efficient level if there occur off-site costs from on-going soil erosion. In the latter case however, given the long period of time required for soil conservation benefits to accrue, a leaseholder would only capture the benefits which occur within the period of the lease. For a leaseholder to carry out soil conservation works to the same level as a freeholder, a guarantee would be required, on the part of the owner, to compensate for the on-going benefits of any such improvements which accrue after the lease has expired. The determination of a fair and accurate estimate of such benefits, would likely pose substantial difficulties.

Different forms of land tenure, may also be indicative of a different relationship between the land-holder(s), and the land. This may have a bearing on the extent to which the profit maximisation is the dominant objective for land use. Land use decisions on communally held land derived from a long-standing family or tribal association may involve factors outside the economic arena. Land on which a farmer both works and lives, may be treated in a manner distinct from that owned and run from a distance, given that in the former case the property is both home and source of income to the individual or family.

3.6.2 Categories of Land Managers

Despite the "persistence of family farming" alluded to by Moran *et al.* (1993:22), the family farm cannot be regarded as the "norm" for land managers and owners. There are a range of categories by which land owners and managers may be classified and it is essential to distinguish between the particular situations faced by each. The categories identified for the case study presented here are outlined in Chapter Five.

For each category of land manager, such as owner/farmers, leaseholders, farm managers, Maori owners or public companies, the economic context of land use decisions varies markedly. Each group differs significantly both in their relationship to the land used, and in their objectives in the management of such land. In the first case, the farmer and family own the land outright, and stand to gain or lose from any improvement or decline in the capital value of the farm. The farm is an asset which may have been inherited from a previous generation, and may be passed on to the next one.

In the second case, the farm is not an asset in the same way. Whether or not the leaseholder stands to gain from improvements to the farm will depend entirely of the conditions of the lease, such as its length, and whether capital improvements made by the leaseholder are to be compensated. In the situation of the hired farm manager, the manager does not benefit directly from the profitability of the farm, but from a wage or salary. In contrast to the precious two groups, the manager is divorced from the risk or potential gains involved in farm ownership.

---

[40] With the notable exception of transferability for communally held Maori land which may be protected from sale.

Nevertheless there may however be a degree of commonality amongst these three groups, if all three both live on and manage the land they farm. It is this group who will be responsible for implementing soil conservation measures.

In addition to the category of land owners already mentioned, a second group of land owners are those who do not live on the land they own. This does not always imply that the land is not managed by the owner. The farm may be leased out or a manager employed, but could also be managed by the owner, who chooses not to live there, or for whom this farm is not the primary source of income.

Where ownership is held collectively, as is generally the case for Maori land, it would not be practicable for all the owners of live there. Many may well live nearby, but it is also likely, given the degree of urbanisation among Maori, that many will also live some distance away. In the case of ownership by a private or public company, a manager is generally employed to work the farm. Again, for each of these situations, the objectives and context of management decisions differs. For the latter situation, a primary objective of profit maximisation may well be a fair assumption. For land under Maori ownership, many would argue that profitability objectives may be subject to strong cultural values regarding the use of land. There is also a difference between land for which ownership is traditional, and land which has simply been purchased, since the latter involves a choice, based on preferences, while traditional owners do not in that sense "choose" ownership of their land.

For those groups that both live on, and farm, a property, such a decision will involve criteria other than pure profit maximisation. This arises due to the fact that a farm is not only a business and source of profit, but also a place to live. In contrast to the situation assumed in most economic models, on a farm, the units of economic production and consumption coincide (Puijk, 1984:134). A farmer and his/her family derive benefits other than profit (or wages) from their farm, according to their particular preferences. This implies that the goal of profit maximisation is but one of a number of objectives that a farmer seeks to achieve in the management of a property. Social considerations such as the quality of education and health services available, may be particularly important where the farmer has a young family. Distances from schools, shops, businesses and other amenities may also influence decisions. Such objectives may be in competition

with profit maximisation. For a farm manager, objectives may include the building up of experience or capital in preparation for a future move.

3.6.3 The Economic Unit

The concept of the "economic unit" is one which derives very much from the development of the family farm ideal in New Zealand agriculture, and Planning Authorities have historically accorded it considerable priority. Strict controls have often been placed on property subdivision, and on small part-time or lifestyle farms, as opposed to those of an area sufficient to support a family (Fowler and Meister, 1983:5), although they point out a decline in concern for this concept among local authorities. The term is however useful to this study, since their exist in the catchment a wide range in the size of properties, some operating as economic units or family farms, while others simply form one farming enterprise among other interests, be they outside employment, or other holdings.

In a situation where an owning family derive virtually all their household income from farm sources, the concept of an economic unit will be very important. A large property will have potential for some land to be taken out of pastoral production and into forestry, without diminishing the ability of the owners to derive sufficient income from the property. However, on a small property, the loss of any land could significantly affect the viability of the unit. The length of time required to grow a forest to maturity mean that this is a crop which contributes nothing to the farm's cashflow for some 30 years, yet requires substantial investment.

For a block planted by commercial foresters, the notion of an economic unit takes on an entirely different significance. Whether a block is an economic unit (read commercially viable) will depend heavily not only on its own size, but also on the size of blocks around it, and its distance from a port or processing facility.

As a term it also has quite particular cultural implications. The size of blocks of land which have remained under Maori ownership may not have been in anyway influenced by the desire for such a block to support one family under private ownership. Shares may be dispersed widely among the particular tribal or sub-tribal group who owns the land,

while individuals may hold shares in numerous small blocks. Several blocks may be farmed together, or barely farmed at all.

Thus the concept of an economic unit is dependent on both the tenure of the land, what it is used for, and the way that it is used. It may be of paramount importance to some land-holders, while for others, it may be of little consequence.

3.6.4 Capital Constraints

As was noted above, the capital required for afforestation means either the ability of the investor to obtain capital from reserves, increased debt or some other arrangement. This will also have a bearing on land use decisions. Where the change is not regarded as being a profitable investment, there would likely be considerable resistance to incurring debt or using reserves to plant trees.

For land held in communal ownership, constraints may be even greater, as the ability to raise a loan may be dependent on the land being able to provide the security. Where land cannot be sold, Maori land-holders may not be able to finance particular changes in land use where outside capital in needed.

3.7 Macro-Economic and Policy Context

Over the historical period in which pastoral farming has been significant in New Zealand, the policy concerning land use and management has changed enormously. Rhoades categorises the development of "European" agriculture in New Zealand into four stages, in which differing strategies and philosophies of land management were reflected in government policy and agricultural research. For Rhoades, these phases have been a *pioneer* phase, in which an expansory, mining philosophy was dominant, to meet objectives of equity and autonomy; a *production* phase which emphasised increased productivity through technology, market development, and price support where necessary; an *economic* phase, in which efficiency of production replaced goals of little specified productivity increases and now, an *ecological* phase, ushered in by the RMA 1991, under which sustainability has become the central philosophy for resource allocation decisions.

One way of interpreting these changes is that used by Valentine (1991:3) when he considers the particular *emergent properties* which policies have tried to maximise at different times. Valentine traces the changing status of several emergent properties, over the course of these four periods. He finds that early high levels of rural autonomy which were acceptable in the earlier phases, have declined. Echoing the discussion on property rights above, the beginnings of the ecological era of the RMA 1991 has involved a substantial loss in autonomy to farmers.

3.7.1 Pastoral Development Policy

The desire to see forest land converted to "productive" pastoral land is one which persisted long beyond the era of deforestation to be described in Chapter Four. Government policies such as the Livestock Incentive Scheme and the Land Development Encouragement Loan Scheme were undertaken to give strong incentives to land users to clear land and to increase pastoral productivity. These policies fit well into Valentine's production phase.

In some cases these policy directives operated in direct conflict with other objectives. A pertinent example of this in the East Coast region, was the existence of both the East Coast Forestry Project, which aimed at taking highly erodible land out of pasture production, and the Land Development Encouragement Loan Scheme. The latter under the stated purpose of the national interest of increased productivity, assisted the clearance of native bush and regrowth vegetation (Fowler and Meister, 1983). Often such clearance took place on land which had been allowed to revert, precisely because it was not commercially viable to apply fertiliser and so maintain pasture, or it could not be adequately fenced and grazed.

The objective of the Loan Scheme was:

> "to encourage the development of unimproved or reverted land for pastoral and agricultural purposes, by ensuring initial capital is available and that work can continue without disruption despite fluctuations in farm income in the first few years of the programme" (McIntosh, 1981:3),

Two separate reviews[41], conducted in anticipation of the scheduled termination of the scheme on March 31, 1981, both pointed to the scheme as having been highly successful. O'Neil (1980:1) indicated that:

> "many farmers have taken advantage of the scheme to undertake worthwhile development of unexploited land. The increase in the effective national farmland area and improved stock-carrying capacity suggest that the scheme has been of great benefit to the farmer and the country as a whole".

Average rates of return in the order of 16% for New Zealand in general were produced from the ex-post cost/benefit analysis carried out by MAF. It is notable that neither review saw fit to take into consideration the classes of land which had been developed under the scheme; this despite the fact that for all North Island regions, the vegetative cover on over 80% of land involved was classified as either "bush" or "scrub and brushweed" (*ibid*:Appendix I).

3.7.2 Forestry versus Farming

The pastoral bias to policy also meant that land use planning during the 1970's and early 1980's was characterised throughout New Zealand, by the existence of conflict and antagonism between forestry and farming interests. The latter were very prevalent on local councils and Planning Tribunals (Fowler and Meister, 1983:62), a factor which frequently led to the view that forestry was a distinctly "second class" land use, requiring "particular treatment" in district planning schemes (Bush-King, 1987:263; Procter, 1986). This was supported in the Town and Country Planning Act 1977, which clearly favoured agriculture over forestry, calling as it did for the "protection of land having a high actual or potential value for the production of food".

Where it was considered that large scale uncontrolled forestry would have disruptive social effects, forestry was often declared a *conditional* land use[42] for "good" agricultural land, without a clear indication that this overriding of the market, was in fact better for society. Meister (1987) lists a bevy of reasons put forward as grounds for such treatment, ranging from gut level dislikes of forestry, or a bias toward food producing land use, to arguments of market failure, or undesirable social effects. He notes that

---

[41] These reviews were conducted by the Rural Banking and Finance Corporation (the body in charge of administering the scheme) and the MAF Economics Division.

[42] Conditional uses of land are those permitted only by consent of the council and are subject to public notification (Fowler and Meister, 1983:3).

while many of these were perhaps ill-founded, some at least were, at the time, well founded social or economic arguments, (such as the external costs of road damage) or based on real experiences of lost services, school closures.

The level of this antagonism between forestry and farming has diminished somewhat. In land use planning, Fowler and Meister (1983:66) find that preoccupations with land being used for food production are being replaced by recognition of land as the basic resource for the production of primary products in general. This is consistent with a move to an emergent property of economic efficiency. This is also evident in the RMA 1991. In contrast to the Town and Country Planning Act, this Act refers much more generally to maintaining "life supporting capacities", and meeting "reasonably foreseeable needs," rather than specifying particular land uses.

Meister (1987:31) in fact concludes that the previous conflict has all but disappeared, with all parties concerned willing to accept that both can live "harmoniously in a symbiotic relationship". This is accounted for by a number of factors including a changed perspective of forestry, as being a source of employment, diversification, and a profitable investment. Such optimism is perhaps a little hasty. In long-established farming districts, the rapid growth of forestry on former farmland would seem still to be viewed with some unease.

In the Gisborne District Council, there is little evidence of continued favouring of farming over forestry interests by local government. With reference to forestry as a means of erosion control, the Council (GDC, 1994:61) stated that:

> "forestry will not be confined to only the more severely eroding land in order to protect the economic viability of the pastoral farming industry and its support services. Forestry is a legitimate interest in its own right. ... The council is anxious to create a positive environment for forestry, because of the soil conservation benefits and considers that any attempt to restrict forestry to certain land classes will detract from the overall attractiveness of the Region to the industry".

Such views have not dispelled public concern over the effects of large areas of formerly pastoral land being converted to forest on agriculture in the region, on the future of such substantial employers as the Weddel Kaiti freezing works (the largest employer in the district with 800 employees), and of stock firms and wool buyers. Concerns were raised by both management and workers over the long term future of the works, and for its

employment value to the high numbers of Ngati Porou who work there (Mr Ned Tibble, Gisborne Herald, 18 May 1993:1; Mr Grant Allen, 15 May 1993:1)[43]. Others argue that forestry returns are uncertain, that spending in the district will be lower for forestry than for agriculture (see "Trees to Lower Local Spending", Gisborne Herald, 24 August 1993).

3.7.3 Agricultural Productivity and Efficiency

The sort of reasoning which accorded primacy to agricultural productivity in the past, is perhaps well illustrated by a paper entitled "Efficiency in New Zealand Agriculture" (Pearson and Corbet 1980) in which considerable emphasis is given to the need to intensify agricultural production and so raise productivity overall. In this paper, efficiency is considered to involve "expansion of the competitive sections" of the economy, but this is then equated with raising productivity per hectare, and "maximising net export value of agricultural products" (*ibid*:161). In their discussion of the stagnation of growth in productivity since the late 1960's, Pearson and Corbet only consider factors such as poor farmer motivation for improving land productivity, urban political bias of a mainly urban electorate, and inflexibilities in the labour or land markets. It is assumed firstly that increased agricultural output would automatically be beneficial to the country, and secondly, that farmers and land managers, by not raising productivity per hectare, were not operating in an economically efficient manner. The possibility that farmers were indeed operating quite efficiently given their particular circumstances and objectives is not raised, and their finding that labour productivity had risen greatly relative to land productivity is attributed to a "lack of enthusiasm in farming circles for improving land productivity" rather than the rising cost and scarcity of labour over the period (*ibid*:154).

3.7.4 The Current Role of Policy

As land use policy has moved into the efficiency and ecological phases, the role of policy and planning has altered. By and large, planning departments, subsidies and regulatory

---

[43] These concerns were not without basis, for within a year of the latter article, it had been announced that the Weddel company had been placed in receivership by its owners, the British Vestey family. The works in Gisborne was to close despite considerable opposition. The fate of the Gisborne Freezing Works must be regarded as more the corollary of past policies which subsidised pastoral production, rather than as a result of forestry in the region.

bodies have been done away with, or replaced by economic instruments which facilitate the finding of a more market solution.

In the Brundtland report it was stated that land should be delineated into broad categories, each defining areas in need of: *enhancement* - of land capable of sustaining intensive use; *prevention* - on land that should not be developed for agriculture, or if already developed, converted to other uses; or *restoration* - of land which has suffered total loss, or drastic reductions in its productivity. This document was not intended to provide a detailed plan by which sustainable land use could be achieved, but rather to define the critical areas of importance, and to argue a general course of action. In the case of land use change on prevention areas, the report does not advocate regulation, but rather a notably "hands off" approach. Decisions should be made "by common consent" (WCED, 1987:133), and government's role in influencing land use on prevention areas should be, by "denial [of] supports and subsidies that would encourage their development for intensive agriculture". The assumption appears to be that the reason land was used unsustainably is because of past market distortion due to support or subsidisation.

MAF (1993:13) defines the role of central government as

> "primarily that of encouraging market-led adjustment to sustainable practices. This can be done through identifying and removing impediments to change."

It is also suggested that government promote a policy of "degrader pays", whereby the resource user should bear the full cost (i.e. include externalities) of resource management practices. It is held that government has a particular role to play where there is a

> "compelling national interest, and where the consequences of non-involvement would impose high risks of unsustainable, cumulative, and major resource degradation; irreversible damage from flooding and other environmental disasters; or exposure of government to high levels of unplanned expenditure due to the inability of local communities to meet the costs of resource degradation" (*ibid:13*)[44].

[44] Two other reasons are included in this list, relating to "potential threats to trade from inadequate or improper management of hazardous wastes; and costly and unacceptable damage to public health and safety". Notably, government is only assigned a role where hazardous wastes threaten trade. Here again the motivation for sustainability is that "consumers worldwide are increasingly concerned about the effects of some farming systems on the environment.

The principles of government involvement in this document advocate (i) the search for an efficient solution, where costs and benefits are fully accounted for and attributed; (ii) local responsibility for problem solving; and (iii) where the private sector investment is not forthcoming, a cost benefit approach to government funding. A fourth principle, which retains the potential to negate all three preceding ones is (iv) consistency with policies regarding the avoidance, remedying and mitigation of adverse effects.

For land users this means that the direction of land use change will be left to the market, with the policy and planning process mapping out as Peet and Gray (1987:24) describe, "the *envelope of physical and ecological constraints* and to indicate clearly those forms of interaction which are also morally and ethically acceptable." Such a role suggests a similar sort of passive government role envisioned in the Brundtland Report, yet the mere defining of boundaries does not address the change required to bring activities currently outside of these boundaries back into line. Land use and management practices on much pastoral hill country are not currently sustainable and the impediments to effecting change are great.

The debate around sustainability has clearly shown that market solutions may be neither efficient, socially optimal, or sustainable. It is likely that in order to effect the changes in land use and management required, both a carrot and a stick will be needed from policy. Perhaps the parameters of the interventionist debate should be altered from an intervention versus a *laissez-faire* approach, to a consideration of what might be *appropriate* intervention versus *inappropriate* intervention.

3.8 Social and Cultural Context

This discussion has not yet addressed the issue of the physical changes in land use. For Category 3 and 4 land currently in pasture, the erosion control measures required involve not only large transition costs, but also a complete change of land use for that area. This has implications far beyond the immediate question of who funds the change. The altered pattern of land use, will also bring huge changes to the nature of the community and economy of an area.

The conversion of large areas of pastoral land to commercial or protection forestry will involve a movement of people off the land, and may involve a declining population

outside of rural townships. These changes will impact on rural schools and services, as well as on the local community. Correspondingly, since forestry in New Zealand tends to be dominated by large commercial companies who employ wage labour, there will be a decline in the number of owner/workers in the area, and a rise in wage labourers.

Alongside any form of land use or community, there is also a culture which depends on that land use. For small communities, the degree of change in culture or community may be large. These changes must also be considered when looking at the process of land use change. They may be central to some of the perceptions which people have about what the change might mean. They are particularly relevant to changes in land use rather than simply changes in management. Where the required change is simply the implementation of on-farm conservation measures, far less disruption would be involved.

3.9 Conclusion

Chapter Two concluded that sustainability requires the identification of biophysical thresholds determined not in the first instance by economics or the workings of the market, but by the biophysical and ecological processes operating in the area, and the impact which particular land uses or vegetative covers have on these processes. This chapter has applied this principle of biophysical sustainability to severely erosion-prone pastoral hill country on the East Coast.

It is argued that, for the East Coast region, the locally developed Land Use Category system offers a practical tool for the definition of minimum levels of protection to ensure the maintenance of the option value of land to future generations. This should be seen as one step toward the "broad ethical goal" of a more sustainable pattern of land use.

Within this boundary, resource allocation will also be governed by other principles or social objectives. The returning of a system to a pattern of land use within this boundary will require specific attention to the current institutional set up, its prevailing or default property rights, and to the social, political and economic contexts within which decisions on the use and management of land are made.

CHAPTER FOUR

Soil Erosion and Land Use Change on the East Coast

> "Land use patterns are an expression of deep political, economic and cultural structures; they don't not change overnight when an ecologist or forester sounds the alarm that a country is losing its resource base" (Eckholm, 1978:167).

4.1 Introduction

This chapter examines the background to soil erosion in the East Coast Region. The history and changing pattern of land use and erosion control on East Coast hill country are traced in relation to the goal of sustainable land use, and to the changing response to the problem among the planners and policy makers.

4.2 Pastoral Hill Country in the East Coast Region

Soil erosion may be regarded as the most serious form of land degradation in the East Coast Region. Land in the region is inherently prone to erosion due to the steep and unstable nature of the terrain and the variable climate. This natural instability has been greatly exacerbated through changes in the dominant land cover.

4.2.1 Physiography of the Region

The Gisborne - East Coast region covers an area of approximately 623,300 hectares (MoWD, 1987: Appendix II), of which 9% is classed as "flat", 12% "rolling", and 79% as "moderately steep to steep" (NWASCO, 1970:4). There are two main river systems: the Waipaoa which drains the southern part of the region and reaches the sea at Gisborne; and the Waiapu which flows north past Ruatoria to Tikitiki. In addition there are several smaller rivers systems, including the upper-reaches of the Hangaroa and Motu Rivers and the Turanganui and the Uawa. It is the latter whose main tributary drains the Hikuwai catchment under study in Chapter Six.

The East Coast may be roughly divided into two broad types of geomorphic terrain, corresponding to areas underlain by rocks formed in either the Cretaceous or Tertiary ages (Marden, 1989:3). The rocks which make up these two types have notably different properties, which can be observed in the forms of erosion which predominate on each.

Within each of these two categories there exists a wide variety of individual rock types, each with differing erosion characteristics. The situation is made more complex by the severe tectonic activity that has occurred in the region and is partly responsible for the rugged nature of the terrain. This activity has caused considerable structural deformation and interbedding of underlying rock-types, creating a somewhat bewildering mosaic.

Rocks of the Cretaceous age (argillites, greywhackes, and basalts), tend to be concentrated in the Western part of the region, and are thus more commonly found at higher altitudes (1200-1400 m a.s.l.), and under conditions of higher annual rainfall (2000-3800 mm) than their Tertiary counterparts. These rocks are high in clay content, fine grained, with severe tectonic crushing. They are profoundly influenced by the erosive action of water. Typically deep gullies have been cut along water courses, and slopes are dominated by mass movements such as earthflows and deep seated slumps (Varnes, 1978). Previously covered by fertile forest soil and a thick mantle of volcanic ash originating from the Taupo eruption, these layers are now mostly confined to the tops of ridges which have escaped major erosion.

Hill country in the south and east of the region is predominantly underlain by Tertiary rocks, generally of sedimentary origin (mudstones, sandy mudstones, sandstones and limestones). In contrast to area of Cretaceous rocks, these areas often support steep, but comparatively stable, valley slopes and are generally more prone to shallow land sliding, than to deep seated instability. More severe forms of erosion may be present, but usually where the rock sequence is dominated by mudstones, weakened through tectonic crushing. Tertiary rocks also tend to have retained thicker mantles of forest and ash soils, especially on gentler slopes.

Two rocks in particular are of great significance to the erosion problems of the region: soft Tertiary mudstones, and Cretaceous argillites. Both were originally marine deposits, that have since been uplifted and crushed in the process. They are similar in grainsize, mineral content and structure, but differ in the degree to which they have been compacted (MoWD, 1987). Tertiary mudstones tend to disperse into fine silt, which is easily transported to the sea. They erode easily but tend also to be quite fertile, and resultant scars may revegetate rapidly. Cretaceous argillites are much harder, but severely crushed. Movements of these rocks tend to be deep-seated. They do not

disperse, but contribute to rapid aggradation of river and stream beds due to large quantities of relatively coarse material that they supply. Scars left on argillite country do not revegetate easily, but tend to remain active and can develop into large gullies.

More detailed analysis of the geological causes underlying erosion problems in the region is to be found in Gage and Black (1979), and Pearce *et al.* (1981, 1987).

4.2.2 Climate

The high mountains of the Raukumara Range to the west of the region have a major influence on the climate of the East Coast. These mountains shelter the region from the prevailing westerly winds and air reaching the area tends to be warmer and drier than in the west. Summers are generally very dry and temperatures regularly exceed 30° C, although average temperatures decrease and rainfall increases with altitude.

For most of the region, annual rainfall is relatively high. Though it ranges from around 1000 mm on the Poverty Bay Flats to over 2500 mm in the north-west Raukumaras, most hill-country receives between 1500 and 2500 mm (Department of Lands and Survey, 1964:9). This rainfall tends to be concentrated in the winter months but displays high variability in comparison to other parts of New Zealand, particularly in the period December to April (*ibid*)[45].

Associated with this variable rainfall is the susceptibility of the region to large magnitude cyclonic storms of tropical origin, which increased in frequency during the erosive periods discussed in Chapter Three. During the 1980's four such storms hit the region in 1980, 1982 (Cyclone Bernie), 1985, and 1988 (Cyclone Bola). These storms all had an expected recurrence interval of 15 to 100 years (Phillips *et al.*, 1990), though they each centred on different areas.

Such storms, combined with the general alternation between periods of severe drought and heavy rain are key factors contributing to severe erosion of the region's hill country.

---

[45] The variability of rainfall in the area is not a recent phenomenon. Early data collected from Puketiti, in the northern part of the upper-Hikuwai catchment, shows wide monthly and annual variation around an average annual figure of 2128 mm, and numerous exceptionally heavy individual falls. Both 1916 and 1917 recorded a total rainfall of over 3300 mm with the bulk of the excess falling in single months. May 1916 saw a fall of 1169 mm over 10 days. 1938, a year of severe regional flooding, witnessed an annual total of 3353 mm. This included two months of exceptional rainfall, with one fall of 457 mm in 24 hours (Cumberland, 1944:53). This compares with figures recorded during Cyclone Bola at nearby Te Puia Springs, of 700 mm over 4 days (Gisborne District Council - Cyclone Bola information sheet, unpublished).

4.3 Land Use and Vegetation

While the climate, geomorphology and topography of the region all combine to making East Coast hill country highly susceptible to erosion, it has been the dramatic removal of the original forest cover has contributed most to the accelerated erosion process described in Chapter Three.

4.3.1 Pre-European Vegetation and Land use

Prior to the arrival of Europeans, and the emergence of pastoral farming as a dominant land use for steeplands in the East Coast, the region was, unlike some other parts of the country, still almost entirely covered in dense indigenous mixed podocarp and hardwood forest (McGlone, 1989; MoWD, 1987: Appendix II, 2; Williams, 1980)[46].

McGlone (1989) finds evidence of large-scale deforestation on parts of lowland New Zealand by the fires of pre-European Maori, however deforestation on this scale appears to have been limited in the East Coast region. While there is evidence of regular burnings and the existence of clearings with stands of "pyrophitic" manuka, these appear to have been confined largely to the tops of ridges (Jones, 1986: 15) and to coastal areas (Rasch, 1989:6). Early European surveys between 1840 and 1860 also indicate extensive forest cover throughout the hill country of the region (McGlone, 1989:119).

4.3.2 The Establishment Of Pastoral Farming

Until 1870, European settlement in New Zealand concentrated on the tussock grasslands and shrublands to the East of the main ranges on both islands, on which a system of extensive pastoralism was developed. Although Poverty Bay was the first landfall for Captain Cook in 1769, the European presence in the region remained primarily one of traders, whalers and missionaries for nearly 100 years. For a variety of reasons including the reluctance among many East Coast Maori to sell or lease their land, the bloody Maori-Pakeha conflict which dominated the region throughout the 1860's, and the isolated and rugged nature of the district and its terrain, Pakeha settlement was for many years confined to the flats around Turanga (now Gisborne).

---

[46] Forest composition varied both with altitude and with latitude as is described by Rasch (1989:6). Coastal areas tend to be dominated by pohutakawa forest, leading into semi-coastal broadleaved-podocarp forests. Lowland forests included those dominated by tawa, rata, kohekohe, and kahikatea. At higher altitudes, the canopies as today, were dominated by beech species, with black and hard beech on the lower slopes, rising to red and silver varieties, and finally submontane vegetation, which also includes beech, as well as kaikawaka, mountain toatoa, and silver pine (ibid.).

Thus, in 1869 only around 4000 acres of land had been purchased from local Maori. By 1870, however, the supply of unoccupied grassland elsewhere in the country had greatly diminished. Competition for land remained strong and many of the large sheep runs in other areas were being divided up to form family farm units and their pastures developed with imported grasses. Attention soon turned to forested areas such as the East Cape, which would first require clearance, and over the last three decades of the century, substantial areas of land in the region were acquired by both Pakeha settlers and the Crown.

4.3.3 Land Alienation

The primary means by which land was acquired from the local Maori was via purchase or lease, though the crown also confiscated three areas around Poverty Bay, as penalty for Maori involvement in the Land Wars (Oliver, 1971:98)[47]. The process by which land was transferred from Maori to Pakeha or government control was both confused and haphazard (*ibid*:111). Though a Native Land Court was established to investigate ownership and mediate transfers, many transactions occurred outside this process, while others became caught up in litigation. Oliver (*ibid*:99-100) describes the legal structure devised to facilitate and control land transfer as one with "few equals for ineptitude in the history of colonisation ... Yet through the whole infinitely confused process the major object was clumsily and painfully achieved". By 1907, the 4000 acres under settler or Crown ownership had grown to 946,600 (72% of the area) in southern Cook County, and 322,000 (46% of the area) in Waiapu. A further 285,577 acres or 14% of land in both counties was under lease to Pakeha settlers.

In the Tolaga Bay and Tokomaru Bay areas, Oliver (*ibid*:107-111) records the transfer of numerous large blocks of land into European ownership or lease during the 1870s. The areas of several of these impinge in the upper-Hikuwai catchment, including two sold privately, and three which were negotiated in the Land Court, with the facilitation of local government land purchaser, Thomas William Porter. The former properties of Puketiti (area not given, though currently reduced to around 2777 hectares) and Waingaromia No.2 (11,336 hectares) were sold to private buyers, while the latter, including Te Marunga (2834 hectares), Tuakau (3643 hectares) and Tauwhareparae

[47] Oliver notes the arbitrary nature of this confiscation, which saw loss of land by both "loyal" and "rebel" Maori, with no compensation for the former.

(17,813 hectares), were acquired by the crown. The Tauwhareparae block passed quickly into the ownership of the recently formed Gisborne Harbour Board, as an establishment endowment in 1884, where it has since remained, barring the sale of 5200 hectares.

Over this period, much of the alienated land, whether privately or government owned, as well as much Maori land was progressively cleared and burnt. With the sowing of pasture seed, it was developed as grazing lands for the production of wool and - with the advent of refrigerated shipping - meat.

4.3.4 Forest Clearance

This development occurred at a time when the land frontier for agriculture in New Zealand was being rapidly expanded. Given its abundance, native forest was widely regarded as having little value beyond that of timber production for construction, a use which was adequately supplied by selective logging prior to clear felling. The pace and scale of clearance during the latter part of the 19th century were such that some 22.5% of the 1840 forested area in New Zealand was cleared between 1890 and 1900 (estimated by Jackson, 1992:135).

The rapidity at which forest clearance proceeded had an extremely depressing effect on the price of timber. Much of the timber cut was never harvested, but simply burnt, especially in areas remote from large centres of population (Jackson, 1992:133; Roche, 1990:295). In the East Coast region, timber milling did become a significant local industry between 1870 and 1930. In 1902 a railway was constructed to link inland areas in the south with the Port of Gisborne, and substantial quantities of milled rimu and matai were sent to Auckland and Australia (Bray, 1983:12). As elsewhere however, such activities were limited to the most accessible trees and most opportune localities. Few trees were harvested in areas isolated from either port or railway.

During this period the vegetative cover of the region was altered on a massive scale. The area in indigenous forest is now largely confined to the Raukumara State Forest Park. While this park covers an expansive area of 115,552 hectares of the Cape, this is primarily on the north western side of the Raukumara range. To the east it is only the very upper-reaches of the river catchments that remain in substantially unmodified native

vegetation. To the south and east, only scattered remnants remain. These tend to be either secondary or heavily modified forests, considerably altered by human activity, or by browsing (Rasch, 1989:13). The Department of Conservation Protected Natural Areas (PNA) survey of the region, notes the relative dearth of representative vegetation types in much of this latter area. Most of this clearance took place in the late 1800's, and occurred to a greater extent than in the country as a whole.[48]

4.3.5 Impact of Land Use on Vegetation and Ecology

By 1964 indigenous forest cover was recorded as occupying just 17% of the area, while pasture and crops accounted for 69% (Department of Lands and Survey, 1964:75). More recent figures are given below in Table 4.1 based on the 1992 satellite mapping project conducted by Landcare, though these are subject to some uncertainty. Firstly, due to cloud cover and poor imagery, nearly 17% of the region's area was described as "undefined", incorporating a large element of uncertainty into the figures. Secondly the areas shown in the satellite images tend to be gross areas. This may account for the apparently large discrepancy between the area of exotic forestry shown of over 109,000 hectares, and that recorded in National Exotic Forest Description (NEFD) Survey conducted by the Ministry of Forestry which assessed net stocked areas as at 1 April 1993. In the latter, the existing area of exotic forest is given as only 74,791 hectares. The difference can be partially accounted for by the distinction between planted or net stocked areas measured in the NEFD survey, and the gross areas recorded by the satellite imagery, since it is not possible to separate out small areas of scrub or other vegetation within a forest area. It is also possible that the satellite data analysis requires some refinement.

The total area of indigenous forest recorded by Landcare was 43,052 hectares, or just 5.2% of the total area.

Pasture remains the dominant class of vegetation on the region's hill country, accounting for at least 51% of all land. Low levels of fertiliser application and pasture improvement[49] (relative to pastoral hill country elsewhere in the country) have, however,

---

[48] Prior to European arrival, 70% of New Zealand's total area was covered in native bush; the corresponding area today is just 22% (Glasby 1991:65).

[49] The replacement of low producing pasture species and native grasses with higher producing species, especially in the North of the region, has occurred far more slowly than in other parts of New Zealand. In the late 1960s,

helped contribute to the reversion of a considerable area of land to "scrub", or predominantly manuka and/or kanuka shrubland[50]. The area of this class of vegetation has increased significantly in New Zealand in general, but particularly in the East Coast region, due to the extent of primary forest clearance (Rapson, 1992:16). By 1987 it occupied some 4,157,000 hectares and was the second largest class of vegetation in the country after pasture (Newsome, 1987).

Table 4.1 - Land Cover Type in the Gisborne District in 1992.

Vegetation Type	*Total Area (ha)*	*%*
Indigenous Forest	43,052	5.2
Manuka/Kanuka	61,530	7.4
Broadleaf scrub and Fern	25,490	3.1
Exotic Forest	109,536	13.2
Pasture/Crops	422,622	51.0
Bare Ground	25,482	3.1
Undefined	140,189	16.9
Total	***827,901***	***100.0***

Source: Landcare Mapping Project 1992.

In 1964 scrub was classed as the land cover on 12% of the total area of the region, while a further 16% was considered to be "pastures with reversion to scrub and secondary growth" (Department of Lands and Survey, 1964:31). Land falling into the former classification, tended to be more extensive in the northern counties of Matakaoa, Waiapu, and Uawa[51], with these recording between 17 and 19% of their total area in scrub, compared to only 7 and 10% recorded in Waikohu and Cook counties respectively. Under the second classification, 23% of the total area of Waiapu county fell into this category, indicating that over 40% of land in this county was covered by scrub or reverting scrub.

Currently the estimated area in manuka/kanuka in the Gisborne District is substantially less, given as at least 61,530 hectares, or 7.4% of the total area, with other scrub types bringing this total to 10.5%. Again these figures are subject to some uncertainty.

---

improved pasture was confined to about 15% of the total developed area in the Poverty Bay - East Coast district (NWASCO, 1970). Similarly, while fertiliser technology had been in use in New Zealand since the 1920s, and aerial topdressing since the post-World War II period, by 1961 again only 15% of pastoral land in the region was top-dressed. The majority of this 15% was to be found in the Southern catchments.

[50] In recent years the terms of common usage, "scrub" or "scrubland" have been criticised for denigrating or down-playing the significant ecological roles that this class of vegetation may play (Conservation Quorum 9, March 1993). The ecological term "shrubland" is now often used to denote such areas.

The ecological change that is indicated by such a dramatic decline in the area of indigenous forest, by its replacement with pastoral grazing lands and regrowth manuka/kanuka over the past 100-120 years, can only be regarded as extreme.

In the case of indigenous forest it is not only the drastically reduced area which is of significance, but also the decline in the integrity of much of the remaining area. Park (1991:332) calls for greater protection and care of forest remnants which "if surrounded by agriculture and forestry [are] ecologically in trouble." It is these remnants Park argues, that can provide a benchmark against which to measure sustainable land use, but only if they receive adequate protection, and study into the ecological processes currently occurring. Protection of areas of original vegetation is thus important, not only for the protection of the biodiversity that they may house, but also as a yardstick, against which other areas (those in productive ecosystems) may be measured.

The decline in area and integrity of forest in the region has also affected fauna of the area. The Raukumara State Forest Park is now home to a large number of threatened or endangered species, that once were common. These include the kokako, blue duck, parakeet species, kaka, kiwi, weka[52], the New Zealand falcon, Hotchstetter's frog, and both long and short tailed bats. The substantial clearance of forest that has occurred in the region, and the introduction of mammals including rats, possums, goats, cattle, sheep, and deer among others, have contributed to the decline or loss of many species from the region. The stitchbird, saddleback, huia, kakapo, the laughing owl, and reportedly the piopio, are no longer to be found in East Cape forests. In view of the lack of forest in the Waiapu, Turanga and Tiniroto Ecological Districts[53], and the declining populations of some species of indigenous wildlife, Rasch (1989) recommends the protection of all *Sites of Special Wildlife Interest* (SSWI)[54] in these areas.

---

[51] Although tributary to the Uawa river, the upper-Hikuwai river catchment to be studied here in fact falls inside the former Waiapu county boundary.

[52] The East Cape region was until recently a stronghold of the Weka, which was a common sight around farms, waterways, and even in towns. Recent years have seen a sudden decline in numbers.

[53] Ecological districts are used to recognise the unique combinations of vegetation, geology, topography and climate, that give rise to distinctive ecosystems in an area. These three ecological districts comprise mainly all of the cleared pastoral land to the east and south of the Ruakumara State Forest Park. The upper-Hikuwai catchment falls into the Waiapu Ecological District.

[54] These sites include all areas of shrubland and forest larger that 10 hectares, and all wetlands of 0.5 hectares or larger.

To this end, the DOC Protected Natural Areas Programme is a start, since it identifies, surveys, and ranks all areas of remnant native vegetation, according to their representational significance, with a view to protection.

As colonising species, both manuka and kanuka are extremely effective in a wide range of environments due to abundant production of minute seeds that disperse readily and will germinate easily given adequate water and light. Some established shrublands may be "virtually monotypic" (Rapson, 1992:16) containing one species and very little else, though most also include a diversity of other species and often act as nurse crops for the re-establishment of successional forest. This process is assisted by the often dense protective canopy formed by both species. Though generally regarded as a successional stage on the way to a taller forest climax, some areas of shrubland may be semi-permanent, especially "in harsher environments" (*ibid*) or where seed dispersal of other species is poor.

As a land use manuka/kanuka may also perform a number of economic functions, *(Conservation Quorum*, Conservation Division of GDC, March 1993:4). Where it is well established, and forms a canopy, it may provide a level of protection against soil erosion comparable to that of pines (Herbert, 1992:3). As opposed to pine rotations, shrubland does not need to be felled. As mentioned above, shrubland, particularly the higher growing species kanuka may act as a nurse crop to reverting forest, and also to exotic timber species such as Tasmanian Blackwood (*Acacia melanoxyian*), and Macrocarpa (*Cupressus macrocarpa*) or even to indigenous species such as Kauri or Totara. Manuka is also an important source of heating fuel in the district. Alternative uses include manuka honey, which has been shown to have excellent anti-bacterial properties *(Conservation Quorum*, Conservation Division of GDC, March 1993:4), and the distillation of essential oils.

More recently the growth of exotic forestry in the region has added to the changing ecology of the area. Salmon, in an essay on human influence on the Biota of New Zealand writes "second only to the development of pasture lands in New Zealand have been the development of Pine forests from the introduced species *Pinus radiata* .... The ecological change in the country brought about by the growth of these pine forests is as yet little understood, but the introduction and growth of a monoculture on such a vast

scale as is practiced in New Zealand cannot help but have a profound effect on the long term ecology of the area" (1975:647).

That pine forests are in fact large "monocultural" plantations is a point hotly disputed, by writers in the forest industry.

> "Such plantations are the exception rather than the rule... ... and are restricted to areas in the central North Island planted in the first planting boom. ...there is a great variety of understorey plants, usually of native trees, many of which will not have been common in the previous landscape, These species, together with the inherent genetic diversity of radiata pine, belie the myth of biological risk" (Forestry Council, 1980:14).

In the East Coast Region, pine forests account for a larger proportion of total land than for the country as a whole, and this has occurred with great ecological rapidity. The time period required to return the area to some degree of ecological stability, not to say sustainability, may take much longer.

4.3.6 Erosion Severity Acknowledged

The changes in vegetative cover described above, in conjunction with the physical and climatic characteristics of the East Coast area have contributed to an erosion problem of immense proportions. The particular severity of erosion in the region has been widely acknowledged. Once deforested, the natural rate of erosion accelerated rapidly, as noted in the early writings of Hill (1895), and Henderson and Ongley (1920). The former, through information collected by letter from Poverty Bay/East Coast land-holders, found that estimates of the area slipped as a proportion of the combined area of farms surveyed totalled 0.66%. While this does not appear high, much of this country was then not fully deforested. Variation between individual districts and farms was great, with one district recording 3.64% of its area slipped, and individual properties reaching 15%.

J. Henderson and M. J. Ongley, spent three years in the district[55] conducting a number of geological surveys of the area. In their 1920 report, they noted the presence of severe accelerated erosion, due to the removal of forest cover, and evidence of pronounced variation in annual and short term rainfall. Henderson and Ongley projected that the effects of deforestation would be:

---

[55] One such survey was undertaken in the Puketiti area, part of which lies in the upper-Hikuwai catchment under study here.

> "...greatly increased sheet washing of the soils; great increases in the number of slips, slumps, and rain gullies; aggradation of the stream beds; wandering of the streams over valley bottoms; burying of culverts and bridges and more severe and frequent flooding" (Henderson and Ongley, reprinted in *The Conservation Quorum* No.1 March, 1990).

They recommended that all "steep" slopes and headwaters be left in bush and a programme of reforestation be undertaken where clearance of such areas had already taken place.

These recommendations went largely unheeded in the first half of this century, though soil erosion continued. In 1938 the region experienced a brief but intense downpour, which raised streams by up to 18 m, causing severe flooding, and slips and washouts on farms (Thornton, 1938). Cumberland (1944:57) notes that although "the *rainfall* in this particular storm was not unprecedented, the *flood* was well above anything previously known in *pakeha* records or Maori legend". This distinction indicates the greater severity of flooding caused by rainfall which was not extraordinary for the region.

Barely two months later, a period of three days heavy rainfall totalling 1000.76 mm[56] resulted in severe flooding of the Esk river in the Hawkes Bay. In this case the rainfall was extraordinary, but the resultant hill country erosion and siltation downstream was again without precedent (Grant, 1938). McCaskill (1973) attributes to these two East Coast floods and the immediate crises which they provoked, the beginnings of public support for formal soil conservation in New Zealand.

4.3.7 Establishment of Catchment Boards

In 1941, the first major response to the problem of soil conservation came with the Soil Conservation and Rivers Control Act, designed "to make provision for the conservation of soil resources and for the prevention of damage by erosion, and to make better provision with respect to the protection of property from damage by floods" (quoted in Poole, 1983:20). Under this legislation, Catchment Boards were set up in districts throughout New Zealand, served by both locally elected representatives, and public servants. Similarly, funding for the boards came from a combination of locally raised rates, and central government funds, allocated via a national Soil Conservation and Rivers Control Council (SCRCC) also established under the Act.

---

[56] This figure can be compared to that which was recorded during Cyclone Bola on the East Cape in 1988.

These boards were given the power to promote soil conservation in their districts both through the encouragement of voluntary cooperation of farmers and landowners, and through mandatory enforcement. In order to avoid the unpopularity of the latter option, the Poverty Bay Catchment Board has relied heavily on voluntary cooperation. Early works were carried out under the guidance and encouragement of the Board, but were financed by the landowner. Part of the cost of completed works could then be reclaimed from funds provided by the SCRCC. Although compliance was entirely voluntary, the establishment of the boards was a huge step toward the planning and regulation of land uses which degraded the resource.

One of the earliest undertakings of the SCRCC was the commissioning of a book "Soil Erosion in New Zealand" by Kenneth Cumberland (1944). This was the first detailed national study of the geographic incidence and severity of soil erosion in the country. Notably it includes a significant section on the erosion problems peculiar to the East Coast, observing with unashamedly vivid language that:

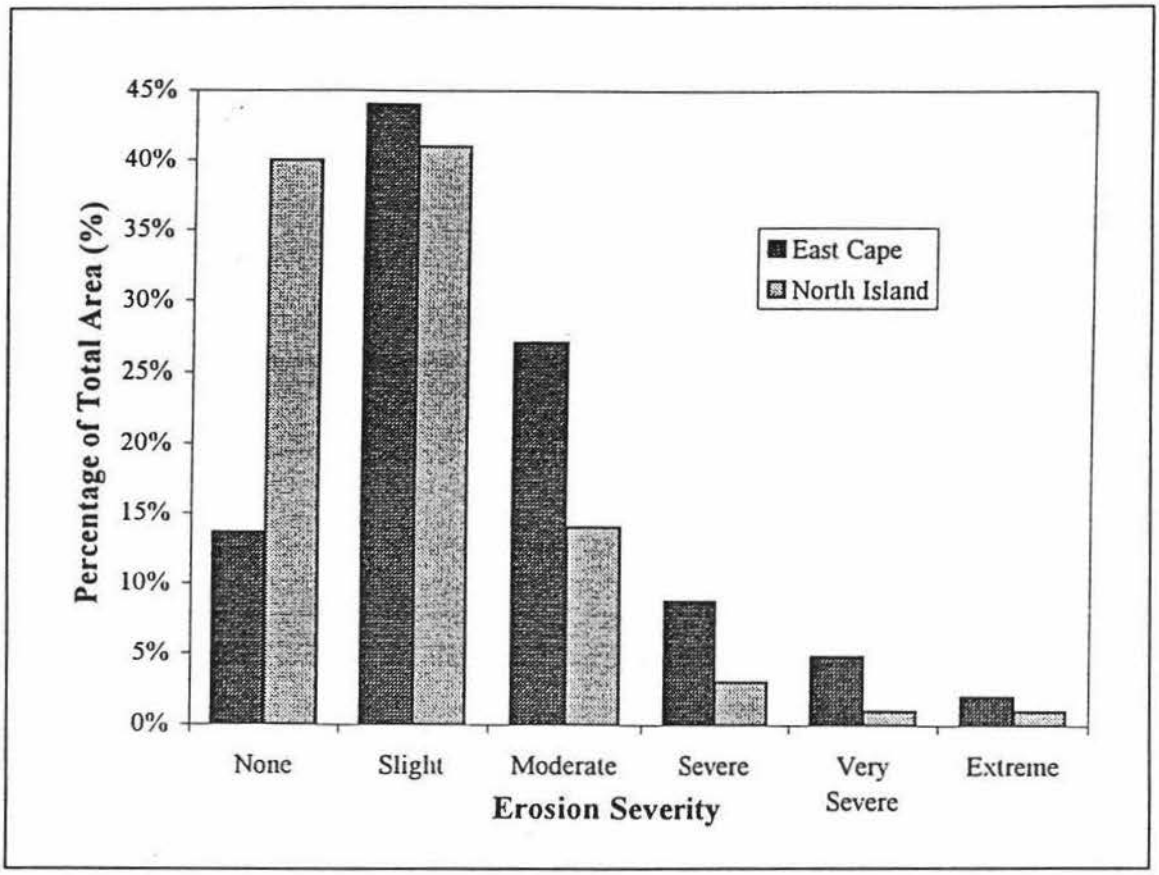
> "...there is no doubt that this entire countryside is crumbling and sliding away with rapidly increasing momentum. Disruption has now reached cataclysmic proportions. Entire valley sides are migrating slowly into their talwegs" (p.53).

Such warnings were again repeated in a subsequent SCRCC publication in 1947 entitled "Down to the Sea in Slips" by D.A. Campbell, though this was not appreciated by all who read it. The council of the day attempted to have this publication banned, considering it to be outlandish and scare-mongering.

In 1970, the Taylor Report declared that "the accelerated erosion of the district is one of the most spectacular examples of its kind anywhere in the world" (NWASCO, 1970:8). The severity of erosion in the region relative to the remainder of the North Island is indicated below in Figure 4.1. It is seen that the region contains a substantially greater proportion of land falling into each of the categories, "moderate", "severe", "very severe", and "extreme", and far less land described as having "none".

While the East Cape represents only 8.9% of the total North Island area, it accounts for over 26% of severe erosion, and over 50% of very severe erosion on the island (*ibid*).

Figure 4.1 - Erosion Severity in the East Cape and the North Island



Source: 1986 Soil Conservation Effectiveness Survey, p.56.

4.4 Forestry for Erosion Control

In 1948, soon after its establishment, the Poverty Bay Catchment Board undertook trials of large scale forestry on eroding gullies in the upper-reaches of the Waipaoa River. Plantings were made using a number of species on areas surrounding the Te Weraroa Stream, one of the most severely eroding sites at the time. These plantings clearly showed that canopy formation greatly reduced runnoff and hence slowed erosion of these gullies (NWASCO, 1970:9). Similar trials aimed at slowing active gullies and protecting riverbanks and riverbeds through both plantings and physical structures, were in contrast rapidly overwhelmed (*ibid*).

4.4.1 Plantings at Mangatu

On the basis of the success of these trial plantings, the SCRCC in 1959, recommended that eroding land in the area be purchased and afforested for the dual purposes of soil conservation and commercial production. This recommendation led to purchases by the

New Zealand Forest Service, and the establishment by 1968 of a 3,300 ha forest at Mangatu, of which about 500 ha was planted solely for protection.

At the same time as upstream plantings were progressing, the Poverty Bay Catchment Board was implementing a flood protection scheme for the Waipaoa River on the Poverty Bay Flats. This scheme, and the trial plantings, followed a series of severe floods in 1938, 1948, and 1950, which served to heighten local concern over hill country erosion and associated aggradation of riverbeds downstream. Such erosion and flood control measures however were confined largely to the Gisborne District and the Waipaoa River catchment, with areas further north remaining unchanged.

Acknowledgment of the area as a special case came in the report of a 1949 Royal Commission on Sheep Farming. This report called for the general abolition of catchment boards, and for their functions to revert to the Lands Department. Following however as it did, in the wake the severe flooding of the previous year[57], the Poverty Bay - East Coast district was singled out as requiring special treatment, due to the magnitude of the problem.

The severity of the problem however was not always evident to all. Then Prime Minister Holyoake remarked on visiting the region than "the crux of the whole problem is highlighted by the need for greater use of fertiliser" (Gisborne Herald, 18 February, 1965). The same article alludes also to the lesser use of available farm finance in the region relative to other areas, and the need for more farm advisers so as to assist in "self-help".

4.4.2 The East Coast Project

In 1963, a Technical Committee of Inquiry was set up by the SCRCC to "inquire into the conservation problems of the Poverty Bay - East Cape district, and to make recommendations on a comprehensive control programme" (NWASCO, 1970:1). The resultant report provided the basis for an ongoing programme of government funded afforestation in the region, which became known as the East Coast Project. It was also

[57] The Gisborne Herald of 16 August 1949 includes an economic survey of this flood. Flooding costs are estimated at £314,356 and are compared with the estimated cost of a (downstream) flood control scheme of £667,000. It was argued that nearly half the cost of such a scheme had been lost due to the single 1948 flood.

the first of a series of reports concerning the progress of the project and of afforestation in the region.

Widely known as the "Taylor" Report after Norman Taylor, former director of the Soil Bureau DSIR, and chairman of the committee which undertook the study, the official name of this document was "Wise Land Use and Community Development - Report of Technical Committee of Inquiry into the Problems of the Poverty Bay - East Cape District of New Zealand." The study examined the historical and physical background to both the erosion problem and to land use and vegetation patterns in the area. It assessed and praised the previous trial plantings and the work and scope of the local catchment board in combating erosion. It also included an analysis of the social and economic problems, and has been described as "one of the most comprehensive plans for regional development ever to have been accepted by a New Zealand Government" (Walton, 1971:39).

The committee went on to analyse five "projects" ranging from the "status quo" which envisioned no intensification of erosion control measures, to "conservation farming on the pastoral foreland and complete afforestation of the critical headwaters area" (NWASCO, 1970:19). These projects were each based on a different proportion of forest to farmland, with increasing emphasis on production forestry, and varying assumptions were made regarding the establishment of sawmills, and plywood factories in the region. Each of these scenarios was subjected to a cost-benefit analysis.

The findings of this report were first presented to the Government in 1967, and were published in a book form in 1970. The committee found that land erosion in much of the region was severe, and required urgent attention. Erosion was seen to hinder the growth and well being of the district, and contributed to an "abnormal and long-continued rate of decline in population, and land values in back-country areas [being] extremely depressed" (*ibid*:1).

The recommendation of the committee was that the project which envisioned the greatest level of forestry be adopted and that it provide the basis for a long range regional plan of land use. Land was separated into two basic areas. The "pastoral foreland" comprising two thirds of the district was to have a long term future in pastoral

farming given the application of adequate on-farm erosion control measures. The remaining "critical headwaters" were recommended as being suitable only for protection/production forestry, contained "the highest and much of the steepest land in the district and is subject to the highest annual rainfall" (NWASCO, 1970: 15).

Of this latter area, a further class described as high watershed and recommended for protection forest was almost entirely under existing native forest which would be left. Some allowance for regeneration of protective scrub on "sub-marginal" land was made. The breakdown of regional land use recommended by the Report is given below.

Table 4.2 - Recommendations of the Taylor Report.

Physical Subdivisions	*Recommendation*	*Area (ha)*	*Total (ha)*
Critical Headwaters	Protection Forest	44,939	
	Protection/Production Forest	93,522	
			138,462
Pastoral Foreland	Sub-marginal Land	48,988	
	Require erosion control	291,093	
	No erosion problem	150,607	
			490,688
Total			*629,150*

Source: NWASCO (1970).

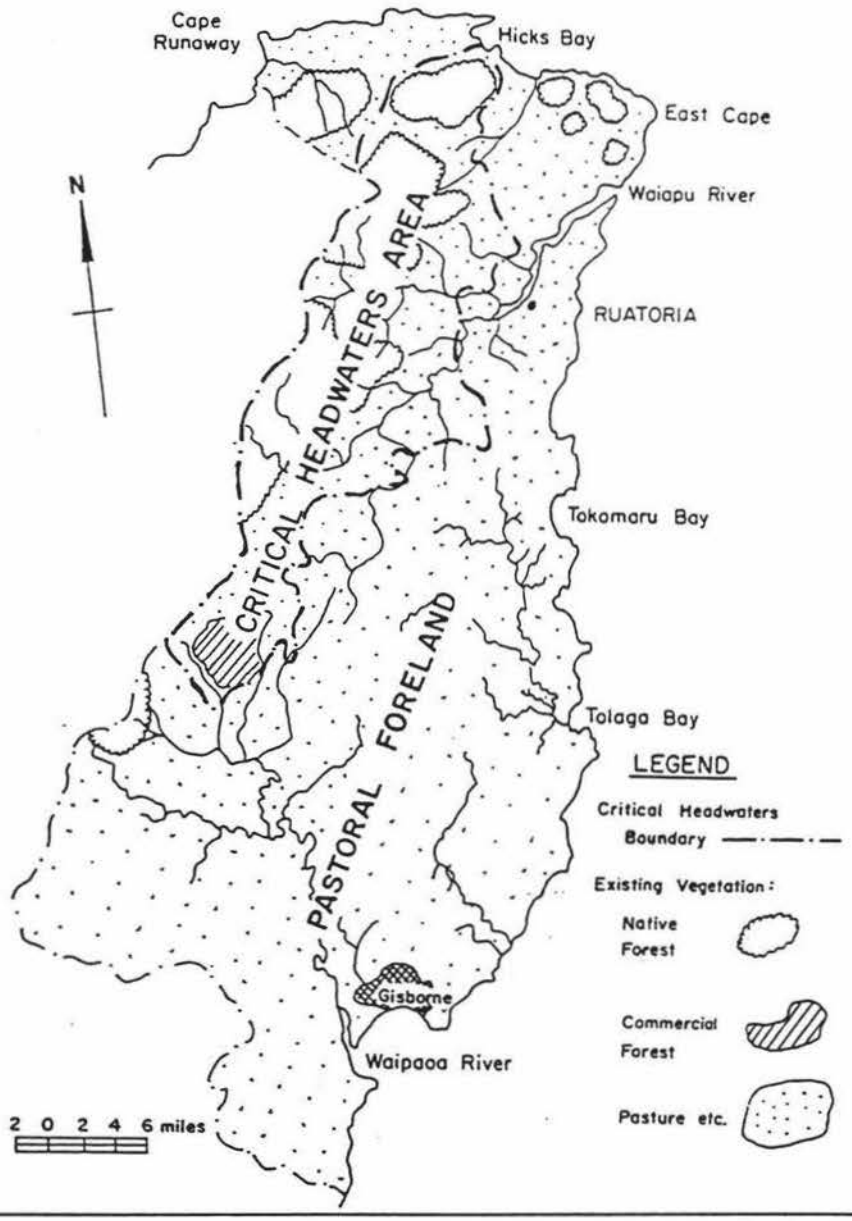
Recommendations were made to Government that a programme of afforestation be undertaken by the Forest Service, whereby the 93,522 acres of unforested land deemed to be the "critical headwaters" would be progressively purchased and planted in dual purpose forest (*ibid*:29). While such purchases were to be intended to be entirely voluntary on the part of the existing landowners, an optimistic annual rate of planting of some 2000 hectares per year was envisioned. In May 1968, these recommendations were acted upon, and the New Zealand Forest Service began a programme of afforestation which became known as the East Coast Project, and which continued up to 1987 when the Service was corporatised.

The division of pastoral from forest land was made with a rather arbitrary and soon to prove highly controversial line, known as the "Blue Line", depicted in Figure 4.2. While the report argued that the "Blue Line" was valid and agreed with existing hydrological data, it also stated that "the boundary between the two areas needs more exact definition, taking into account factors other than the physical ones considered by the committee" (*ibid*:29). The Taylor Report was also limited by the availability of land resource data at

the time, preventing the development of a more detailed division. "Future soil conservation work, whether on catchment, individual farm, or trouble spot basis, should be planned from basic land use capability assessments. This means carrying the present survey into more detail where and as required" (NWASCO, 1970: 32).

Figure 4.2 - The Blue Line dividing the Critical Headwaters from the Pastoral Foreland, with Existing Vegetation for 1967.

This map shows the blue line that divides the two basic categories of land defined in the Taylor report. Only the highest and most remote areas of the critical headwaters remained in native forest at the time of the report, and exotic forest was restricted to the plantings at Mangatu.



Source: NWASCO (1970:16).

This hoped for improvement in definition, however, did not eventuate, and the Blue Line, largely by default, became the operative boundary. As a result, a large number of landowners found that their properties now lay wholly or partially behind the blue line, and carried a recommendation for state purchase and afforestation. Opposition to this development was vocal, and came from both Maori and Pakeha landowners alike. For the former, unwillingness to part with ancestral lands meant that the rather narrow option of state afforestation was unlikely to be taken up by Maori land-holding groups. For the latter, problems of low land values which were alluded to in the Taylor Report, were seen to be compounded due to the changed status of the land, and would pose difficulties in re-establishing a farming venture in other, more prosperous districts. Both considered that the opportunity for consultation and participation in the planning process had been highly inadequate.

In a series of articles in the New Zealand Farmer, Vine (1970a, 1970b, 1970c) detailed the productivity and potential of "blue line country". In doing so, he effectively voiced the opposition of "blue-line country" farmers to the uncompromising nature of the Taylor Report recommendations. In these articles, Vine did not underplay the severity or the extent of the erosion problem, or the fact that on much of the most severely eroding land classes its best means of combat was afforestation. The main concerns raised were that this area,

> "while containing most of the seriously eroding areas, also contains a very large proportion of land not suffering critically from accelerated erosion, and much of this land certainly has a very high potential for pastoral production" (1970c:13).

Vine claimed that the recommendation for "blanket afforestation" of the 200,000 acre area in the critical headwaters not already in native bush, would include about 100,000 acres of land that "is not essential for erosion control". It was argued that in coming to the conclusions it did, the Taylor report had been influenced by the desire of the Forest Service and local businesses that there be established a "major complex of afforestation". The approximately 100,000 acres (40,000 hectares) of land which required planting was considered by the Service to be on its own "unsuitable for production forests because of their scattered nature, type of terrain, difficulties of access and remoteness from a likely market" (*ibid*). Similar sentiments were expressed in an article in the Gisborne Herald

on 1 July 1969 which quoted Mr H.T. Reedy, local farmer and member of the Maori Council as saying:

> "The Taylor Report has been inspired by the thought of business advantages for Gisborne and little if any for the East Coast. I say this for the simple reason that the formidable list of signatures of owners protesting against the report[58] clearly shows that the scheme did not originate from the owners, nor is there a single representative of Federated Farmers on the Gisborne East Coast Research and Development Committee. This demonstrates a despotic disregard and contempt for the feelings and opinions of the owners of this vast area of land before embarking on this colossal project".

In conclusion, Vine listed six concerns that he shared with affected landowners. These are summarised below:

- The recommendation would have a depressing effect on land values.
- Despite assurances that landowners would have a ready buyer as and when they wanted to sell, blocks of land offered to the government at government valuation had already been refused by treasury.
- Government valuation would not enable displaced farmers to re-establish themselves at a comparable living standard elsewhere.
- Incentives to improve land and intensify production were largely gone.
- Affected landowners felt they had not been adequately consulted.

A sixth and most serious concern related to the apparent contradiction between the ministerial assurance[59] that no-one would not be obliged to sell their land against their wishes, and the planned 2000 hectare planting rate. The concern was that "the progress of the scheme itself will generate conditions which leave land-owners with little option but to offer their land "voluntarily" (*ibid*:15).

Despite this controversy, the Forestry Service managed to acquire and afforest substantial areas of land behind the blue line.[60] By 1978, the area acquired had increased to 31,359 hectares, although only a proportion of this had been planted. Of this area, 60

---

[58] This reference is to a document prepared by affected land-owners opposing the project, that was presented to the Poverty Bay East Cape Co-coordinating Committee in that year.

[59] In November 1969, as part of a pre-election address in the region, Hon P.B. Allen the Minister of Works, assured land owners that all land purchases would be voluntary (Gisborne Herald, 18 November 1969).

[60] The most comprehensive studies of the progress of the East Coast Project, is to be found in the Forestry Development Study (1979) and the East Coast Project Review (December 1987), both produced by the Ministry of Works and Development.

percent lay in the Waiapu catchment and 40 percent in the Waipaoa, forming two large forest blocks within the "critical headwaters" area (MoWD, 1979:2.3). While the rate of land purchase varied widely according to the availability of suitable land, plantings proceeded steadily, though at a slower rate than the 2000 ha per year recommendation of the Taylor Report. On the whole, the scheme was reliant on the continued commitment of central government to providing the necessary funding and resources for wholesale purchase and afforestation of the demarcated areas, and on the willingness of landowners to accept the broad categories recommended.

The extent of local dissatisfaction with the "blue line", led in 1978 to a review of the basis of land classification, and the publication of a second document which became known as the "Red Report".

4.4.3 Revised Land Classification

Officially titled "Report on Land Use Planning and Development Study for the Erosion Prone Land of the East Coast Region", this second report was produced by the Poverty Bay Catchment Board (1978), at the suggestion of the National Water and Soil Conservation Organisation, to investigate the inadequacies of the "Blue Line". The report found that "the simple decisive zoning between the Pastoral Foreland and the Critical Headwaters Area .... had served its purpose, but it is now recognised as being too general" (foreword to the Red Report by F.W. Brown, then Chairman of the Poverty Bay Catchment Board). It was stated in this report that while the Taylor report had been:

> "an excellent piece of national planning, ... it initially had no follow up from a regional, district or farm detail point of view. It was announced to the people without warning or explanation. ...landowners were neither aware of, nor understood the implications of the land use proposals" (*ibid*:19).

In its place, the Red Report, following consultation with landowners and Maori, proposed the derivative system of land classification, Land Use Categories, described in Chapter Three. The categories of the Red Report, and the capability class units to which they correspond are further explained in Appendix I. By 1978, LUC classes were mapped for the entire region at a scale of 1:63,360. This scale is sufficient for regional planning, though still somewhat broad for individual farm plans. It enabled Land Use

Categories to be mapped at the regional level at least. Areas of each category to be found in the region are given below in Table 4.3.

Table 4.3 - Land Use Categories by Area of the Region[61]

Land Use	*Former District Boundary*		*New District Boundary*	
Category	*Area (ha)*	*% Total*	*Area (ha)*	*% Total*
1	234,600	38%	337,703	41%
2	173,100	28%	213,383	26%
3a	55,600	9%	92,971	11%
3b	50,300	8%	51,087	6%
3c	65,100	10%	70,724	9%
4	44,600	7%	62,033	7%
Total	***623,300***	***100%***	***827,901***	***100%***

Source: MoWD (1987).

This new classification system had two important implications. Firstly, the previous recommendation for blanket afforestation no longer applied in many areas where these categories formed a mosaic. Secondly, since categories 3b, and 3c, carried recommendations for afforestation with moderate to high priority for protection, the total area requiring afforestation would rise from 93,522 to 115,400 hectares.

Initially the new classifications also ran into opposition from some farmers (MoWD, 1987:16), mainly due to the lack of mapping on a finer scale that would allow delineation of land categories within individual farm boundaries. The need for more detailed mapping was however acknowledged by the Red Report, and was being progressively undertaken by the ECCB. This mapping process laid the groundwork for a plan of land use much more in keeping with the local potential of the land, and more acceptable to land-holders.

4.4.5 The East Coast Planning Study

At the same time as the Red Report was being produced, the East Coast Project was also being reviewed by the Ministry of Works and Development, specifically regarding the economics of forestry development (*The East Coast Planning Study: Forestry Development Options*, 1979). Three alternative scenarios were analysed in this study, including a slow-down of the rate of afforestation, an approximate continuation of the status quo, and an increased rate of forest planting.

[61] The former column pertains to the combined area of the Waiapu, Cook and Waikohu District Councils, while the latter covers the larger area now encompassed by the Gisborne District Council.

Recommendations advanced in this report were that the rate of afforestation advised by the Taylor Report, and currently being achieved was not sufficient to maximise net benefits[62]. An increase from an average forest planting rate of about 2000 hectares per annum to nearer 6000 was advocated, with the additional costs to be supplied by an increase in the allocation of funds to the Forest Service. This recommendation was however, never implemented. Funds allocated to the Forest Service were not increased on a sustained basis, and planting continued at a rate of about 2000 ha per annum up to 1987 (MoWD, 1987).

4.5 Afforestation Reviewed

In 1987, the New Zealand Forest Service was disbanded, along with the Department of Lands and Survey, and its various functions were divided between three new bodies. The Department of Conservation (DOC) received a conservation role, the Ministry of Forestry, a regulatory and policy role, while the New Zealand Forest Corporation (NZFC) would manage the state's plantation forest assets on a commercial basis. Roche (1992:139) notes the separation of responsibility for subsidised protection forestry from that for commercial forestry which this move involved.

The following year 1988, the government announced the intended sale of the 550,300 hectare area of State forests. This was part of the much larger programme of privatisation of state assets, aimed at reducing government involvement in the economy, and releasing capital which could be used for public debt reduction. Originally a full sale was envisioned, however this was subsequently revised, to allow for the sale of the standing tree crop only, together with a Crown Forest Licence permitting rights of land use for 70 years. This revision followed opposition from Maori to land sales, and concern among the general public regarding possible purchases of New Zealand land by overseas interests (Roche, 1992:144).

In 1987, at the prompting of the Ministry of Works and Development, a major review of the East Coast Project was undertaken, due primarily to the disbanding of the Forest

---

[62] This outcome rested heavily on the forests being productive. The benefits allowed for in the economic analysis conducted only included income from logging. Employment, migration effects, and erosion control were classed as social or environmental benefits, and though attempts were made to quantify them, they were not valued economically.

Service, and the profound effect this would have on the project's non-commercial objectives. This was "the first comprehensive review of the rationale for the project to date" (MoWD, 1987: (i)), and resulted in the publication and release for public comment of a Review Report in December of that year.

The report was divided into two sections, the first of which reviewed the rationale and progress of the project, and examined how well it had met the objectives laid out in the initial Taylor Report. The second went on to propose a range of options available for the future and to assess the environmental, social, economic and funding implications of each.

4.5.1 Progress of the East Coast Project

The Review Report found that by 1987 the Forest Service had planted a total of 35,908 hectares, of which about 31,000[63] could be attributed to the East Coast Project. During the 1980's a third large forest had been established inland from Tokomaru Bay, outside the now defunct "blue line", to give three major blocks of afforestation. In accordance with the recommendations of the Red Report, forest planting was directed toward the more severely eroding land purchased. The main form of land acquisition remained via the purchase of entire farms or large blocks. In addition to the above areas the Forest Service also established a small (1348 hectare) forest on Maori land leased to the Crown at Te Araroa, mainly to provide employment for local residents. The mixture of objectives of the original Taylor Report had remained a feature of the project after the Red Report. The Catchment Board also established a number of small forest lots for farmers on Category 3 land under a 66.7% government subsidy, as part of the Soil and Water Conservation Plans conducted on various properties.

Private forestry companies were also active in the area over this period, establishing blocks generally on land in the "pastoral foreland" (*ibid*). The rate of commercial afforestation in the region was slow through the 1970s but increased substantially in the 1980's (MoWD, 1987:21). Most of this area received a 45% subsidy for establishment under the Forestry Incentive Scheme, up to 1985.

---

[63] The difference is due to land which was purchased and planted at Mangatu prior to the formal beginning of the East Coast Project.

Table 4.4 shows the areas of forest established by 1987 according to the land use categories planted. The NZFS established the most extensive areas of forest on Category 3c land, covering nearly one third of land of this category in the region. Plantings on category 3c land accounted for 55% of the Service's total area. By contrast, commercial plantations were minimal on this category, and were proportionately more oriented toward categories 1 and 2, though a significant area of class 3b was planted.

Table 4.4 - Forestry Established by 1987

Establishment Source	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
NZFS	6156	5100	352	4600	19700		35908
Commercial Forestry	7513	5800	3200	4710	900		22123
Other (ECCB+Tokorarangi)[64]		1900	1348[65]	1790			5038
Total	*13669*	*12800*	*4900*	*11100*	*20600*		*63069*

Source: MoWD 1987.

The total area afforested by 1987 was approximately 63,069 hectares, the majority of which was located in several large forestry blocks. Table 4.5 indicates that this left 75,400 hectares of Category 3b and 3c land under pasture or partially reverted land.

Table 4.5 - Land Cover by Land Use Category Area for 1987

Type of Cover	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
Pasture	220931[66]	137600	19000	38600	36800		452931
Native Forest or Shrubland[67]		22700	31800	600	7600	44600	107300
Exotic Forest	13669	12800	4900	11100	20600		63069
Total	*234600*	*173100*	*55700*	*50300*	*65000*	*44600*	*623300*

Source: MoWD 1987.

[64] This division refers to the area established by the East Cape Catchment Board, and the New Zealand Forest Service at Te Araroa.

[65] This figure represents the forest at Te Araroa (Tokorarangi) for which the total area planted was 1,348 hectares. No accurate categories were available for this area, however "most" was found by the East Coast Project Review to be Category 3a land.

[66] No breakdown of vegetation on Category 1 land was given in this report as this Category is of little concern for soil erosion. The figure stated for pasture is therefore overstated since this must include areas under native forest and scrub.

[67] Areas having over 40% scrub cover are classed as shrubland, while those with less than this, are classed as pasture.

The 31,000 hectares of afforestation under the Project had occurred at an estimated cost of $229 million[68]. At the time it was considered that little of the remaining 75,000 hectares of highly erodible pasture land would be commercially attractive to private forestry or to the recently formed New Zealand Forest Corporation, unless projected returns to forestry increased substantially. Commercial viability of future plantings was estimated to require a subsidy of some $300-$550 per hectare. This would be increased by about $470 per hectare, if a proposed port development at Hicks Bay were undertaken and costs charged to this subsidy. Costs of establishing protection forest would be in the order of $800 per hectare.

The Review concluded that "*in as far as it has been implemented*, the Project has helped to control on-site erosion and maintain productivity of the land, has had significant social benefits and some production forests have been established" (MoWD, 1987 (ii)). Social benefits of afforestation had occurred primarily in small predominantly Maori communities through employment and the retention of services in these areas, which was in line with initial objectives. In one statement, which apparently disregards the value or existence of off-site benefits, the review concluded that "the main beneficiaries of [on-farm] soil conservation in the region are the farmers" (*ibid*). Since the Taylor Report had allowed for a 50 year period of analysis and did not make many of its assumptions and calculations explicit, the Review considered that insufficient time had elapsed to assess the magnitude of downstream benefits. The Review also questioned the continued validity of the Taylor Report finding that erosion was the "key problem" (NWASCO, 1970:17) in the district. Rather it was felt that erosion was now simply one of several major problems, including those of social and economic "dislocation" (MoWD, 1987:78).

The key questions which were raised for public comment by the Review were:

- Is erosion still the "key problem" in the region?
- Who have been the beneficiaries of the project?
- Is there justification for the taxpayer to continue to subsidise the project?

---

[68] Total direct costs of planting, tending, and pruning, were estimated to be $92 million. The figure quoted in the text incorporates all Forest Service indirect costs incurred in the region.

- Is there a case for the government intervening in the region to maintain the social benefits of the project?
- Is the project the best way to overcome some of the problems that confront the region today?
- Are there more cost effective ways of overcoming these problems?
- Are there other means of financing the project or associated ventures?

Clearly the report was providing a basis for a shift away, if not from the project altogether, then at least from the current method of implementation in an effort to reduce the call on the public purse.

In February 1988 the Review Report was presented to Cabinet , whereupon yet another report was commissioned from an Officials Committee to be established by the Ministry of Regional Development (MoRD). This committee was to "comment on the findings of the Review, the submissions received, and the future of the East Coast Project" (MoRD, 1988:1). While this was under way, the region was hit by Tropical Cyclone Bola (early March 1988), which caused the most severe and extensive flooding and erosion seen in the region this century. The committee also took these impacts into account in their evaluation. The severity and timing of the cyclone meant that the outcome of the review was somewhat overshadowed by the urgent action required by the region.

4.5.2 The Cyclone Bola Agricultural Assistance Package

Immediately following the impact of Cyclone Bola, the Government pledged a major assistance package to affected farmers. This followed similar though smaller assistance packages in Ngatapa (1985) and Southland (1987). Of necessity the package was developed quickly and covered a range of objectives, including: the restoration of the farms' financial position to roughly that prior to the cyclone; to facilitate land use and ownership changes in some area; and to give a "significant psychological and economic boost to a devastated region" (Webber *et al.*, 1989:ii).

Under the scheme, farmers were to be compensated for 60% of the estimated value of both lost income, and assets, including land, above a threshold level of $5000. The total package amounted to over $56 million, of which a lion's share of $43.9 million went to property owners in the Gisborne East Coast. In order to encourage flexibility and

efficiency of use of the funds provided by the scheme, use of the payments was not tied to restoration of flood damage, but was entirely at the discretion of the recipient. It was hoped in this way to facilitate change away from uneconomic or inappropriate resource use.

In an evaluation of the package, Webber *et al.* (1989) found that the compensation had "brought immediate psychological and practical benefits to many farmers" although they noted that the threshold of $5000 had important equity implications. For many farmers the payment was critical to restoring viability to their farms, which even prior to the cyclone, had been marginal. While a significant amount of compensation money was spent on restorative work, much was also spent on reducing debt servicing. On the whole it was considered successful in meeting the short term objective of helping to maintain the social and economic fabric in the area.

It was not however felt that the package helped to advance its longer term objective of encouraging land use change. The pre-Bola pattern of land use remained little changed, and while a few farmers were induced to sell or make changes in land use or management, it was concluded that social objectives aside, the package "probably hindered rather that accelerated" this change, by "keeping some farmers on the land" (Webber *et al.*, 1989:iii). The expectation that future climatic disasters would be met in a similar way would also act as a disincentive to a more risk averse pattern of land use.

From a policy perspective it was noted that "ad hoc" responses such as this could be inequitable, in that they provide assistance only where the impacts of a disaster are widespread and severe, while smaller impacts that do not receive the same publicity may affect individual land owners with equal severity. This was particularly relevant since erosion and flooding as severe as that experienced during Bola but on a smaller scale, occur in many parts of New Zealand, yet individuals receive no assistance unless the event was region wide.

4.5.3 Officials Committee Report

The Officials Committee made three sets of recommendations, each set relating to the diverging positions taken by particular government departments represented on the committee. The first set of recommendations were agreed on by all officials. These

largely concurred with the findings of the Red Report, but indicated that "stronger statements about the benefits of erosion control in the hill country for helping mitigate flooding downstream" could now be made following Cyclone Bola. It was recommended that both control and funding of future erosion control works be given over to regional government, as part of the general devolution of responsibility anticipated in the review of resource management legislation occurring at the time. It was noted that no money was available in existing central government allocation in Vote Environment for catchment works to enable funding of a comprehensive strategy of erosion control in the region.

It was also noted that central government assistance with the costs of relief operations and compensation packages, will tend to blunt the "incentive on the regional authorities to prevent these costs in the first place or for property owners to make investment decisions that are appropriate to the risks they face" (MoRD, 1988:26).

The committee stated that the economic off-site benefits of erosion control work will depend on the value of the downstream assets potentially being protected. For the East Coast, benefits would be greatest from protection of catchments upstream from the Poverty Bay Flats (Waipaoa and Waimata) and Tolaga Bay (Uawa).

The divergence in positions arose in the subsequent recommendations. The Departments of Conservation, DSIR, Environment, Forestry, Labour and Maori Affairs all recommended that the restructuring of local authorities would mean that the East Cape Catchment Board would be unable to fund or implement a comprehensive erosion control scheme for several years, and that to target land upstream from the Poverty Bay Flats and Tolaga Bay, would require a five year scheme designed to plant 15,000 hectares of severely eroding hill country in these catchments. This was to be carried out with a two-thirds subsidy from central government amounting to $1.6 million per year, with the remaining third to be funded by the region.

In direct opposition to this stood the officials from Trade and Industry, Treasury, and Agriculture and Fisheries. These officials argued that catchments had sufficient powers under existing legislation to carry out erosion work, and that based on estimates of flood damage (which did not appear to be substantially greater than in other regions) the

treatment of the region as a special case was not warranted. They considered that the total cost of reforestation at a rate of 3000 hectares per annum was not beyond the capacity of the region to fund. These officials also noted that other objectives of the East Coast Project such as employment and regional development were best handled through "the appropriate national policies" (MoRD, 1988:34).

One further set of recommendations arising only from the Ministry of Maori Affairs was that a similar five year scheme be implemented for the Waiapu area at an annual cost of $4 million.

After consideration by the Cabinet Policy Committee, all the general recommendations were adopted as policy, along with the specific recommendations for a five year scheme in the southern part of the region.

In response to these recommendations of the Officials Committee Report, the Government approved a temporary programme of protection forest planting, to run for five years from 1989 to 1993. These plantings were to be aimed at 15,000 ha of the most severely eroding pastoral land in the catchments upstream from Gisborne, the Poverty Bay Flats, and Tolaga Bay[69]. This would account for the majority of outstanding Category 3b and 3c land in these three catchments.

4.5.4 The East Coast Project Conservation Forestry Scheme

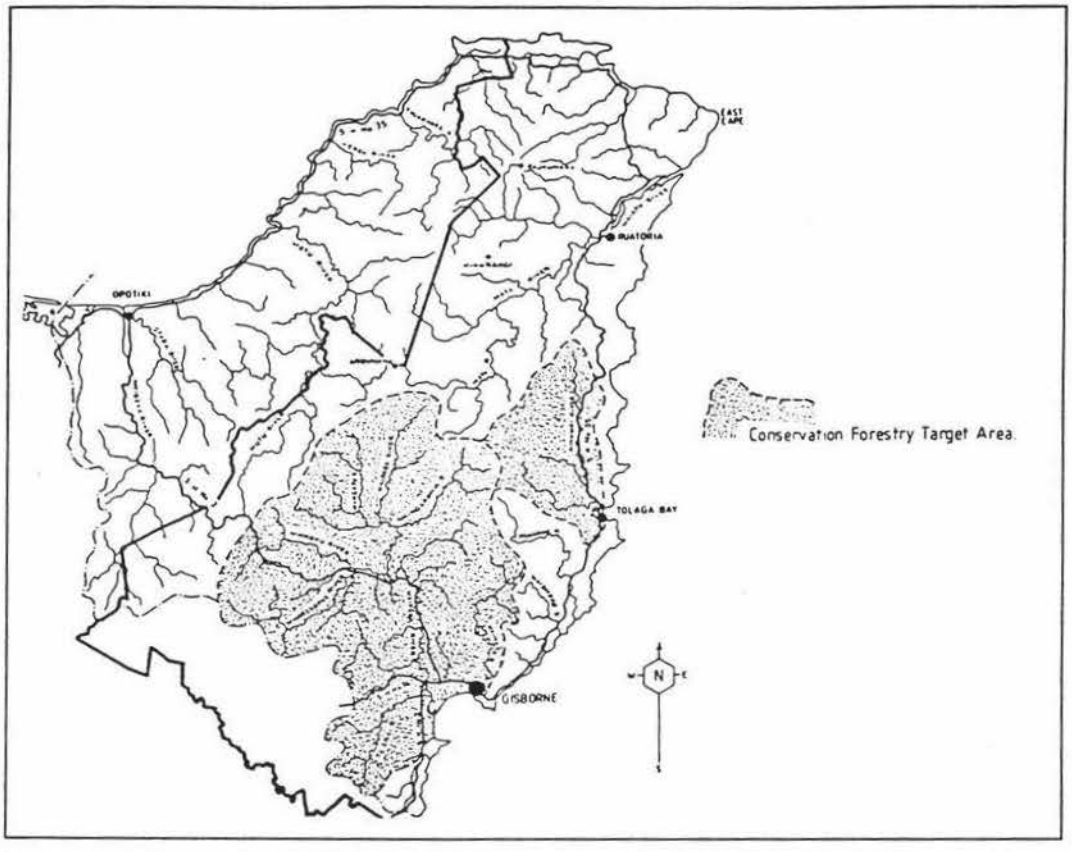
The new scheme was also termed the *Southern East Coast Afforestation Programme*, as it did not include land in the more northerly catchments. Central government funds were to be targeted towards "land upstream of the most valuable assets on the East Coast" (MoRD, 1988:30). While it was acknowledged that the erosion problem in the northern catchments was of greater areal extent[70], this area was considered to be of lower priority. In the absence of the Forest Service, it fell to the East Cape Catchment Board, now the Conservation Division of the Gisborne District Council, to organise and carry out this new scheme. The area included is depicted in Figure 4.3 below.

---

[69] The upper–Hikuwai catchment area was included in this scheme.

[70] Approximately 80% of the remaining 75,400 hectares of unforested Category 3b and 3c land was located in the Waiapu catchment.

Figure 4.3 - Map of East Coast Project Conservation Forestry Scheme



Source: Conservation Division of GDC, Conservation Quorum 1, March 1990:6.

The anticipated cost of the scheme was $12 million, of which the Government would provide $8 million. The remaining cost would be split between landowners (5% of the total cost) and the District Council which would make up the balance[71]. The temporary nature of the scheme was well illustrated in the Committee recommendation that "no central government funds will be made available for erosion control on the East Coast after 1993, apart from what may be available from the national policies at that time" (MoRD, 1988:36). This was subsequently adopted as policy by Cabinet in August 1988.

This scheme provided for far greater flexibility in forest establishment than any preceding arrangement, since it did not require the purchase of large blocks of land. It was also an attractive proposition financially for participating landowners, given the 95% subsidy provided, although major thinning was required in years seven at the expense of the landowner. The costs of establishing a forest block without such assistance can be

[71] The targeted area to be planted was subsequently revised downwards to about 13,000 hectares for a total cost of approximately $15 million (Miller 1991:493), due to the inclusion of GST in this figure.

prohibitive since it involves not only the cost of establishment and silviculture, but also the opportunity cost of land lost to agricultural production, and a thirty year wait for any return on the investment. Since it was administered by the District Council together with on-going soil conservation works, considerable complementarity of these two programmes was facilitated. Forestry blocks were integrated into new farm soil conservation plans, on land that formerly would have been excluded. Similarly, active gullies were planted in willows on all areas of severely eroding land that were to be planted in pines, since the latter have little protection value for eroding stream-beds or gullies.

By 1994 approximately 13,500 hectares had been planted under the scheme primarily on classes 3b and 3c as proposed (Dominion, February 25, 1994:23). This accounts for 87% of the 15,513 hectares net stocked area of forest established over this period, indicating that the scheme was the major vehicle for afforestation in the region during its five years lifespan.

As was noted above, the total area planted in exotic forest in the region is subject to some uncertainty, however the areas listed in the 1992 Landcare mapping project are shown below in Table 4.6, broken down by land use categories.

Table 4.6 - Gross Area of Exotic Forest by Land Use Category

Vegetation Type	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
Exotic Forest	29225	24577	12197	16333	24313	2891	10954
% Total Category Area	8.7	11.5	13.1	32.0	34.4	4.7	13.2
Total Category Area	***337703***	***213383***	***92971***	***51087***	***70724***	***62033***	***827901***

Source: Landcare Mapping Project 1992.

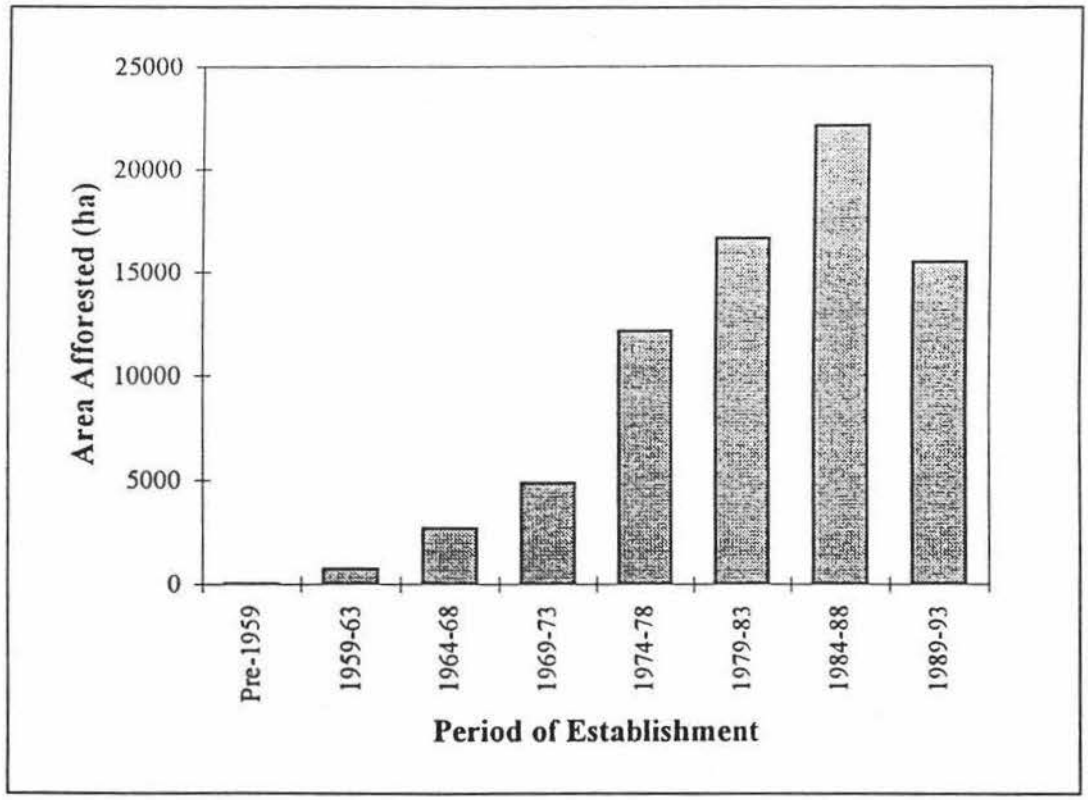
This indicates that exotic forest is present on approximately one third of both Category 3b and 3c land in the region. On all other land categories it accounts for a much smaller proportion of the total. Due however to the prevalence of categories 1 and 2 land in the region, almost 50% of exotic forestry is to be found on these two categories, both carrying a recommendation for pastoral use. 2900 hectares was on land recommended for protection forestry.[72] It is worth noting that the area of Category 3a land afforested

[72] This district encompasses a larger area (a total of 834,000 hectares) than that included in the East Coast Project, due to local body restructuring which saw Northern Hawkes Bay included in the Gisborne Region.

is directly proportional to its prevalence in the region, despite its poor suitability to pastoral use. At least 33% of this category remains in pasture, with another 33% in indigenous forest or scrub.

Figure 4.4 depicts the breakdown of existing forests in 1993 by period of establishment, derived from Ministry of Forestry figures for the region. The graph clearly shows a steady increase in the area of plantings established from around 1964. This reached a peak during the 1984-88 period, after which the annual planting rate declined again, and, as was indicated above, new plantings were almost exclusively due to the Conservation Forestry Scheme.

Figure 4.4 - Existing Area of Exotic Forest in the Region by Period of Establishment



Source: Ministry of Forestry

4.5.5 The FARM Partnership Scheme

Although never undertaken, one further scheme deserves mention. In August 1990 the pilot scheme for a nationwide sustainable land management programme was endorsed by the then labour Government, for initial implementation in Northern Hawkes Bay, Gisborne, and the East Cape. Termed the FARM Partnership scheme, it was a programme based on the principles of community participation in policy formulation and

implementation, flexibility, local responsibility, and cost sharing between Government[73], land-holder and community (refer MAF Policy Paper 101, 1990). It this respect it is comparable to the Landcare scheme operating in Australia. The estimated cost over an initial three year period was $28 million, 70% of which was to be funded by Central Government.

It was hoped that a more sustainable pattern of land use could be achieved through the rational adoption of soil conservation measures, afforestation where necessary, and adjustments to farm boundaries, to better reflect the land's sustainable productive capacity. The scheme did not focus solely on soil erosion but envisioned a broader outlook, including such objectives as risk management and drought proofing. As with the Australian Landcare schemes, there was a strong emphasis on the central role of the land-holder in the implementation of more sustainable land use patterns or practices, and on the importance of local community involvement in problem solving and in defining the specific needs of the region. The role of MAF as the Central Government body involved was to be primarily one of facilitation, of targeting grants so as to achieve the scheme's stated objectives, and of overall monitoring.

Approval for the FARM Partnership Scheme by the Labour Cabinet came however, only months prior to the 1990 general election, and this timing had the effect of turning the scheme into a political issue. Critics accused the Labour Government of having used it as a "political bribe" aimed at swaying the rural constituency (Sutton, 1991:316). The election saw a change of government, and a change of fortunes for the FARM Partnership Scheme. Due to the substantial financial input required from government, the scheme came immediately under review by the new Minister of Agriculture John Falloon. In what the ousted Minister of Agriculture and Forestry described as a "wave of post-election expenditure cutting" (*ibid*:315) it was discontinued, having not had sufficient time for any meaningful implementation.

Whatever the political motives behind the scheme, or its rapid demise, it appears to have been a well founded attempt to achieve integrated and rational land use change. The participatory approach is very much in line with that advocated in the Brundtland report, and with much contemporary thought in development. The envisioned partnership

[73] The planned contribution of Central Government was to be approximately 70% of the total cost of the scheme.

between government, community and land-holder, could have provided a positive atmosphere for problem solving; one which has had a remarkable degree of success in Australia. In this case it appears the scheme mainly lacked political sustainability.

4.5.6 Revival of the East Coast Project

In 1990 while in opposition, the leader of the National Party Jim Bolger, declared at an Environment and Conservation Organisation Conference in Christchurch that:

> "This region [the East Coast] contains one of the world's worst land erosion zones." ... "My government will revitalise the East Coast Project. We will extend the East Coast Forestry Scheme to cover all erosion prone land in that region" (quoted in Gardyne, 1991:9).

Yet by 1992, with the farm partnership scheme discontinued, the five year term of the Conservation Forestry Scheme due to end in 1993, and the 35% subsidy available for on-farm conservation works set to be removed, the future of both forestry and on-farm erosion control on the East Coast had never been in more doubt. It seemed highly improbable that the government would return to a programme of purchase and afforestation, or continue with the high levels of subsidisation involved in the five year scheme. Nevertheless strong appeals for on-going assistance for the district continued to be sounded from various bodies. Gisborne's MP Wayne Kimber, made this the subject of his maiden speech in parliament, arguing that the region would require much more than simply tax relief. "A positive approach along the lines of the FARM Partnership Scheme would be necessary if sustainable land use and conservation values were to be promoted on the East Coast" (quoted in Gardyne, 1991:9).

Similar calls were expressed by R.C. Miller, Regional Conservator for the Gisborne District Council in a letter to the Prime Minister in 1990 (reprinted in *Conservation Quorum* 2, June 1990:8) in which he states that "the environmental problems facing this region are hopelessly beyond the resources of the region to solve". The letter recommends that the government reactivate the East Coast Project, providing for both land purchase, and subsidised planting of small areas, tax incentives for commercial forestry, raised subsidisation of on-farm conservation from 35% to at least 50%, and continued support for Ngati Porou Forests Ltd.

Finally in July of 1992 the government announced its committment to a major afforestation scheme covering the whole District[74], designed to afforest in excess of 200,000 hectares (approximately one quarter of all land in the region) at a rate of 7000 hectares per year. While the scheme is termed the East Coast Forestry Project, it represents a complete break from the two previous programmes, which had involved land purchase, government afforestation, or substantial assistance. All forest established under the new scheme would be established on private land, and would be owned and managed privately as commercial forests. Land holders would be eligible to tender for grant assistance to establish forest on Class VII land (Categories 2 and 3).

This schemes objectives are "to promote contiguous commercial forestry as a means of controlling soil erosion", and to provide "employment and regional development" (Ministry of Forestry, 1993:2). In this case the region is clearly treated as a special case not only because of the severity and extent of erosion, but also due to other socio-economic aspects such as the high unemployment rate and limited diversification of the local economy. No clear priority is given to either commercial, conservation, or employment objectives, but these seem to be approached in an integrated manner. The vehicle for all is private sector afforestation, through grant assistance from central government.

While targeted at Class VII land, the project also aimed to plant to "practical forest boundaries" so would accept up to 40% Class VI land in a tender area. Preference would be given to tenders with higher proportions of Category 3 land or severely eroding Category 2 land. These criteria would be reviewed at the end of the first three years to ensure that sufficient severely eroding and eroding land was being planted. Planting densities reflect those recommended by Kelliher *et al.* (1992) of 1250 sph on Category 2 land and 1500 on Category 3 land.

The minimum planting area was initially to be 50 hectares to ensure that plantings would be of a commercially viable area, though this was subsequently revised to 25 hectares to avoid exclusion of land-holders unable to set aside a larger area. The finalised details of the project also allow for species and planting regimes other than radiata, though tenders

[74] In 1993 land in the Waipaoa, Waimata and Uawa Catchments would not be included as these were still covered by the final year of the 5 year scheme. In 1994 the project would apply region-wide.

for such species would be considered in the same overall selection process, so would need to be competitive against standard radiata plantations.

Information based on the Landcare satellite survey indicates that there is a total of 428,000 hectares of Category 2 and 3 land in the District, or just over half the total area (refer to Table 4.3). At least 41,000 hectares of this is under manuka/kanuka, although other estimates suggest much more. Herbert (1992:2), quotes a figure of 169,000 hectares of "manuka/kanuka scrub and pasture substantially reverted to scrub".

The targeting of both Category 2 and 3 land (including Category 3a) clearly goes beyond the requirements of biophysically sustainable land use. On Category 2 land, the scheme favours forestry over farming since under the recommendations of the Red Report such land is seen to have a potentially long term use as pastoral land provided on-farm conservation works are carried out. Such research as has been carried out indicates that on-farm conservation works which have been adequately implemented and maintained, may be as effective as plantation forestry at controlling erosion. The extension of grant assistance to class 2 land appears not to be aimed solely at the sustainable management of soils, but incorporates the objective of establishing a *commercially* sustainable forestry industry in the area (Randolph Hambling (MoF, Gisborne Office), pers. comment).

An important feature of the project, is that it is scheduled to proceed for a period equal to the average length of a *P. radiata* rotation. At the intended planting rate of 7000 hectares per year, it will take approximately 31 years to cover the desired area of 200,000 hectares. With the requirement that all cut-over areas must be replanted, the scheme provides the basis for a steady on-going industry in the region, with reliable and regular production of wood and demand for labour.

4.5.7 Shrubland

Probably the most serious opposition to the revived project came in relation to the large areas of regenerating manuka and kanuka present in the area targeted. This arose in part as a result of the 1991 Forest Accord which was a voluntary multi-party accord signed by a range of conservation groups, and members of the New Zealand Forest Owners

Association[75]. The basis of the Accord was to recognise the value of plantation forests as an alternative to the clearance of indigenous forest with a high conservation value. Signatories to the Accord would undertake to exclude "all areas of naturally occurring vegetation" that met any one of four stated conditions. These conditions included any area greater than 5 hectares with "actual or emerging predominance of naturally occurring *indigenous tree species*", any "viable" area between 1 and 5 hectares with a canopy height of at least 6 metres, or any area either recommended for protection in the DOC PNA surveys or by the former Wildlife Service. Parties to the accord agreed on a definition of a native tree as being "any indigenous woody plant which ultimately forms part of the canopy of a naturally occurring forest in the locality under consideration and also includes any indigenous tree species which attains a diameter at breast of 30 cm or greater" (New Zealand Forest Accord, 1991). Clearly, many of the tall kanuka-dominated stands on the East Coast easily meet this description.

Of the 41,000 hectares of manuka/kanuka identified in the Landcare Mapping Project, on Category 2 and 3 land, some 28,000 is on Maori land.

On soil erosion grounds, it is not possible to justify the clearance of manuka/ kanuka vegetation where this forms an established canopy. In the light of the discussion in Chapter Three on the conservation value of manuka/kanuka, the clearance of this vegetation class for the establishment of forestry could be seen as contrary to the RMA 1991, for it would expose this land to renewed erosion for a period of 5-6 years.

In this respect the Maruia Society have advocated the concept of *net sustainability* for the area. This concept is described by Gow (1992:22) as "the deliberate depletion or loss of some natural capital from one area, provided this is compensated by its enhancement somewhere else". In this case it involved allowing areas of Ngati Porou land to be cleared for afforestation , in exchange for the setting aside and protection of larger areas of shrubland. The suggested ration was a three hectare to one hectare ratio of protected to cleared land.

This position was strongly rejected by Kevin Smith of the Forest & Bird Society, who argued that there would be no net conservation benefit, since such a deal would simply

[75] Membership of this Association accounts for the owners of 90% of New Zealand's plantation forests (Smith,

mean less shrubland than existed at present. While this would be the case, there does appear to be an argument that an inherent benefit would lie in the protected nature of the land set aside, which at present does not enjoy such status.

On April 6 1993 the debate between Ngati Porou and Forest & Bird made prime time television when Api Mahuika, Chairman of Ngati Porou Forests, and Kevin Smith appeared on TV3 News. Forest & Bird made the point that kanuka must be considered a native tree species under the Native Forest Accord, since it grew to a sufficient height and trunk diameter and formed a canopy in extensive areas of the East Coast. Mr Smith laid the blame for the division between himself and Ngati Porou at the government's feet, since the project was at odds with the Forest Accord. While the Accord was a private matter negotiated between conservation groups and commercial foresters, it was nevertheless hailed at the time by government as a landmark document.

Mr Mahuika presented the case of the Ngati Porou, particularly with regard to the right of the iwi to make use of their land. He pointed to instances in the past when Ngati Porou had been fined for not cutting kanuka, but were now being told they could not. He stressed the need for jobs among people on the East Cape and the potential forestry had to relieve the poverty of the area.

For Mr Smith, the issue was whether public money should be used to finance the clearing of kanuka from potentially eroding land - thereby increasing risk of erosion. Mr Mahuika however pointed out that the dole queues in Ruatoria were also public money. He also made the point that kanuka and manuka were important resources for people on the Coast, providing fuel, building materials, and potentially supporting a honey industry. "We are not going to cut manuka indiscriminately" he argued.

4.5.8 Special Purpose Species

In a detailed economic analysis which compared radiata with several other species including *C. macrocarpa*, *C. lusitanica*, and *A. melanoxia*, Cavena and Glass (1985) found that all these species achieved comparable rates of return in the order of 4.0 to 9.9%, with substantial potential for fluctuation according to yield and price movements.

1993:17).

Herbert (1992) notes the ability of these species to absorb the higher costs of extraction and transport from isolated locations, due to the higher value of the timber.

4.7 On-Farm Soil Conservation

While afforestation carried out under the East Coast project was undertaken by the Forest Service, responsibility for planning and promoting on-farm soil conservation works continued to reside with the various catchment authorities, under partial funding from central government. As such the on-farm soil conservation programme was never officially part of the East Coast Project, and the region was not treated in a manner substantially different from other regions. Soil conservation works were available to all farmers at a subsidy of about 67%, with control over the distribution of such funds held by the Soil Conservation and Rivers Control Council. This situation remained largely the same from 1968 to 1987, although the size of the subsidy was reduced slightly during the last 5-6 years, according to the type of works required. Over the duration of this period, the various catchment authorities of the East Coast region received a total of $14.3 million, of which the government contribution amounted to $9.2 million or 64% (MoWD, 1987:101).

4.7.1 Progress of On-farm Soil Conservation Work

The progress or extent of on-farm soil conservation works is less easy to measure than are forestry areas. Such works may include debris dams, seedling planting or pole planting under a variety of regimes. While the quantity of such works is on record, it is not easy to relate this to a measurable "treated" area. The breakdown given in Table 4.7 is taken from the East Coast Project Review, and is based on the assumption that all such works were carried out on Category 2 land[76], as well as a number of assumptions concerning the average area protected by particular conservation works (*ibid*: Appendix I).

The table indicates that around 28,300 ha of pastoral land had been treated with on-farm soil conservation measures at the cost mentioned above[77]. A further 109,300 hectares or

[76] Since small amounts of work were done on classes 1b and 3b, these figures slightly overstate the true area on untreated pasture.

[77] The works considered in this table include only those carried out since 1975 when the catchment board began to implement full scale farm conservation plans. Prior to this works had been done on a largely ad-hoc basis. By

79% of Category 2 land in the district, was yet to be treated with on-farm conservation works. The projected costs of full implementation of the programme on all Category 2 land were estimated to amount to an additional $(1987)97 million.[78]

Table 4.7 - Estimated Extent of On-Farm Soil Conservation Works in 1987

Conservation	*Land Use Category Area (ha)*						*Total*
Works	*1*	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
Pasture Treated		28300					28300
Pasture Untreated	220931	109300	19000	38600	36800		424631
Total	*220931*	*137600*	*19000*	*38600*	*36800*		*452931*

Source: MoWD (1987:29).

It is estimated that approximately 22% of required on-farm conservation works on pasture or bare ground are complete. The estimated area on which outstanding works (including afforestation) were required was some 359,000 ha, of which 257,000 was considered sustainable in pasture, 86,000 required afforestation, and 15,000 was considered better left to revert to native vegetation[79]. The estimated cost of these works was calculated to be (1993)$185 million, or an average of $518 per hectare.

4.7.2 Reduction and Removal of Subsidies

In 1987 in conjunction with other measures to reduce public expenditure, the subsidy for on-farm soil conservation works was reduced to 35%, although authorised programmes would continue at previous rates for a maximum of five years. Participation by landowners in on-farm soil conservation schemes was considered likely to diminish with this reduction. At this point it was NWASCO which took on the role of allocation of the soil conservation vote between regions. Initially the basic 35% subsidy was applied uniformly across the country, although it was anticipated that there would emerge a policy aimed at ensuring a basic standard of soil conservation throughout the country. This would then possibly involve a greater allocation to regions such as the East Coast,

---

1987, 455 farm conservation plans were being implemented, covering an area of 304,000 hectares. Only a proportion of this area is Category 2 land, and much of this has yet to be treated.

[78] These figures pertain to a lesser area than that presently covered by the GDC, which now incorporates an area of Northern Hawkes Bay. Appendix 3 to the GDC Proposed Regional Policy Statement contains updated estimates of both completed and outstanding works, for the new total area of the region as at 1993.

[79] These figures are derived from areas and requirements of individual LUC Units, and do not relate directly to Land Use Categories.

which experience large soil conservation problems and relatively small population and asset bases on which to rate.

The formation in 1989 of the Gisborne District Council (GDC) in November 1989, saw the dissolution of the East Cape Catchment Board, along with various other local bodies, and its functions taken over by a Conservation Division operating under the Environment and Planning Department of the new council. This change, and the fact that the GDC as a unitary authority has the functions of both a district and regional council, has encountered some teething problems in the environmental management arena[80].

In 1992, as part of a move to encourage greater local responsibility for activities such as erosion control, central government subsidies for on-farm erosion control were stopped. In response, the Gisborne District Council was obliged to review the current level of council expenditure on erosion control. In 1991 it was calculated that when compared in relation to their rateable capital base, the contribution of the GDC to erosion control works, was some 20 times that of the next highest contributor, Wellington (Miller, 1991:490). This is due largely to the combination of a small population, a relatively low capital base to rate, and the significant contributions at the time both to on-farm works, and to the Council's 29% contribution to the Conservation Forestry Scheme.

4.7.3 District Council Policy on Soil Erosion

In its Proposed Regional Policy Statement (February 1994) the GDC identified erosion as a major issue, and took as its objectives in this area:

- Rehabilitation of eroded land and stabilisation of erosion prone land.
- To protect downstream natural physical resources from the adverse effects of induced soil erosion.

To achieve these ends, the policies proposed were primarily ones of regulation, facilitation, and encouragement of soil conservation; discouragement of land uses which

[80] Within a year a significant conflict broke out between two departments within the council over an issue of water quality (Parliamentary Commissioner for the Environment 1990:2-3). The principle cause of this conflict was identified in a report by the Parliamentary Commissioner for the Environment (1990:27) as being the "high potential for conflict between regulatory and service delivery objectives" in the council, since these two functions do not enjoy the same degree of separation as is found where the bodies are separate entities. The report recommended that these two functions be clearly separated in the organisational structure of the council, in the interests of transparency of decision making. It was felt that this could then assist the council in resolving internal disputes, without the need to resort to litigation as was threatened in this particular incident.

maintain or cause erosion; and to take on an educative and advocacy role. Material or financial assistance was allowed for only "where such funds exist", and considerable emphasis was placed on the need to "vigorously promote and encourage" assistance from central government in this area.

The primary method to be undertaken was the development of a Regional Sustainable Land Management Plan which would address among other things, all aspects of erosion control, preservation of significant natural vegetation and habitats, and management of riparian margins.

The possibility of implementing "eroder pays" principles was to be investigated, as well as the identification and levying of off-site beneficiaries of soil conservation. Also to be considered was a regulatory approach which would extend existing controls on vegetation removal and earthworks, to require all landowners to avoid uses and practices which cause soil erosion. It was however surmised that such an approach would likely meet with considerable opposition, and would have a high enforcement cost.

The RMA also demands that public authorities having to prepare regional policies and district plans under the Act, must "consult" with Maori as the tangata whenua (cl.3(1)(d), First Schedule), and to "have regard to" any relevant planning document of an *iwi* authority. In this respect, the RMA follows a series of Acts affecting environmental law that demand some recognition of the principles of the Treaty of Waitangi, but few of these specifically state as does the RMA, that such authorities must "have regard to" Maori interests in resource management decisions (Boast, 1992:248). Such consultation is clearly necessary if the requirements of Sections 6, 7 and 8 of the Act as discussed in Chapter Two, are to be addressed.

This requirement of consultation poses a number of difficulties. Firstly, it is not entirely clear what degree of consultation is required, nor exactly who should be consulted. Within the East Coast region, the tangata whenua includes eleven separate iwi or *hapu* groups, and a number of *Runanga* that represent Maori interests (Gisborne District Council, 1994:25-38). Nor is it clear once consultation has taken place, what weight these consultations must carry in the decision making process. The proposed Regional Policy Statement for Gisborne makes the point that while it is obliged to take into

account iwi or hapu strategies, and that Maori concerns must be specifically addressed in any resource management decision, rather than left to "objection to some particular proposal", local authorities are not bound to such strategies. Authorities must "balance a number of apparently competing interests, including Maori interests" (*ibid*:38).

4.8 Conclusion - A Changing Framework for Analysis

Over the past 30 years, the nature of the reports and recommendations on the problem of hill country erosion in the region have altered considerably. The early Taylor report, drawing together as it did, experts from a number of fields, and putting together a plan for direct government intervention, was highly geared to direct government intervention. It was produced by a planning department, and not surprisingly, placed faith in the ability of planners, with due process, to assess the situation accurately and to recommend the action necessary for government to bring about "wise" land use. It was conducted at a time when all governments had established influential planning departments, and planning was seen not only in a regulatory capacity, but as an engine for economic development.

This report also strongly advocated that change be initiated by direct government involvement, through the purchase and afforestation of areas of land susceptible to erosion. This recommendation was reflected in the emergence of the East Coast Project and the subsequent establishment of sizeable areas of state-owned forest in the region. The use of public funds to support such activities was justified on the basis of an economic cost-benefit analysis which attempted to take account of both the value of forestry and the avoided costs of severe erosion, and to further regional development objectives.

Twenty years on, this approach could be dramatically contrasted with the later Officials Committee Report in a number of respects. Firstly the acceptance of central government responsibility had strongly diminished, and the onus placed much more firmly on regional government and landowners to provide for a solution. Secondly, government involvement by way of direct purchase and afforestation was largely a thing of the past.

The arrival of Cyclone Bola at the same time as this report undoubtedly helped to establish the case that a solution to the problem in a realistic and urgent time frame was beyond the means of the region to fund. The five year scheme, while avoiding direct

involvement of central government, acknowledged this by providing state funding for the lion's share of the cost of the reforestation process. This scheme even allowed for considerable public afforestation by the District Council which undertook much of this work itself.

Such was not to be the rule in the revival of the East Coast Project. The philosophy which governs this scheme, is that direct responsibility for afforestation should lie with the private sector. Public funds are provided in the form of tendered grants to make up the shortfall between the market determined inherent rate of return on erodible land, and that required for commercial viability. The implication is that all land afforested under this scheme must be for commercial logging.

4.8.1 Equity

Within the current scheme there are issues of equity which must be addressed. In two key respects, the scheme fails to promote an environment consistent with the much vaunted concept of the level playing field.

Firstly the scheme clearly favours commercial forestry over farming in the region. While the scheme is designed to achieve a market solution, it has not been drawn up exclusively on environmental grounds. The objectives of the scheme include regional development and employment, with the inherent assumption that commercial forestry will provide more of both than is currently the case under pasture. Afforestation is the only accepted solution to the problem of erosion on Category 3 and 4 land, but not on Category 2. Yet on the latter category, a sizeable subsidy is available for afforestation, but not for on-farm soil conservation. This represents a bias against pastoral farming.

To ensure that the resulting land use meets the goal of sustainability, the parameters of permissible land use must alter and be regulated. The previous chapter explored the property rights implications of such a change. Current pastoral farmers would be required to implement a programme of soil conservation in accordance with that recommended at the regional level, just as commercial foresters are currently required to do. Yet pastoral farmers receive no subsidy for such works.

The reasoning behind this clear inequity, appears to lie in the objective of the scheme, to establish a viable commercial forestry industry in the region. For this it is argued that a

large contiguous area of forest is required. This is the reasoning behind the minimum area of 25 hectares to be eligible for a grant. Yet given the current extent of forestry in the region, such arguments are less than convincing. While a larger area of forestry in the region may well promote the greater commercial viability of the forest industry there, the decline in area of pasture that this would involve can equally be argued to reduce the commercial viability of pastoral farming on lands not subject to severe erosion. Of course in a purely market environment, no commercial forester would be likely to purchase the most severely eroding land for afforestation. It follows then that those who already own such land should not be forced to meet such costs.

Secondly, being a regional scheme, the project does not look to a solution that is equitable across the country, either in terms of the level of environmental protection afforded, or the contribution that is being made to employment and regional development.

With regard to the former, it is argued here that government assistance where it is deemed necessary should be targeted toward achieving a standard level of erosion protection across the country as a whole. While it seems evident from the extent of the problem that the East Coast is a special case, it can be argued that this is only because it falls so far below this standard.

Similarly, if the project is to incorporate employment objectives in an economically depressed area with strong cultural importance to the local tangata whenua, what is the rationale for such a project to operate only on the East Coast, and not in other regions with similar problems and similar importance?

One of the key difficulties of the original East Coast Project was that the objectives, while all admirable, allowed for confusion of purpose. The current scheme would not appear to have remedied this. Clearly there exists great potential to integrate objectives of employment, regional development and sustainability into any regional solution. When, however, these objectives are pursued with the use of public money unevenly between regions, their implementation becomes arbitrary and lacks equity.

4.8.2 Summary

This chapter has indicated the cause, extent and severity of the problem of soil erosion to the East Coast region. The case for the region being a special case has been made since the 1920s and continues to be made by those working in the field of soil conservation. Although early warnings went largely unheeded, since the 1940s the current understanding of the problem has been due to the invaluable work of the SCRCC and local Catchment Boards in mapping the problems as well as promoting the implementation of soil conservation measures.

The response of central government has varied dramatically over the past 50 years, strongly affected by the changing economic philosophy of government. Early strategies which emphasised direct afforestation by the state and subsidisation of on-farm conservation work succeeded in afforesting significant areas of land. Such strategies were, however, always plagued by political controversy given the cost to the public purse, and by opposition at the local level as it was seen to be imposed from the outside. The latter problem was only partially remedied by the reclassification of land under the Red Report.

After 20 years of on-farm soil conservation works, and 31,000 ha of state afforestation strongly targeted to the most severely eroding hill country, there remained an estimated 86,000 ha of land in the district requiring afforestation, and a massive 257,000 ha of pastoral land requiring on-farm works. State purchase and afforestation tended to be expensive and inflexible. Nevertheless the early trials and the forests and on-farm works established during this period, which would otherwise not have been implemented, are currently providing the technical information on which future environmental regulation will be based. They have also been credited with greatly limiting the extent of the damage caused by Cyclone Bola in 1988. Cyclone Bola appears to have made visible both the extent of work still to be done, as well as the immense value of the works carried out.

In the late 1980's with the restructuring of the Forest Service and the sale of state forests the government extracted itself from direct responsibility for afforestation. This ran parallel to a declining commitment to subsidisation of on-farm soil conservation measures. This appeared to sound the death knell for the East Coast Project.

In the wake of Cyclone Bola, however, there followed a brief return to strongly targeted state subsidised afforestation, designed to facilitate the capture of areas both small and large on existing properties. This five year scheme was both the most strongly targeted, and the most flexible of all schemes. The large subsidies meant however that it was still expensive to both central and local government. This has been followed by a new East Coast Project, which does not require either state purchase of land or active afforestation. It does however incorporate considerably wider objectives, and formalises a strong incentive for forestry over pastoral farming even on land which, with proper treatment, could have a long-term use in pasture.

The changes in land use and management achieved by the policies over the past 50 years have succeeded in effecting land use change on significant areas of land. The changing nature of state involvement has had a major impact on the sort of land on which change has been effected, and the ownership of that land. These issues will be dealt with in more depth in the discussions for one catchment in the region, in Chapter Six.

CHAPTER FIVE

Methodology

5.1 Introduction

This chapter outlines the grounds on which the particular catchment studied was selected, and gives a brief description of the land in the catchment area. The preparation for the fieldwork is discussed, along with the contents of the questionnaire (Appendix II) and the interview process. It concludes with an introduction to the analysis of the data collected which is presented in Chapter Six.

5.2 Choice of Catchment Area

Since the choice of a case study framework for analysis tends to limit the ability to extrapolate information gained for application to other areas, the choice of catchment is very important. Within the region there exists a high degree of variation in both physical, and human geography, which makes the search for a "typical" catchment exceedingly difficult. Distinctive landforms and patterns of erosion susceptibility vary from catchment to catchment, as do patterns of land tenure. In the more northerly catchments, communally held Maori land is often the predominant form of land tenure, while in the South, catchments may be almost entirely under private ownership.

Thus in many ways a typical catchment does not exist, since each displays its own peculiarities, which would influence the results achieved. Rather than seek such a typical catchment, an area was sought which would at least incorporate representative features, typical of the region as a whole. In this way, the catchment chosen need not show a high degree of similarity with other catchments in the region, but should indeed be arguably "representative" of the region as a whole, through the inclusion of the features typical of the region.

The choice of a suitable catchment on which to base the case study was done with the assistance and advice of staff of the Conservation Division of the Gisborne District Council. The decision was based on a number of criteria which are discussed below. On

a purely practical base, the most important of these criteria was that any suitable catchment had been subject to a recent (within the last 10 years) land use capability survey at a scale of 1:15,750. This was to form the base for a sustainable land use plan, and was therefore essential. These surveys were conducted by the former catchment board which has since evolved into the Conservation Division. The staff of this division work closely with land managers throughout the district and were therefore the most suitable source of information and advice for the selection of a suitable catchment.

It was important that the catchment chosen would be one in which the problem of soil erosion was acknowledged as being severe, and that it incorporated significant areas of either currently, or previously, unprotected pasture. A variety of land use capability classes were sought, ranging from land with few limitations to long term pastoral use, to land with a recommendation only for protection forestry. This would allow an analysis of the relative treatment of different land classes.

Since the study wished to examine land use change over time, it was desirable that the catchment have at least partially undergone such a change. Ideally, a range of land uses and vegetation types would be present, including areas of native bush, exotic production forestry, manuka and kanuka-dominated shrubland, and pasture, both treated with on-farm conservation measures, and untreated.

It was desirable that the area contain the range of land tenure arrangements found in the region, for both pasture and forest land. Most importantly this should include Maori land both farmed by the owners and leased, and privately owned farms. It was also desired that the area in exotic forest would include both state-established forests as well as private company or landowner-established blocks. Information on land tenure, vegetation, land use and capability classes was available in the land use capability survey reports for each catchment considered, and from Conservation Division staff.

5.3 The Upper-Hikuwai Catchment

The catchment which was felt to best comply with all these criteria was that of the upper-Hikuwai River. This catchment is located centrally in the region, and comprises an area of some 27,530 hectares, inland from Tokomaru and Anaura Bays, and above the Mangatokerau River confluence. The catchment is drained by the Hikuwai River and

seven smaller streams including the Waiau, Mangarakai, Pauariki, Mangahauini, Waikare, Mangaroa and Waitoroko. All are tributary to the Uawa River which has its mouth at the southern end of Tolaga Bay township.

5.3.1 Catchment Boundary

The use of the watershed boundary to delimit the study area created some difficulties. While forming a logical border for the hydrological workings of the catchment, it was not a natural border for patterns of land use and vegetation, or for farm or community boundaries. Of the 30 main properties surveyed, 10 extended out of the catchment boundary. This meant that the area for which land use decisions are made was distinct from the area included in the study. Exotic forest plantations also extended outside the catchment, and the study area incorporated three different communities, all of which were located on the outskirts of the catchment.

For the limited issue of soil erosion however, the catchment boundary is a logical and useful spatial bound on the study. Choice of this boundary was also advantageous since catchment boundaries were also used by the catchment board in land use capability surveys, making this survey information directly applicable.

5.3.2 Land Use and Vegetation

In 1984/85 a land use capability survey was conducted for the area, at a scale suitable for individual farm planning. In addition to classifying land into land use capability units, the survey measured the prevalence of vegetation types and the extent of varying forms of erosion. The summarised results of these measurements are given below in Tables 5.1 and 5.2. At the time it was surveyed the catchment contained a total of 26 main properties, all of which were surveyed. Land belonging to these properties which extended outside the catchment boundary was, however, generally not included.

Land use and vegetation on these 26 properties, involved a reasonable degree of diversity. In a separate survey conducted in 1988, Marden *et al.* (1991) found that in that year, 98% of all exotic forestry in the Uawa catchment comprised new plantings, under 8 years of age. This indicated (and was supported by later results) that prior to 1980 there existed almost no exotic forest in the catchment. By 1984, however, this had risen to 10% (as indicated by Table 5.1). Conservation Division staff confirmed that

significant plantings had continued in the catchment after 1988 up to the present day. Included in these plantings were blocks established by the New Zealand Forest Service, by private forest companies, and by private landowners in association with the 5 year Forest Establishment Scheme. This ensured a representation of both private sector and state forests established under the East Coast Project.

Table 5.1 - Predominant Vegetation Types (over 40% of area)[81]

Vegetation Type	*Area (ha)*	*% of Catchment*
Pasture	18559	67
Scrub	6978	25
Exotic Forest	2801	10
Bare ground	1588	6
Hardwood Forest	1009	4
Podocarp-Hardwood Forest	756	3
Conservation Trees	237	0.9
Crops. Horticulture	63	0.2

Source: Upper-Hikuwai River Catchment Land Use Capability Survey Report, 1985: 6.

Table 5.2 - Subdominant Vegetation (less than 40% of area)

Vegetation Type	*Area (ha)*	*% of Catchment*
Scrub	7776	28
Rushes. Sedges	4324	15
Conservation Trees	2214	8
Bare ground	1756	6
Hardwood Forest	924	3

Source: Ibid.

Both pasture and scrubland were also well represented, with the former accounting for two thirds of the total area, and the latter being dominant on one quarter, and subdominant on a further 28%.[82] Conservation trees were a significant form of vegetation on about 7 % of the area and, prior to Cyclone Bola, soil and water conservation plans were in operation on 10 properties, with erosion control programmes on a further two. This left 12 properties with substantial areas of pasture but little on-farm conservation works.

Indigenous podocarp and hardwood forest covered a lesser area than did scrub, being dominant on only about 7% of the area and subdominant on another 3%. The majority

[81] These figures do not refer to exclusive areas, since two types of vegetation may both be found occupying more that 40% of a given area, eg. scrub and pasture, or hardwood forest and scrub. This explains the total of the "% of Catchment" column, which adds up to 116.1%.

[82] This area comprised predominantly regrowth manuka and kanuka on land recently cleared for pasture.

of this 7% was, however, made up of several large contiguous areas of native forest, making this a significant vegetation type on several properties, and the only major vegetation type on three reserve areas.

The area forms part of the Waiapu Ecological District, which incorporates an area stretching from the Poverty Bay flats to Tikitiki and east of the Raukumara ranges, under a system of classification used by the Department of Conservation for its Protected Natural Area surveys. This broad district is broken down into subdistricts, the boundaries of which are drawn with some precision, based around particular landforms. These subdistricts have considerable relation to erosion classifications, since landforms are both contributors to, and result from, erosional processes.

The upper-Hikuwai catchment lies on two main sub-districts: the Waiau, dominated by alternating sandstone and mudstone and gentler slopes; and the Tokomaru, dominated by massif sandstones and steep slopes. A parallel to the distinction between these two sub-districts can be drawn with the two broad rock-types discussed at the beginning of the previous chapter. With indigenous forest dominating only 7% of the area, surviving areas may be relatively important representatives of their ecological subdistricts.

Accounting for an area only slightly less than indigenous forest is bare ground, giving testimony to the extent of erosion in the catchment. The extent of erosion is also evident in Tables 5.3 and 5.4, taken from the 1984/85 survey.

Table 5.3 - Erosion Severity.

Degree of Severity	*Area (ha)*	*% of Catchment*
Nil	1072	4.0
Slight	16682	60.4
Moderate	5956	21.5
Severe	2975	11.0
Very Severe	845	3.0
Extreme	37	0.1

Source: Upper-Hikuwai River Catchment Land Use Capability Survey Report, 1985: 6.

It can be seen that some form of erosion was present in all but 4% of the catchment area, with the most common forms being gully and slip erosion, and to a lesser extent, earthflows. It appears, however, that this erosion was not classed as severe in the majority of cases. Table 5.3 indicates that over 64% of the area, the erosion present was only 'slight' or 'nil'. Thus, the figures in Table 5.4 indicate only that these forms of

erosion were in evidence on the given area of LUC units, and in most cases would be only slight, or account only for a very small proportion of the unit. Nevertheless 'severe' to 'extreme' erosion was found of 14% of the area and 'moderate' on another 21.5%.

Table 5.4 - Prevalence of Forms of Erosion.

Erosion Type[83]	*Area (ha)*	*% of Catchment*
Nil	1072	4.0
Slip	15416	56.0
Earthflow	8402	31.0
Gully	21474	78.0
Slump	1462	5.0
Streambank	1600	6.0
Deposition	126	0.5

Source: Ibid.

5.3.3 Land Classification

The breakdown of land use category areas depicted in Figure 5.1 highlights a number of important differences between the proportions of each category found in the catchment relative to those in the region as a whole. The catchment contains a slightly lower proportion of Category 1 land, but considerably more Category 2 land. The combined total for these two categories, which together form the part of the total area which generally has a potentially long term future in pastoral production, totals 78% in the catchment as opposed to only 67% in the region. This is due to the much larger proportion of Category 2 land in the former, which in fact exceeds the proportion of Category 1 land in the area.

The catchment also contains a much greater proportion of Category 3b land than does the region, while noticeably less of Categories 3c and 4 which account for only around 1% each. The proportion of land of Category 3 susceptible to erosion is, however, similar for both catchment and region, amounting to around 15% of the total area of each. Category 3a land is not included in this calculation as it is not prone to erosion.

[83] Areas given here add to more than the total area of the catchment since more than one form of erosion may be found on a single land use capability unit.

Figure 5.1 - Proportion of LUC Areas for Region and Catchment.

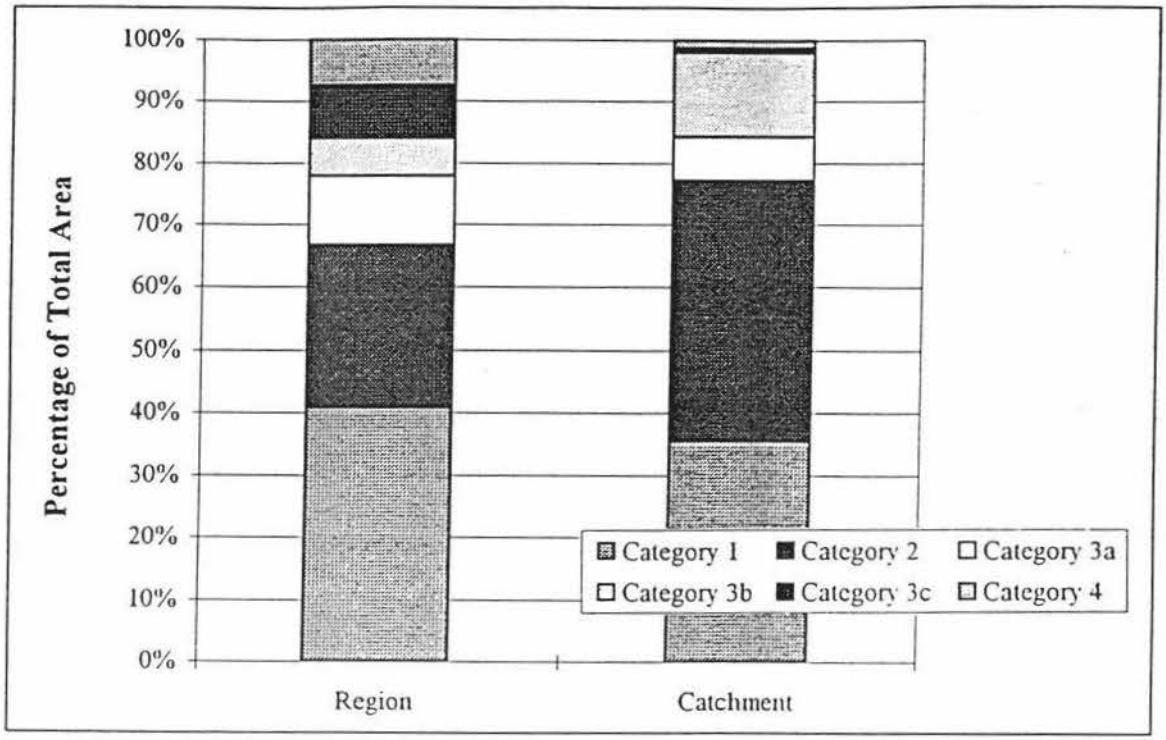


Table 5.5 - Comparison between LUC Areas for District and Study Area.

Land Use	*New District Boundary*		*Catchment Area*	
Category	*Area (ha)*	*% Total*	*Area (ha)*	*% Total*
1	337703	41%	9640	36%
2	213383	26%	11279	42%
3a	92971	11%	1914	7%
3b	51087	6%	3743	14%
3c	70724	9%	188	1%
4	62033	7%	369	1%
Total	*827901*	*100%*	*27135*	*100%*

In addition to the above criteria, the upper-Hikuwai catchment as part of the Uawa river catchment proved to be one of the areas worst affected by Cyclone Bola. Over the four days of the cyclone, rainfall recorded at Tauwhareparae on the south-west edge of the catchment totalled 843 mm or about half the annual average for the area. The three westernmost properties lay inside the 900 mm isohyet, where the highest recordings were taken, in some cases exceeded 1000 mm over five days. In terms of the aerial extent of land movement, these properties were among the worst affected in the region.

The extent of erosion caused by Cyclone Bola in the upper-Hikuwai catchment is not in this sense typical, since the intensity of the cyclone was higher, relative to other areas of comparative erosion susceptibility. However the severity of damage can nonetheless be

viewed as representative of the *potential* for erosion in such areas of the region, had they also been hit with the same intensity.

Due in part to the relatively small catchment area of the Uawa River (compared to the Waipaoa and Waiapu Rivers), the area of flats downstream at Tolaga Bay has not historically been flooded with great frequency. During Cyclone Bola, however, the peak flow in the Hikuwai River was greater than in any previously known flood. As a consequence, flood damage on the flats was especially severe, there having been a certain amount of complacency regarding the risk of flooding.

5.3.4 Categories of Land-Managers

The breakdown of land managers in the catchment used in the study accords largely with the discussion in Chapter Three. Relevant categories are as follows:

- owner/farmers;
- leaseholders;
- paid managers;
- Maori owners farming the property themselves;
- Maori owners leasing the property out;
- public land;
- farming or forestry companies.

Cutting across these categories, however, is the variable of whether or not the land-holder lives on the property, or general vicinity. This was also considered as a contextual factor affecting land use decisions.

5.4 Fieldwork

Fieldwork for the study took place over four weeks during the months of August and September 1993. Two and a half weeks were spent in the catchment area interviewing land owners, and a further week and a half in Gisborne interviewing land-holders who lived there, as well as the Department of Conservation, the Conservation Division of the GDC, the Ministry of Forestry and Manaaki Whenua.

5.4.1 Preparation

Base data on land use capability in the catchment was available in the form of Land Use Capability Units. The detail of information provided by the 34 separate LUC classifications found in the catchment was greater than required for this study and, as was discussed in Chapter Three, needed to be amalgamated into land use categories, combining units of similar slope stability and erosion susceptibility. This amalgamation was carried out for all the properties in the study area. A new map was produced for each, showing property boundaries, with an overlay of land use categories, and a breakdown of the percentage of each of these on the property. These maps were required in the interview process, both for the land use mapping section, and as a portrayal of the recommended land use pattern for the property.

5.4.2 Questionnaire

The questionnaire used in the interviews is included as Appendix II. This questionnaire was divided into two sections. The first was put to all respondents and dealt with the current and historical land use of the property in question and included information on farm productivity, farm development, and employment. Respondents were asked to respond to those questions which were relevant to their property and enterprise.

This part of the survey also included questions on the respondent's plans for the property, for purchase or sale of land, and their attitude to such issues as the extent of erosion, forestry, to the pattern of land use proposed based on Land Use Categories, and a final question on sustainability. Questions also attempted to gauge both the actual and the perceived effect of Cyclone Bola, the largest erosional event to have occurred in the region, which occurred in the middle of the study period and which severely affected the catchment.

The second section of the questionnaire sought to obtain information on the background characteristics of the respondent. The questions in this section sought to explore the relationship of land-holder(s) to the property, to the region, and to the changing pattern of land use.

Since different forms of land tenure were involved, this section of the questionnaire was prepared in alternative versions. The distinction was drawn between owner/farmer

households, and the representatives of multiple land-holders, since some questions which appropriate to individuals were clearly not appropriate to an individual responding on behalf of an ownership group.

Respondents from forestry companies were not asked these questions, as they were not applicable. Instead, such companies were asked open questions on the structure of the company and its involvement in forestry in the region.

5.4.3 Interviews and Data Collection

Interviews were conducted by the author personally. While a letter had been prepared outlining the purpose of the study and requesting time for an interview and visit to the farm, mailing these proved difficult as a number of the properties had changed hands recently, and in many cases it was not clear who the appropriate person to send it to was. This was made more difficult from Palmerston North. In view of this, it was decided to contact land owners initially by phone. This gave an opportunity to give details of the purpose and scope of the study, followed by a request to meet for approximately one hour at a time that suited them in order to complete the questionnaire.

Almost all those contacted responded positively to this request, and were willing to give up their time and to freely participate and express their opinions in the study. In most cases it was also possible to visit areas of forestry or severely eroding land on the property. Only one person contacted refused to be involved, although one or two proved difficult to track down. In the former case the person had recently sold the property and did not wish to discuss the issue. For the latter it was simply a matter for perseverance.

Respondents from all properties in the catchment except for two were interviewed. One of these two was the refusal above. The new owner was a forestry company based in Auckland which was contacted, and a questionnaire sent, but this was not returned. The other property for which no response was recorded was for a property which had been divided. It did not become evident that this was a distinct property until the mapping stage, by which time the fieldwork had been completed.

For several properties a number of responses were recorded. Generally this arose from the need to interview both leasee and owner where the property was under a leasehold

arrangement. In two cases, however, the property had recently been sold, and the previous owners had been largely responsible for planting the land in pines. Both were happy to be included in the study, which provided considerably more background to the process of land use change than could have been provided by the new owners alone.

Interviews mostly took place in the owner's home or office, and while the questionnaire was structured, questions generally required long answers, in which the landowner was asked to express their motivation, plans or opinions of the issues in question. In two cases the interviewees did not wish to be held down to the interview format, so the required questions were asked while out on the farm. This made recording the responses somewhat difficult, and could have contributed to lack of standardisation, however this was considered preferable to not conducting the interview at all.

Problems encountered apart from those described above, included the difficulty in mapping areas accurately on A4 sized plans of the properties. In most cases, fence lines were evident on the plans, and these assisted the mapping process.

5.4.4 Analysis

Before any analysis could be carried out, the data on land use and vegetation areas had to be mapped onto overlays of the aerial photographs of the catchment, in order to contrast these with the LUC breakdown of that land. This was a time consuming process. For those properties which contained only one dominant land use, the process was relatively simple, as this data was already available. However, the majority of properties contained areas of native forest, scrub, or plantings of exotic forest, each of which had to be mapped.

Once the mapping was completed, the LUC areas underlying each distinct land use or vegetation area were measured with the assistance of a planimetre. The planimetre was set to the scale of the photographs so that a true reading could be obtained. In order to minimise the potential for inaccuracy, the planimetre was use to encircle each unit three times, with the average of the three readings taken as the area.

In all cases, the known areas of particular blocks were used as a reference. Thus if a block was known to be 100 hectares, while the sum of its constituent LUC areas gave a total of 105 hectares, each LUC area would be reduced by a factor of 100/105. A check

was also kept on the planimetre consistency, by dividing the known area of each property by the area measured.

Once this process was completed, it was possible to compile a table showing land use and vegetation by property and Land Use Category for all properties in the catchment. This table is included as Appendix V. It forms the basis of most of the analysis of land use change, since it also contains information on the timing of afforestation on each property.

In addition to the information in Appendix V, the same process gave rise to a table of planned afforestation between 1994 and 1997, which is listed in Appendix VII. This table allows further analysis, not on the basis of past changes of land use, but the changes envisioned in September 1993, by land-holders in the light of the newly established Forestry Scheme, and the absence of subsidies for on-farm conservation work.

Given the small number of properties and respondents, and the open nature of many of the questions, the data from the survey questionnaires was not coded for statistical analysis. Instead, qualitative responses from the attitudinal questions in the survey were considered on a property-by-property basis, with the degree of land use change both required and undergone on that property.

One of the difficulties encountered in this section of the study was how to deal with the diversity of tenurial and management arrangements. The study has certainly supported the findings of Meister and Weber (1991) when they identify three major problems facing policy-makers and planners seeking to promote sustainable land use:

- the heterogeneity of farming situations;
- the lack of information or asymmetric information regarding farmer response, and/or resulting environmental change; and,
- the enforcement of compliance.

The first in particular caused basic practical difficulties. For data collection, all blocks which were held under different arrangements were kept separate for data collection. In the analysis, however, changes in land use needed to be considered relative to an entire enterprise, not simply to a block of land which may be part of a much larger business. In

order to do this, where blocks were amalgamated and managed together, these were combined in the analysis to give figures for a particular enterprise.

A further problem existed where enterprises extended outside the catchment area, either via land outside of the study boundary, or through off-farm business or other interests. Rather than attempt to consider all of the many possibilities which this problem could involve, the study attempted simply to gauge the existence and size of such outside lands or interests relative to the area under scrutiny, and to take these into account when discussing land use on the land under study.

The analysis used the data on changes in land use and dominant vegetation to highlight what appeared to be the most significant changes in the region, relative to the biophysical bottom line represented by the mapped LUC areas and their respective recommendations. These changes were considered and discussed in relation to the context of each property and land-holder and, in particular, to the East Coast Project, soil conservation subsidies, and afforestation assistance available over the period.

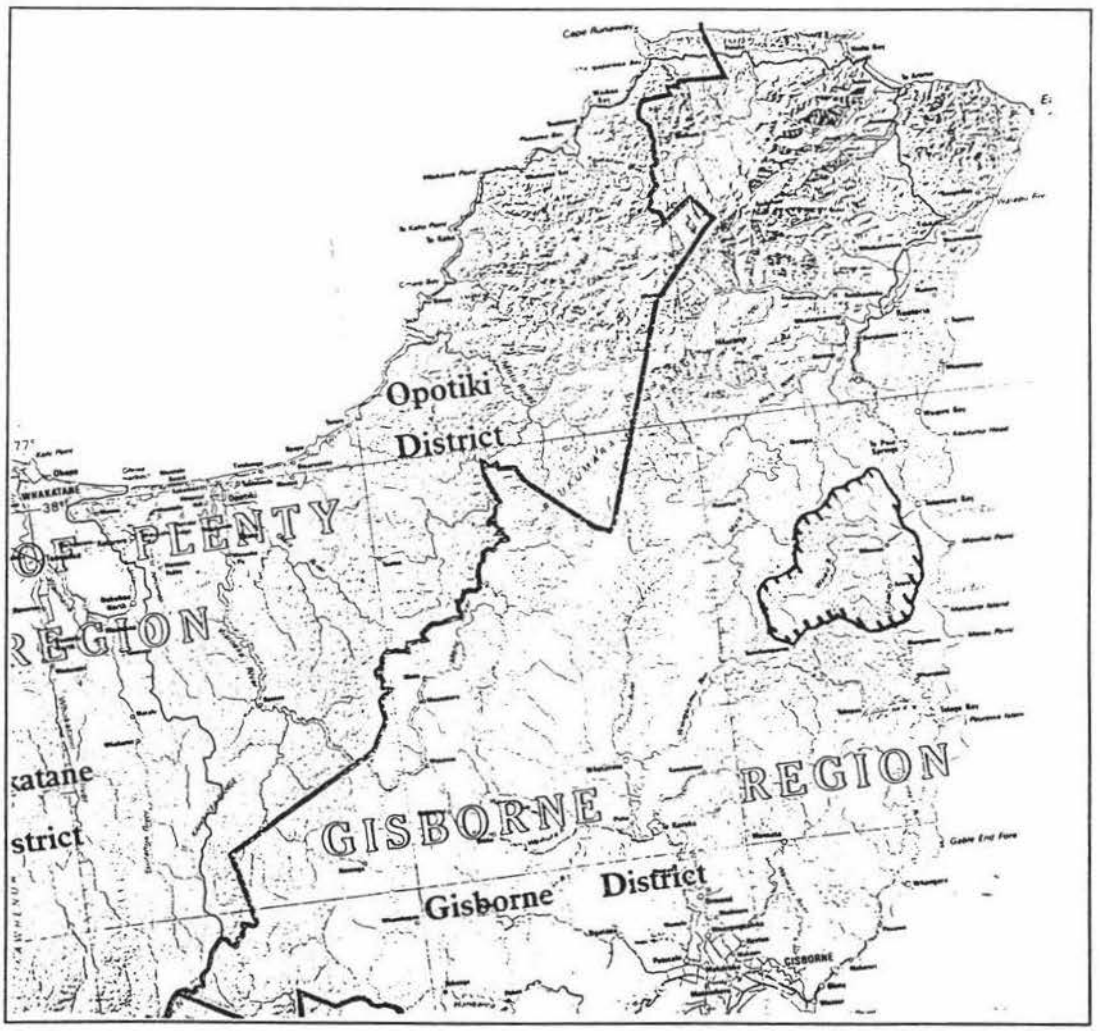
CHAPTER SIX

Land Use Change in the Upper-Hikuwai Catchment

6.1 Introduction

This Chapter outlines the main findings from the case-study conducted in the lands and properties contained in the upper-Hikuwai catchment. The location of the catchment is shown in map below. In order to retain the anonymity of the respondents and properties covered, the names of properties have been replaced by numbers, and no map of the property boundaries has been included.

Figure 6.1 - Location of the Upper-Hikuwai Catchment.



Source: Land Resource Inventory

The key questions to be asked in this case study, relate to how effectively land use change has brought land up to the biophysical bottom line, represented by the LUC recommendations. The critical categories are Categories 2, 3b, 3c and 4, all of which are susceptible to erosion if not treated appropriately. Thus the chapter examines the changes in land use on these categories in particular, in relation to the time of the change, the stage of the East Coast Project, the tenure of the land and other contextual or attitudinal factors highlighted in the survey.

6.2 Land Ownership in the Catchment

Land ownership in the upper-Hikuwai catchment could best be described as a complex patchwork of tenurial arrangements. While a total of 27 distinct "properties" were identified in the 1984/85 survey, this is representative neither of the true ownership pattern, nor of the structures of land use and management which operate on those properties. Since such information was not available prior to conducting the current survey, the properties included were primarily those listed by the 1984/85 LUC survey. In some cases, especially where land uses have changed, so have the tenurial arrangements under which it is held. Where it was both possible and helpful, these properties have been further broken down to provide information and comparison for these smaller units which have been treated differently. This was the case where the original surveyed property had since been divided up. Thus, properties 22, 23 and 24 which were originally single units, have been broken down into a total of eight separate blocks; 22a and 22b; 23a and 23b; and 24a, b, c and d[84].

In 1981, property 8 was purchased by the owner of property 5 and the two were farmed together (although they do not physically bound each other). In the year preceding the survey, however, both properties were sold to different owners. Thus it has been included here as two separate properties. This is discussed further in the section on land exchanges later in the chapter.

Alternatively, several properties previously farmed separately have since come under joint management, either through leasehold arrangements, outright purchase or joint

[84] For the purposes of clarity and anonymity, each of the properties detailed in the 1984/85 survey have been assigned a number and are referred to as "properties". Individual areas which have since been partitioned off, are referred to as "blocks" even though they may now be entirely separate legal entities.

ventures. Falling into this category are blocks 2 and 4 which are farmed together by an incorporation representing several groups of owners. This incorporation also leases block 22a, farming all three as a single unit. Properties 11 and 18 are leased by the same person, and are farmed as one entity. The owners of property 13 have purchased block 24c. These arrangements are shown in Table 6.1 below, which summarises the properties that are managed as one enterprise. The final column in this table also indicates the total area of land of enterprises which extend beyond the catchment boundaries. Generally this relates to the total area owned and/or leased by that enterprise, and which is managed as one entity[85].

Table 6.1 - Summary of Separate Enterprises in the Catchment.

Property	*Area Freehold (ha)*	*Area Leased (ha)*	*Total Area in Catchment (ha)*	*Total Area of Enterprise (ha)*
1	397.8		397.8	1895.9
2/4/22a	1201.2	256.0	1457.2	4628.0
3	2791.1		2791.1	2791.1
5	666.9		666.9	666.9
6	607.1		607.1	607.1
7	801.8		801.8	801.8
8	153.0		153.0	153.0
9/24b	1122.2	570.3	1692.5	3464.0
10	826.5		826.5	1442.7
11/18		1398.5	1398.5	1398.5
12	1275.2		1275.2	1310.9
13/24c	1315.1		1315.1	1544.1
14	1402.2		1402.2	11269.1
15	213.5		213.5	213.5
16	901.8		901.8	2777.6
17	841.9		841.9	841.4
19	282.6		282.6	1335.0
20	565.9		565.9	1361.9
21	4960.8		4960.8	5218.0
22b	186.4		186.4	186.4
23a		327.5	327.5	327.5
23b	1015.4		1015.4	1015.4
24a		287.0	287.0	287.0
24d	1629.1		1629.1	2376.0
25	912.0		912.0	912.0
26		126.8	126.8	126.8
27	99.1		99.1	120.1
Total	***24168.6***	***2966.1***	***27134.7***	***49071.7***

[85] An exception occurs in the case of forestry companies, where the total area relates to the size of the particular forest, not all forests held by the company.

The above table indicates that for nine of the enterprises listed, land in the catchment is just a part of a much larger area. For three others (12, 13/24c and 21), while most land lies in the catchment, the full area is somewhat larger.

6.2.1 Maori Land

The survey highlighted the existence of 14 separate Maori ownership groups in the catchment. These ownership groups ranged in size from 35 owners, to around 1,650. Most were unsure of the current number of owners, and stated "several hundred" in response to Question 58 (Appendix II) for multiple owners. These were all whanau or family groups for whom both the region and the land were traditional. The tenure of properties under Maori ownership or control is set out in Table 6.2 below.

Table 6.2 - Tenure of Maori Land in the Catchment

Tenure of Property	*Property*	*Area (ha)*	*Total (ha)*	*No. of Groups*
Properties farmed	1	397.8		1[86]
by an Incorporation	2	410.7		1
	4	790.5		1
	13	983.9		1
	24c	331.2	2914.1	
Properties	9	570.3		1
leased out.	11	427.2		1
	15	213.3		1
	18	971.3		3
	20	565.9		1
	22a	256.0		1
	22b	186.4		1
	26	126.8	3317.2	1
Total			***6231.3***	***15***

The total area of Maori land amounted to 6,231.3 ha, or 22.8% of the catchment. Average size was 445.1 ha. Of this area, four ownership groups farmed the land themselves through a manager, generally as incorporations. Two of these groups farmed their land as one incorporation under a joint venture arrangement (properties 2 and 4) and lease a further property (22a). Property 24c has been purchased by the owners of property 13, and the two areas though not adjacent, both lie on the main road and are

[86] Property 1, actually includes two small area of densely scrub-covered land leased from separate landowning groups. These extended out of the catchment, making boundary areas unclear. To avoid extra complexity these two areas have not been included. Both areas were leased for a period of 20 years of which 9 remain.

farmed as a unit. One further incorporation farmed land itself, this being the owners of block 9, who farmed their own land, outside the catchment, and who leased block 24a. It should be noted that property 24a is in fact not strictly Maori land. It is cross-leased to the group who farm it by the Department of Conservation (DOC) under an exchange to be dealt with in more detail later in this chapter.

These four incorporations, farmed a total of 3457.1 ha in the catchment[87]. The total area farmed by each is however much greater than this since all own land outside the catchment, amounting to some 9,570 ha. Areas held by individual incorporations range in magnitude from 1,502 to 4,628 ha.

The lands belonging to the remaining 10 groups are, in general, much smaller blocks. Most are leased out through the agency of the Maori Trustee. Excluding property 9 which is entirely in native bush and crossleased to the DOC, the average area of these leasehold blocks is 393.7 ha[88].

Four of these which lie adjacent to each other (properties 11 and 18), were leased to one person, together forming a larger block of 1398.5 ha which is farmed as one unit. This formed part of a still larger farming operation including freehold land outside the catchment area to give a total of approximately 2,500 ha. This enterprise was not a Maori Incorporation, although the leaseholder also held shares in a number of the blocks he was leasing. The other five were leased separately, although as stated above, block 22a of 256 ha was leased to one of the incorporations.

The remaining nearly 77% of land studied was managed as 19 separate enterprises. These enterprises are listed below in Table 6.3

6.2.2 Publicly-Owned Land

Prior to 1980, two main areas were under public ownership. Two properties (14 and 21) formed part of a large endowment made in 1884 to the then newly established Gisborne Harbour Board. These had been developed and farmed by the Board to finance and

---

[87] This is the sum of the areas of properties 1, 2/4/22a, 13/24c and 24a as indicated in Table 6.1. Property 24a is included since it is farmed in exchange for block 9.

[88] This figure includes the entire area of property 20, the only one which extends outside the study area.

establish the port at Gisborne. A further two properties were owned by the Lands and Survey Department (19 and 24).

Table 6.3 - Tenure of Non-Maori Land.

Ownership	*Property*	*Area (ha)*	*Group Total (ha)*	*Mean Area (ha)*
Freehold Land	6	607.1		
Owned and Farmed	7	801.8		
	8	153.0		
	12	1275.2		
	16	901.8		
	17	841.9		
	19	282.6		
	27	99.1	4962.5	551.4
Owned by Forestry	3	2791.1		
or Farming Company	5*	666.9		
	10	826.5		
	14	1402.2		
	21*	4960.8		
	23a*	327.5		
	23b	1015.4		
	25	912.0		
	24d	1629.1	14531.5	1816.4
Conservation Estate	24a	287.0		
	24b	1122.2	1409.2	704.6
Total		***20903.2***	***20903.2***	***1100.2***

Notes: 5 - This property was sold in the year of survey, but the former owner was still on the property and responded to the surve; 23a - This block is leased out; 21 - Part of this property is leased out.

Since that time there has been a significant change in the make up of publicly owned or leased land, with the Harbour Board reducing its holding, and central government firstly purchasing land for afforestation, and then directing its ownership through DOC toward areas of high conservation value. In 1980, Lands and Survey sold block 24d, and the Harbour Board sold the entire property 21, both to commercial forestry companies. At the same time, the New Zealand Forest Service, under the new system of land classification, made purchase of property 3, for the purposes of afforestation. These changes heralded the arrival of commercial and protection exotic forestry in the catchment on a plantation scale.

The Harbour Board retains property 14, however the former Lands and Survey holdings, how inherited by Landcorp have been further reduced, as is described below.

The Department of Conservation owns two areas of land in the catchment, these being blocks 24a and 24b. These holdings date from a series of negotiations between government departments, private foresters, and landowners. In 1980, a local forestry company purchased Huanui Station, a property to the north west of the upper-Hikuwai catchment, with the intention of afforesting it on a commercial basis. The Land Use Committee of the region, however, having powers to regulate land use, considered Huanui to be "too good" for forestry, and there ensued a forced sale, whereby the forestry company received a portion of property 24 (block 24d) - a large station owned by the Lands and Survey Department. Property 24 had originally been a large, substantially bush and regrowth-clad, privately-owned farm.

With the general restructuring of government departments in the mid to late 1980's, most of the remaining land in Property 24 became allocated to the Department of Conservation (blocks 24a and 24b). The latter in particular incorporated the majority of the substantially reverted bush from the property.

Following this transfer, DOC then negotiated an agreement in order to gain tenure of block 9, an area of 1,140 ha of native forest immediately adjacent to block 24b. The agreement involves the cross-lease of 1140 ha (encompassing block 9) virtually all in native forest, for the 287 ha block almost entirely class 1 flats (24d), predominantly in pasture. No money changes hands, but the land is cross-leased for a period of 33 years with two rights of renewal. The initial term took effect in 1988 and is thus to continue until 2021. This exchange is discussed later in this chapter.

The remaining area of pasture from property 24, block 24c, was sold to the Maori Incorporation which owns property 13.

6.2.3 Forestry Holdings

At the time of the survey, 7 of the blocks listed in Table 6.1 were held by forestry companies. These may be divided into two groups, since three properties (blocks 3, 21 and 24d) were all purchased by forestry interests in 1980, while the others (5, 10, 23a and b, and 25) were purchased only in the 1992/93 year, and had up to that time been farmed[89]. Of the former three properties, block 3 was originally purchased and

[89] Blocks 23 and 25 were being progressively afforested during the years since cyclone Bola in 1988.

afforested by the New Zealand Forest Service, under the revised land classification system. Blocks 21 and 24d were purchased by two separate commercial forestry companies. The lands on which these forests stand has so far all been retained by the original purchasers. Although block 3 was incorporated in the 1988 sale of state forests, the forestry company which bought it was only permitted to purchase the standing forest, and forestry right for two rotations, not the land itself which continues to reside with the crown.

All blocks purchased in the year preceding the survey were substantially afforested under the 95% subsidy available from 1989 to 1993. Of these properties, two (10 and 25) have been almost entirely afforested, apart from 19 ha around the homestead on 25. On the remaining two properties however, a mix of forestry and farming under new tenure arrangements has eventuated.

6.2.4 Family Farms

At the time of the survey, only 8 properties could be classed as "family" farms, this being defined as those properties both owned (or leased) and worked by the farmer him or herself while living on the property. Six of these were owned by the farmer, while two were leased. The number of family farms in the catchment has dropped greatly over the past two years, since all four properties discussed above, that have been planted in forestry, would have fallen into this category prior to 1992. Before this time the number of family farms had been stable since 1980, even increasing in 1990 with the sale of property 19, by Landcorp, to a private farmer.

The remaining family farms are included above in Table 6.3 described as "freehold land owned and farmed.

6.2.5 Leasehold Land

The area and tenure of land leased in the catchment is shown in Table 6.4. It can clearly be seen that the majority of leased blocks in the catchment are on Maori land. The only areas of non-Maori land leased are residual areas of pasture on properties 21[90] and 23,

[90] It should be noted that although property 21 is treated as one property in Appendix V, part of this property is in fact currently leased to the previous manager. No accurate boundary of the area leased was available for this property, but it approximates the area indicated under pasture for this property in Appendix V. The lease is on an annual basis and unlikely to continue beyond the next two years, given the company's intention to completely afforest all reasonably clear areas on the property.

owned by forestry companies, and which have otherwise been planted in forest, and block 24a, involved in the DOC exchange.

Table 6.4 - Leasehold Land in the Catchment.

Land	*Property*	*Area (ha)*	*Total (ha)*	*Mean Area (ha)*	*Length of Lease (yrs)*	*Years to Run (1993)*	*Right of Renewal (years)*
Maori Land	9	570.3			33	26	66
	11	427.2			5	4	5
	15	213.3			20	16	0
	18	971.3			5	4	5
	20	565.9			50	4	50
	22a	256.0			21	17	0
	22b	186.4			21	17	0
	26	126.8	3317.2	414.7	20	9	0
Non-Maori Land	21a	1,308.0			1	1	0
	23a	327.5			1	1	0
	24a	287.0	1922.5	640.8	33	26	66
Total			*5,239.7*	*524.0*			

Of the eleven blocks listed in the table, three were leased to Maori Incorporations farming in the catchment. Three were leased to private farmers living on the property, one to the Department of Conservation in the exchange above, and the remaining four to lessees not resident on the property.

The leases varied in length as can be seen in Table 6.4. The shortest leases were for blocks 11 and 18, although they did include a right of renewal for a subsequent five years. The leaseholder of these two blocks expressed frustration at the length of these leases, and the constraint this placed on land development. Both properties contain large areas of manuka/kanuka, however on property 11 this is primarily in thick patches of closed canopy, whereas on block 18 the scrub is much more open, but a mixture scrub and pasture covers most of the property.

All other leases are of a length of at least 20 years, with substantial time to run, except for block 20, which has been leased by a charitable trust for 46 years, and has only four years remaining on the 50 year lease. While this also includes a right of renewal, the representative of the trust indicated that there was little enthusiasm among trust members to take this up.

6.2.6 Land Ownership and Land Use Categories

Tables 6.5 and 6.6 detail the breakdown of catchment land under different forms of ownership by their Land Use Categorisation in 1980 and in 1993. While the area of Maori land has altered little since 1980, the area and composition of non-Maori land has altered considerably.

It should be noticed that Maori land, although of a much lesser overall area, comprises comparatively more Category 1 land than either publicly owned land, or family farm land. Also for the three land categories most susceptible to erosion, the proportion of Maori land that fell into these categories was only 12.2% as opposed to 17.9% and 16.5% for the others respectively. In general, Maori land in the catchment appears to have been more stable than non-Maori land.

Table 6.5 - Land Ownership by LUC in 1980

Land Ownership 1993	*Land Use Category Area (ha)*						*Total (ha)*
	1	*2*	*3a*	*3b*	*3c*	*4*	
Maori land	2433.3	2278.8	468.3	633.8	0.0	86.0	5900.3
	41.2%	38.6%	7.9%	10.7%	0.0%	1.5%	
Publicly owned	2841.2	4047.4	1334.7	1493.6	0.0	298.1	10015.0
	28.4%	40.4%	13.3%	14.9%	0.0%	3.0%	
Family farms	4301.3	4940.3	39.4	1615.4	188.3	35.5	11120.2
	38.7%	44.4%	0.4%	14.5%	1.7%	0.3%	

Table 6.6 - Land Ownership by LUC in 1993

Land Ownership 1993	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	
Maori land	2419.8	2468.3	353.3	685.8	0.0	20.7	5948.1
	40.7%	41.5%	5.9%	11.5%	0.0%	0.3%	
Publicly owned	975.4	523.0	730.0	550.5	0.0	315.8	3094.7
	31.5%	16.9%	23.6%	17.8%	0.0%	10.2%	
Family farms	2608.7	1485.1	46.6	374.2	188.3	7.5	4710.4
	55.4%	31.5%	1.0%	7.9%	4.0%	0.2%	
Company owned	3571.9	6790.1	712.5	2132.3	0.0	75.6	13282.3
	26.9%	51.1%	5.4%	16.1%	0.0%	0.6%	

Maori land did however also incorporate a substantial area of infertile class 3a land (7.2% of all Maori land). This stands in marked contrast to the minimal percentage of this class to be found on family farms. This may be accounted for by the process of land acquisition by farmers from the local Maori. Areas of Category 3a land, which tend to

be located at the top of steep bluffs, would not have been highly sought after for pastoral production due to their relative infertility. Without fertiliser, much of this category is considered difficult to sustain in pasture. This may also account for the high proportion of Category 3b land held by family farms as opposed to that on Maori land, as this category, despite its susceptibility to erosion, is generally inherently very fertile.

Publicly owned land in 1980, included both farming land and native bush, owned by the Gisborne Port Authority, and central government. This area covered the highest proportion of the three most erosion susceptible land categories combined, as well as easily the highest proportion of Category 3a land. The total percentage of Category 3 and above land held under public ownership in 1980 was 31.2% (31,264 ha), however by 1993, the corresponding area amounted to 51.6% although this corresponded to a much reduced area of just 1,596 ha. This reduction was part of a general reduction in publicly owned land in the catchment from over 10,000 ha to just over 3,000.

The change came about largely as a result of the restructuring of the late 1980s which saw the sale of land by both local and central government. By 1993 only the port company was still involved commercially in the catchment, and even this was on a reduced area. Central government assets were reduced to the conservation estate, and land under a lease exchange for conservation land[91].

The drop in the area classified as family farms was only slightly less than that for public ownership. This area fell from a total of 11,120 ha to 4,710 ha - from over 40% to just 17% of the catchment area. Accompanying this drop, was a change to the LUC breakdown. Most notably, there was a substantial reduction in both the area, and the proportion of Category 3b land held. The more severe Category 3c are remained unchanged as this was all located on one property which did not change ownership.

Overall there has been a trend for better land to remain in pasture, as the proportion of Category 1 land on family farms has risen from 38.7% to 55.4%.

---

[91] Table 6.3 includes property 3 as being owned by a forestry company. As has been stated, this is not in fact the case, since the company was only permitted to purchase the forestry right for two rotations not the land itself. In fact while not indicated in the table, property 3 is owned by government. The reason this property has been treated in this manner is because this study is interested in land use, and it is the forestry company which controls that use for at least the next 45 years.

Tables 6.7 compares the proportion of each Land Use Category on Maori land leased out with Maori land that is farmed by the owners. Table 6.8 indicates the LUC breakdown of leasehold Maori land, and leasehold non-Maori land, relative to total land in the catchment.

Table 6.7 - Comparative LUC Breakdown of Farmed and Leased Maori Land

Mode of Use	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
Leased out	1426.3	1029.3	288.4	487.4	0	86	3317.4
	43.0%	31.0%	8.7%	14.7%	0.0%	2.6%	100.0%
Farmed	2468.2	2446.4	549	684.8	0	90	6231.4
	39.6%	39.3%	8.8%	11.0%	0.0%	1.4%	100.0%

The above table does not show up a huge difference in the quality of land which is leased as opposed to that which is farmed. Land leased out does incorporate more 3b and 4 land, but equally it contains a higher proportion of Category 1 land. What is evident is that where blocks of Maori land are small, there is a greater likelihood that they will be leased rather than farmed by the owners, as was shown in the discussion on Table 6.2. Thus, it would appear that block size is more important that land quality in determining whether Maori groups have farmed land themselves. The owners of property 2 have managed to overcome the difficulty of small block size through the joint venture they have entered into with property 4.

In relation to this, respondents stated the reasons for leasing their properties out (Question 63, Appendix II) as being: "historical", "difficult access" and "uneconomic size on its own".

Table 6.8 - LUC Breakdown on Maori and Non-Maori Leasehold Land

Leasehold Group	*Land Use Category Breakdown (%)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	
Leased Maori Land	43.0%	31.0%	8.7%	14.7%	0.0%	2.6%	100.0%
Leased Non-Maori Land	39.5%	48.4%	0.0%	11.1%	0.0%	0.9%	100.0%
Total Land in Catchment	35.5%	41.6%	7.1%	13.8%	0.7%	1.4%	100.0%

Notably, the three blocks of non-Maori land which were leased, were all areas partitioned off from the remainder of their original properties, in order that they remain in pasture. Two of these were forestry companies (21 and 23), which for the time being

at least, were not afforesting all the land they owned on the properties. For block 21a this was considered to be temporary state of affairs, with the long term plan being to afforest this area as well. The long period over which block 21 has been progressively afforested was not due to a desire to keep parts of the property in pasture, but rather due to the fluctuating availability of capital, and the changing incentives for forestry investment which have occurred over the period. This block included over 213 ha of land requiring afforestation.

For block 23a, however, the owner had made a commercial decision to leave the land in pasture on an annual lease agreement. Here the area partitioned off, comprises much of the more productive land from the original property, and comparatively little land susceptible to erosion. Similarly on block 24a a long term lease, provides an area of land of high pastoral value in exchange for a much larger area of high conservation value.

It is notable that the only areas of non-Maori land leased in the catchment were leased out by forestry companies, and the DOC. It is possible to see from Table 6.8 that non-Maori leasehold land tended to be under lease because it comprised classes of land deemed to be too good to be used for forestry or conservation (24a), while Maori land, whether through cause or effect, incorporates more land of lower pastoral value (categories 3a, 3b and 4).

6.3 Land Use and Vegetation Change by Land Use Categories

The preceding chapter outlined the broad classification of land in the upper-Hikuwai catchment as determined by the 1984/85 survey of the area. The detailed breakdown of these categories for each of the properties and blocks under study, is given in Appendix IV. This table is expanded in Appendix V to include a further breakdown of these categories by vegetation and land use, derived from information gained during the course of the survey, and subsequently mapped and estimated using the planimeter described in Chapter Five. This is the master table from which most other tables and analyses of land use change have been derived.

6.3.1 Forestry

Prior to 1980, virtually all land that was used commercially in the catchment was used for pastoral farming. The area of exotic forest was almost negligible, restricted to

several small stands of established trees, the largest being a 50 ha stand of *P. radiata* on property 16.

This situation changed with the abandonment of the "blue line" such that land in the area became eligible for purchase in the project, according to the new system of classification. Figure 6.2 below shows the growth of exotic forestry in the catchment from 1980 to 1993, as well as that projected by land owners at the time of survey for the coming 4 years.

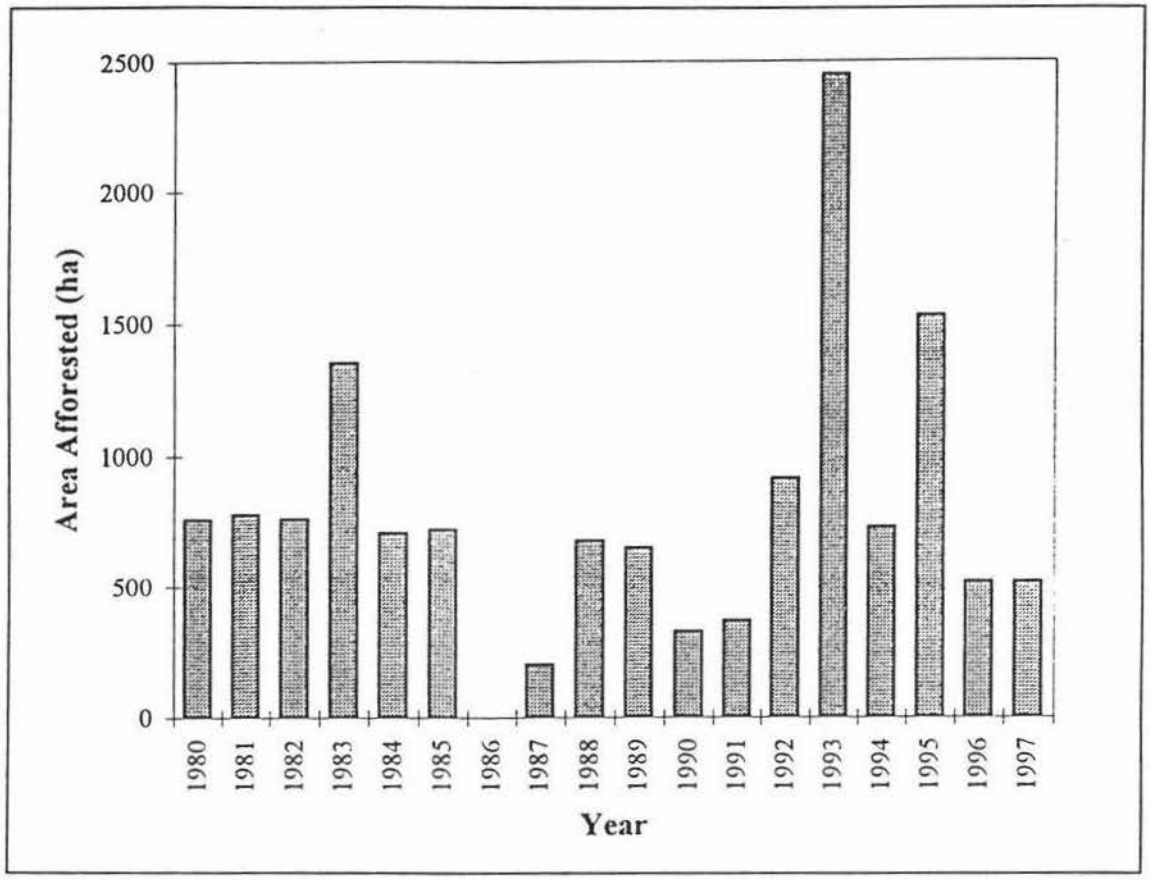
From this graph, it is possible to see that the growth of forestry in the catchment prior to 1994 occurred in two distinct phases. The first occurred during the early 1980s but by 1986 had stopped altogether. The second came in the five years following Cyclone Bola. The graph is derived from the gross areas afforested (or planned for afforestation) as stated by the land-owners from farm soil and water conservation plans, and from aerial forestry maps indicating the areas planted[92].

A breakdown of annual plantings by property is contained in Appendix VII. By far the majority of afforestation during the initial phase was planted on just three properties: by the NZFS on property 3; and by commercial forestry companies from 1980 to 1982 on property 21 and from 1983 to 1985 on block 24d.

Although property 3 was purchased and afforested by the NZFS under the East Coast Project, the majority of land afforested during this first phase was not afforested as part of the project, but was carried out by commercial foresters. It should however be noted that the areas that were afforested commercially are both situated at the Southern end of the catchment, close to the main highway 35. By contrast, block 3 is located some 70km inland by road. Its distance from both highway 35 and hence from the port of Gisborne makes this a less attractive proposition for purely commercial forestry.

[92] It should be noted that although the years 1980 to 1985 show a steady rate of afforestation, these are not based on actual annual figures planted. In two cases, the forestry companies owning the forest did not wish to disclose information on when particular areas were planted. This information was given rather as a gross area which was planted over several years. In the absence of more precise data, this gross area was simply divided over the number of years, under the assumption that the block was planted steadily over the period.

Figure 6.2 - Establishment of Exotic Forest in the Study Area



Notes: The figures used to plot this graph up to and including 1993 relate to the actual areas already afforested. The three years 1994,1995 and 1996 relate to areas projected for afforestation by landowners at the time of survey.

Outside these three, plantings occurred on just three other properties during this early phase. These were all small plantings, ranging in total area from 4 to 31 ha - notably all on family farms. The two largest plantings were carried out by the ECCB as part of the Soil and Water Conservation Plans operating on these properties. Consequently these two areas contained a high proportion of land in the severely eroding Category 3b. On property 5, of the 13 ha planted approximately 11.5 ha was Category 3b. On property 6 the corresponding area was 17.7 ha of a total planted area of 38 ha. Both these plantings were directed towards critical areas of the farms which bordered, and endangered, the council road running between them. While for property 5, these plantings accounted for only a fraction of the Category 3b land present, in the case of property 6, they accounted for more than one third of this category land on the property.

In this case, there existed a clear externality from the erosive potential of these two areas. The externality affected the local Council which is required to maintain and upgrade the road. The Council was able to bargain with the landowners, in order to

afforest the land and so move toward an efficient solution. Afforestation was conducted by the Council, but using central government funds designated for on-farm erosion control. The beneficiaries are clearly the council, the landowners, and the broad categories of people who stand to gain from reduced erosion, and sustainable land use. The subsequent sale of property 6 to forestry interests can be expected to have realised the value of this pre-planted forest to the landowner.

At this time, afforestation by the ECCB was the only means by which small areas of eroding land on pastoral properties could be afforested other than as a commercial venture. Property 12 which planted a total of 4 ha during this period did so without assistance, and directed plantings on an area of Category 1 land bordering the river. The plantings had little soil conservation value and were undertaken by the owner largely as a means of passing on assets to the next generation, particularly to two daughters. It was envisioned that the owner's son would eventually take over the farm. This was also the motivation behind the owner's plan to tender for grant assistance to afforest an area in 1994/95.

Thus during this first wave of afforestation, the only real mechanism for protecting eroding land was for the wholesale purchase by the state of commercial forestry interests on entire properties, or alternatively, the full direct funding of small areas of key concern to the local council.

6.3.2 Conservation Forestry Scheme

After this initial burst of afforestation, the years 1986 and 1987 saw almost no new areas planted, although in the latter year, the company which owns property 21 began a renewed phase of afforestation after a break of 4 years. This company afforested a total of 601 ha, in 1987 and 1988, prior to the Conservation Forestry Scheme (95% scheme), indicating a return to commercial afforestation in the catchment.

The second major phase of afforestation began in 1988, immediately following Cyclone Bola. In contrast to the earlier phase, plantings during this period occurred on eleven different properties. Annual plantings ranged from 10 to 826.7 ha on any single property, and included a number of large plantings on primarily pastoral properties. On all eleven properties, the land afforested during this period was done so within the

Conservation Forestry Scheme with the 95% subsidy that the scheme offered. This contrasts with only one property (property 4 by the NZFS) which had been afforested within the East Coast Project prior to that time.

The properties afforested over this period are listed in Table 6.9 below. This table includes both the total area afforested, plus the area which was covered by the subsidy, since these two figures are not always the same. They diverge particularly where the block to be planted contained patches of unplantable scrub or slips, or an area which was not considered to be eligible for assistance under the scheme.

Table 6.9 - Afforestation under the 95% Scheme by Property and LUC Areas

Property	*Land Use Categories Afforested (ha)*						*Total*	*Area under*
	1	*2*	*3a*	*3b*	*3c*	*4*		*Scheme*
4	39.5	29.7		12.8			82.0	70.0
5	175.8	120.5		103.7			400.0	360.0
6	104.7	109.2		10.1			224.0	220.0
10	124.7	565.5		136.3			826.5	650.0
14	83.9	138.0		127.9			349.9	282.1
16	64.2				117.5		181.7	130.0
17		10.0					10.0	10.0
20	21.6	89.4		60.7			171.7	171.7
21	267.2	388.4		177.4		5.0	838.0	741.0
23b	120.6	570.7		321.4			1,012.7	1,012.7
25	257.4	470.4		156.2			884.0	753.7
Total	*1259.6*	*2491.8*	*0.0*	*1,106.6*	*117.5*	*5.0*	*4,980.4*	*4,401.2*

For four of the properties in Table 6.9, this period saw a change from a family farm, to complete or almost total afforestation. These were properties 5, 10, 23 and 25. On all of these properties, the move to forestry involved a change of ownership, generally after the properties had been afforested.

The owners of properties 23 and 25 which were severely affected by Cyclone Bola were induced to plant their properties in trees in view of the severity of the damage and the availability of the 95% subsidy. For property 25, the farmer was required to afforest approximately 1000 ha of his property as a condition of sale. This sale was made possible through the availability of the 95% subsidy.

On property 5, the availability of the same subsidy was also a major factor contributing to the land exchange described on page 21. Prior to participating in the scheme, this

property was a family farm, predominantly under pasture, although with significant regrowth scrub on much of the land.

The forestry company owning property 21 also took considerable advantage of the 95% scheme to afforest 838 ha of the property. The company representative interviewed stated that the whole of the property was to be afforested regardless of available assistance. It is likely that this property would have been afforested had the 95% scheme not been available, but that the existence of the subsidy sped up this process.

Of the properties listed, only two (properties 4 and 20) were Maori land, despite the fact that a greater proportion of Maori land required afforestation than did family farm land. Property 4 is farmed by a joint incorporation, while the latter was leased to a family charitable trust active in the region. The owners of the former indicated that they simply took advantage of the scheme to afforest a rough paddock on the farm. Further afforestation on this property would probably occur but was dependent on assistance being available, as it was "not possible to fund this themselves". As Maori land, it would probably be afforested in conjunction with the iwi-based company, Ngati Porou Forests who would manage the forest.

Part of the reason for a relative absence of Maori land afforested may be the large proportion of Maori land held under lease. It can be expected that little of this land would have been afforested by the leaseholder. Nevertheless, these two areas represent the first forests planted on Maori land in the catchment.

Property 20 is an interesting case since it was the only area of leasehold land which was afforested during the study period. The trust which leases this property also owns the neighbouring property 16. The full area of property 20 covers 1361.9 ha, but only 565.9 ha of this drains into the upper-Hikuwai catchment. On this property the better land lies outside the study area, while that falling inside includes a sizeable (235 ha) of Category 3b land. Without assistance, this property would not have been afforested since it was still under lease until 1998. The trust however decided to take up the subsidy offered to afforest the entire area on the catchment on behalf of the owners. The property will now be returned in 1998 with half the land in forest, and more specifically that half which was highly susceptible to erosion.

The 95% scheme was also important on property 16 due to the large area of Category 3c land which is severely susceptible to erosion and does not have a long-term for pasture even with on-farm soil conservation measures. Of 181 ha afforested, 65% were on Category 3c land, accounting for over 60% of this category in the catchment.

Further areas of property 16 were projected for afforestation under the current grant scheme, which would incorporate the remaining area of 3c land. These areas have been included in Appendix VII, although it was not a foregone conclusion that this land would be afforested. The owner simply indicated that this was the area which "might" in the next few years be afforested under the scheme.

The only publicly owned area of land which took advantage of the 95% scheme, was property 14, owned by the Port Company. This represents the only remaining area of publicly owned pastoral land other than the area cross-leased by the DOC. The section of property 14 which falls into the study area contains a large amount of Category 3b land, none of which had been treated prior to the 95% scheme. It had been severely hit by Cyclone Bola, along with neighbouring properties 23 and 25. On this property also, the 95% scheme allowed considerable scope for planting of land without sale, and for fencing off of better classes of land.

6.3.3 Forestry Rights for Best Land Exchange

At the time of survey an interesting land exchange, already alluded to, took place between properties 5 and 6. The changes in area, land use categories, and vegetation this exchange involved are summarised in Appendix VI[93].

Prior to the exchange, property 6 contained an inaccessible back block of 207 ha that suffered from severe erosion. The area also bounded a river, the bed of which was some 20 to 30 m wide, making subdivision very difficult and floodgates both extremely expensive and vulnerable to damage with almost any rise in the river. This block was eligible for subsidised planting under the 95% Scheme, however without this land, property 6 would be reduced in area to only 400 ha, and would not have been a viable

[93] This appendix follows the format of the main table in Appendix V, but includes full details of both original properties, the blocks which were divided off, and the new properties they formed after the exchange had occurred.

enterprise for the owner. The owner wished for the time being to remain farming the property.

By contrast on property 5, some 400 ha were eligible to be planted with the subsidy under the scheme. Once this is added to an earlier planting, and the extra land that rational plantings would require, a total of 537 ha would be afforested. The availability of this subsidy provided the impetus for a forestry company to purchase the property (during 1993), however maximum use of the scheme would still leave 130 ha in pasture. Under a new arrangement, the owner of property 6 took title of this 130 ha of the "best land" from property 5, while the forestry company was granted the forestry right on the 207 ha block for a period of 99 years. In a similar exchange to that between DOC and 24a, no money change hands, although the forestry company paid for surveying and legal costs of the exchange, and the 5% which was the owner's portion of afforestation costs.

The owner of property 6 considered that the exchange had been "really beneficial for farm viability".

The decision of the owner of property 5 to sell and look for land in another region was based partly on his opinion that forestry in the area did affect his family's quality of life.

A second partitioning of land on the basis of its suitability to forestry and pasture has occurred on property 23. Here the homestead plus 328 ha of the most stable and accessible area was partitioned off from the remainder of the farm, and leased out as farming land. Property 23a and 23b were formerly farmed as a single unit. The division is contained in Appendix V. The respondent for the forestry company regarded this as an "economic decision" though considered complementarity between farming and forestry to be "the best use of the land". It can be seen from Appendix VI - Table 2, that the area remaining in pasture (23a) is contains only a mere 13 ha of Category 3 land and by far the majority (78%) falls into Category 1. By contrast, the area which has gone into forestry which covers almost all the land requiring afforestation on the old property, while only 12% falls into Category 1.

The current lessee hoped to obtain a similar area elsewhere, so as to establish a viable economic unit. Until such land could be found, both the respondent and his wife were undertaking casual work around the district. It should be noted from Table 6.4, that the

leasing arrangement for this block was on a year by year basis. This currently allows little security to the lessee, nor any long-term assurance that the land will indeed remain in pasture.

Both the above division and repartitioning of blocks may be seen to have been induced by the 95% subsidy scheme. The scheme provided the resources necessary for these areas to be afforested, and both the forestry companies involved stated that they were attracted to the areas due to the subsidy available for afforestation. The flexibility of this scheme made possible the separation and repartitioning of land in a pattern more in tune with its capacity.

6.3.4 Source of Afforestation

Table 6.10 portrays the different proportions of each LUC planted by different means. These include land planted by the NZFS, ECCB, within the 95% scheme, or by private forestry companies or farmers.

Table 6.10 - Land Afforested by LUC Areas and Agent of Afforestation.

Source of Afforestation	*Land Use Categories Afforested (ha)*						*Total (ha)*
	1	*2*	*3a*	*3b*	*3c*	*4*	
NZFS - ECP	692.5	1622.6	0.0	448.0	0.0	28.0	2791.1
Commercial Forestry	798.3	1123.6	613.2	274.9	0.0	22.2	2832.1
Private Farmers	4.0	0.0	0.0	0.0	0.0	0.0	4.0
ECCB	2.8	19.1	0.0	29.1	0.0	0.0	51.0
95% Scheme	1259.6	2491.8	0.0	1106.6	117.5	5.0	4980.4
Total	*2757.1*	*5257.1*	*613.2*	*1858.6*	*117.5*	*55.2*	*10658.6*

This table shows that outside of the 95% scheme, no 3c land in pasture had been afforested, either privately or publicly. While this is primarily due to the fact that 3c land was concentrated on one property, previous schemes did not allow for the capture of this very high priority area.

Similarly, although both commercial foresters and the NZFS had afforested significant amounts of 3b land, the majority of this category which was afforested was also done under the 95% scheme. In addition, apart from the small area afforested by the ECCB, this latter scheme included by far the highest proportion of land in these two categories relative to the total area they planted (24.5%).

The table also indicates that almost no land has been planted by private farmers without the assistance of either the 95% scheme or the ECCB. The 4 ha relating to property 12 was the only area carried out as an investment by a private farmer without assistance.

The respondent representing the Commercial Forestry Company owning property 23 questioned the 500 sph final thinning required by the conservation division, as it was felt that 250 sph was "ideal commercially". It was also felt that a lower density would allow greater light penetration for grass growth beneath the canopy, and that this would produce well in drought conditions, hence reducing farming risk. In support of the argument, the respondent argued that the weight of mature trees planted at greater densities would raise the load on the soil past the shear strength. This argument does not appear to be supported in the literature.

The view that the requirements of the scheme were inappropriate and obstructive to commercial forestry development was expressed by three of the forestry companies interviewed. The extra quantities of plants per hectare, and the greater numbers of stems left per hectare increase costs of planting and pruning, while at the same time reducing the commercial value of the standing forest.

Nevertheless, it is clear that the early presence of many of these companies in the catchment is largely due to the 95% scheme, and latterly to the grant scheme. The assistance has evidently been sufficiently attractive for these companies to conform to the schemes planting and thinning regimes.

A further comment made by one forestry representative was that strict environmental requirements made on foresters were all very well, but the same requirements often did not apply to farmers. Where forestry companies are required to build tracks along ridges, or are prevented from crossing streams with heavy machines, the same controls may not be placed on farm tracks, or on movement of stock across streams. Such a question raises the issue of whether de-facto rights are in fact valid rights, or simply privileges.

Of the area described above, almost all has been afforested using just one species - *P. radiata*. The only exceptions to this rule have been small trial areas of alternative species undertaken on property 3 by the NZFS, parts of property 16, and 2 ha of property 12,

which were planted in eucalyptus. The owner of property 16 objected to the blanket use of pines to the extent that in 1989 he forewent the subsidy offered by the catchment board for pines, in order to plant a third of the area going into forest in eucalyptus at his own expense.

This property has a long history of plantings of other species of trees for conservation value, although these tended to have been more widely spaced than the spacings recommended for on-farm soil conservation.

Although after considerable outcry from environmental groups, provision for assistance to afforest using alternative species, including natives, on specific areas has been included in the grant scheme, none of the properties projecting afforestation planned to take up this option. Only the owner of property 16 favoured the use of alternative species, however the opinion expressed by the Conservation Division for this area of land, was that *P. radiata* was required on land of this susceptibility to erosion.

6.3.5 Future Afforestation

The responses to the question whether tenders would be placed for grant assistance to afforest Category 2 and 3 land were in general clearly yes or no. Only two stated they "did not know or were undecided". Seven respondents were considering tenders, while twelve had no intention of doing this. The areas of planned afforestation in the next 4 years after the survey are included in the second table in Appendix VII.

The owners of property 1 indicated that they would not take part in the grant scheme, since the land in the catchment would not really be eligible, but intended to afforest land without grant assistance, using other species such as poplar or eucalyptus. This property lay on the main highway, and at the southern end of the catchment was one of the closest to the port of Gisborne. Property 6 also intended to afforest small areas of land outside the scheme although any land that was eligible for grant assistance would be tendered.

By far the majority of property owners were not interested in afforesting land outside the grant scheme, with only the two mentioned above responding "yes" and a further four properties indicating "possibly".

6.3.6 Pasture

As a consequence of the above described process of afforestation, the area of pastoral land in the catchment has been declining steadily in area since 1980. This decline is outlined in Table 6.11 below. The years which are highlighted are the year at the beginning of the study period, the two years either side of the 95% scheme, and the year up to which future afforestation was projected.

Table 6.11 - Area in Pasture by Land Use Category - 1980 - 1997

Year	*Land Use Categories (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	
1980	8365	9725	824	3458	188	81	22641
End of 1987	6995	7145	211	2791	188	33	17363
% of 1980 area	83.6%	73.5%	25.6%	80.7%	100.2%	40.4%	76.7%
End of 1993	5608	4468	211	1599	71	25	11982
% of 1980 area	67.0%	45.9%	25.6%	46.3%	37.7%	31.4%	52.9%
End of 1997	5027	3010	211	797	0	10	9055
% of 1980 area	60.1%	31.0%	25.6%	23.0%	0.0%	12.6%	40.0%

This table indicates the dramatic fall in land under pasture throughout this period, to just 40% of its former area (assuming projected afforestation continues as planned). Even by 1993, the area in pasture had been almost halved. It is also evident that, to some degree, the targeting of severely eroding land has been successful, as Categories 3 and 4 decline proportionately more than Categories 1 and 2. Nevertheless, while Category 1 land consistently declines less than the area of pasture as a whole, the same cannot be said for Category 2. A larger proportion of Category 2 land has been taken out of pasture in each of the three phases of afforestation than has been taken of pasture as a whole.

Category 3b land under pasture declines dramatically over this period, particularly during the period from 1988 to 1993.

During the first period, some Category 3b land was taken out of pasture, and notably over half of the area of Category 4 land, but none of the severely eroding Category 3c land. The area of Category 3c land was not large but was situated on one farmed property and could not be captured by a scheme which concentrated on the purchase of whole properties.

By 1997 no Category 3c land should be left in pasture, assuming that the owner of property 16 does indeed carry out his plans.

If these three categories are combined, in 1980 properties with eroding land under pasture had on average 195.8 ha or over 17% of their pasture area classed as severely eroding. This dropped slightly to 177 ha (18.4%) under the early East Coast Project, but it was not until the 95% scheme that these figures really declined. By the time of survey, the average area of these three categories was 120 ha (15.4%). With the afforestation projected at the time of survey, by 1998, this should be reduced to 72.9 ha (10.1%) with, as stated earlier, all Category 3c land afforested.

Appendix VIII details the LUC breakdown for properties in each of the four years of Table 6.11 which continue to have pastoral land that carries a recommendation for afforestation[94]. From these tables it can be seen that the number of such properties has declined from 19, to 17, to 14 and finally can be expected to decline to 11 by 1998. Along with the lesser number of properties, the average area of Category 3b, 3c and 4 land on each property has declined markedly and should continue to do so.

In the first period, from 1979 to 1988, 14 of the 19 properties remained wholly in pasture. Although during this period, commercial forestry accounted for nearly as much land being taken out of pasture as the East Coast Project (2,432 ha and 2,791.1 ha respectively), it was the latter which accounted for the majority of severely eroding land. Commercial forestry succeeded in afforesting some 210 ha of Category 3b and 4 land compared to the 476 ha afforested under the project.

During the next period, from 1988 to 1993, only six properties with land requiring afforestation remained wholly in pasture. In contrast to the earlier period, almost all of the land taken out of pasture during this period was done so through the 95% scheme.

The six properties which did not participate in the scheme, were properties 7, 8, 11/18, 12, 13/24c, 17 and 23a. Of these, the latter, block 23a was simply that area divided off from the rest of property 23, which was afforested. This area had had extensive on-farm

[94] The differences in total areas covered by Table 6.11 and the tables in Appendix VII is because properties which have pasture but do not contain any areas of Category 3b, 3c or 4 land are not included in the appendix.

conservation plantings and was leased as grazing land. It continues to have a small area of 3b (13.8 ha) land which carried a recommendation for forestry.

Properties 7, 12, and 17 were all family farms, on which on-farm soil conservation works were long-standing and extensive. For properties 7 and 17, any loss of land from pasture would have impacted heavily on the viability of the farm, and this, along with a resistance to forestry affected their decision not to afforest any land. Prior to the exchange discussed above, properties 5 and 6 were also in this situation, although property 5 was largely without conservation plantings. This difficulty was resolved through the land exchange, but also meant that two farms were reduced to one farm, and a forestry block.

For property 12, with 33 ha of land requiring afforestation, the farm was of sufficient size that the loss of some 30 - 40 ha would not have affected viability. The farmer, however, was resistant to putting forestry on this land. Instead, he persuaded the Council to treat the largest section of this 3b land as they would a bad patch of Category 2b land, and close plant it with poplars, which was done, with some reluctance. This area was so close planted, as to render it effectively poplar forest.

Properties 11/18 received no afforestation during this period, they being leasehold Maori land, despite a large area of 3b land.

The fourth table in Appendix VIII lists the properties which can be expected to continue to have Category 3b, 3c or 4 land in pasture by the end of 1997, assuming that the projections made by owners are followed. In this table, six properties are not expected to take any land out of pasture over the period. 5 of these 6 are also those on which the area in pasture has not changed over the entire study period. These are properties 7, 8, 11/18, 13/24c and 23a.

The respondents for each of properties 7, 8 and 13/24c expressed their strong belief that forestry was not required on their properties. Only the owner of property 8 believed that forestry was ultimately detrimental to the region.

In this table the largest areas of land requiring afforestation lie on properties 11/18, 16, 2/4/22a, 7, 13/24c and 14, in order of descending area. It is unlikely that any of these areas will be afforested in the near future, except for part of property 18. The different

blocks that this area comprises are all on a short term (5 year) lease and the owners were considering an option of afforestation. Although the current lessee has a 5 year right of renewal, he is also part of at least one of the ownership groups of this land and would consider giving up the lease if the group decided to afforest the land. Much of this property is dominated by scrub of at least 3m in height.

By 1998 properties 16, 2/4/22a, and 14 will all have afforested those areas they identified as a priority, and did not project forward any further forest plantings. None had any intention of selling or giving up the lease on any of their land. Similarly properties 7 and 13/24c were resistant to any encroachment of forestry on their land and had long-term plans to remain farming regardless of changes to the district, or the extent of forestry around them.

6.3.7 On-Farm Conservation Works

During the fieldwork attempts were made to quantify the level of on-farm soil conservation work carried out in the catchment from farm plans of the conservation division and from the farmers own estimates of plantings per year. While this information was able to be collected for some properties it was not available for others. Similarly while respondents could generally indicate the areas on which conservation plantings had taken place, there existed a high degree of difference in the extent of plantings. For this reason, data on soil conservation has been limited to a broad delineation between areas which have been treated with on-farm soil conservation and that which has largely not been treated.

The following two tables list the LUC areas of remaining pasture, for properties both with and without soil conservation works. It will be noted that property 17 is present in both tables, since this property had a clear division between the area treated, and the area untreated. Other properties also having a similar clear division include numbers 6, 23, and 25. The untreated areas of these properties do not, however, appear in Table 6.13 because these areas are no longer in pasture. Most were afforested under the 95% scheme.

Table 6.12 - Pasture with Extensive On-Farm Conservation Works

Property	*LUC Area under Pasture (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
*2	231.1	178.4		1.2			410.7
*6	204.6	115.4		20.5			340.5
*7	319.7	331.8	14.9	109.5		1.4	777.3
*12	890.5	342.6		33.1			1266.2
*13	463.6	458.2	0.0	23.7			945.6
15	66.7	24.3					91.0
*16	285.3	145.0		144.0	70.8	6.1	651.3
*17	311.3	63.5		10.2			385.0
*22a	91.0	92.1		18.6			201.7
*22b	135.3	2.0		2.1			139.4
23a	256.1	57.6		13.8			327.5
*25	18.6						18.6
Total	*2999.1*	*1753.3*	*14.9*	*362.9*	*70.8*	*7.5*	*5554.7*

Notes: Asterisks prior to the property number indicate that a Council soil and water conservation plan was operating for these properties.

Table 6.13 - Pasture without On-Farm Conservation Works

Property	*LUC Area under Pasture (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
1	7.0	140.5	6.7				154.2
*4	195.9	194.2	69.4	108.7			568.1
5	139.9	81.6		32.4			253.9
8	70.5	69.6		12.9			153.0
11	220.7	35.3		9.2			265.1
14	272.8	352.3		422.6			1047.6
17	203.4	189.7		11.8			404.9
18	376.1	367.8		200.8			944.7
19	138.1	12.1	7.2				157.4
20	67.7	152.1		174.4			394.2
21	263.8	830.9		198.0		15.2	1307.9
24a	240.4	42.9		1.0		2.7	287.0
*24c	28.0	153.4	80.7	51.0			313.0
26	42.4	34.9					77.3
27	67.1		32.0				99.1
Total	*2333.8*	*2657.2*	*195.9*	*1222.6*	*0.0*	*17.9*	*6427.4*

Notes: Asterisks prior to the property number indicate that a Council soil and water conservation plan was operating for these properties. The two properties on which this was the case are included in this table, as in the case of no.4, the plan was only recently drawn up, while on property 20, works had only been conducted on land outside the catchment area.

Equally on property 14, owned by the Port Company, the absence of conservation measures on the land which falls in the upper-Hikuwai catchment does not indicate that the owners were not interested in soil conservation. Extensive conservation works were being carried out on this property, but simply not on the land in the catchment, which comprised some of the most susceptible land to erosion on the property.

On these properties the better areas of the farm had been treated extensively, while those areas most subject to erosion had received limited treatment. Almost all respondents indicated both in practice and verbally, that on-farm conservation works were directed at solving erosion problems on the better classes of land, as this was considered the most economic. Prior to the broadening of the scope of forestry which occurred post-Bola, and especially under the 95% scheme, Category 3b land or greater was generally left untreated, due to a recognition that on-farm conservation works would not suffice on this land.

Although property 16 is included as having extensive on-farm conservation work, the works present were far from adequate for the erosion problem on the farm. In the main they were long established plantings, too widely spaced to achieve the degree of control required, especially given the severity of erosion on this property. Nevertheless the owner expressed a strong committment to erosion control on the property using a wide range of tree species.

Property 16 and property 7 were the two farms where on-farm soil conservation had been used, at the owner's expense, to treat erosion on large (>100 ha) areas of Category 3b land. On the latter property this had been a more systematic approach, with trees planted intensively, targeted to problem gullies, or space planted across moving hillsides.

Property 12 also treated its much smaller area of 3b land with poplars as described above.

In addition to those areas listed in Table 6.13, none of the areas which were already in production forest at the time of survey, in particular the forest areas of properties 5, 6, 10, 14, 21, and 23, had undergone any significant on-farm soil conservation work prior to their afforestation for the reasons noted above.

A notable aspect about the properties which did not engage in soil conservation work is that they contain a high proportion of Category 3b land. On-farm soil conservation works have tended to be strongly directed to both better farms, and to the better parts of farms. That is to say, those areas with the best productive potential for pastoral farming, and which tend also to be less susceptible to erosion. This is true both of the areas listed in Table 6.13, and the areas which have since gone into forestry.

Nevertheless, the study also revealed a variation in personal willingness to undertake conservation plantings, both with and without subsidies available from the Council. On family farms, this ranged from properties 6, 7 and 17 which had extensive plantings, to properties 5 and 10 which had received very few plantings at all. It must be acknowledged that both properties 5 and 10 contain large areas of 3b land, as well as of Category 2 land. Nevertheless, the categories present on these two properties are not incomparable to those present on properties 7 and 16, both of which undertook conservation works.

Property 7 is a notable case. This is a second generation family farm, on which both generations have held a very strong commitment to soil conservation. The respondent's father was one of the first people in the district to begin planting poles, and to maintain a pole nursery. All areas of the farm have been systematically treated, with extensive plantings in gullies and on moving hillsides. It can be seen from the LUC breakdown for this property that the farm includes over 110 ha (13.8%) of its total area which carries a long-term recommendation for afforestation.

The extensive plantings on this property however, meant that during cyclone Bola, it suffered less damage than nearby properties (personal comment, Conservation Division of GDC). The owner considered that despite an estimated affected land area of 51% on his property after Bola, the farm was still doing well.

The owner commented that Bola had set the planting programme on the farm back 10 years which was a blow, but that planting would continue unabated. This farmer, who purchased poles and planted them all himself, was critical of the charges placed on landowners by the Conservation Division of the Council for planning and mapping work.

By contrast, property 5 which was a fourth generation family farm, had very little on-farm conservation work carried out. This was despite the ready availability of subsidies for this work during the past 20 years. The owner had begun to plant poles in the past 2-3 years at a rate of around 150-300 per year.

The two areas of pasture owned by forestry companies (21a and 23a) both would require on-farm conservation works if they were to remain in pasture, however 21a is destined for afforestation. In the 13 years since this property was acquired by the forestry

company, no on-farm conservation work was carried out. The owner of 23a considered that the area had been treated sufficiently by the previous owner, and had no plans to continue with on-farm conservation works.

Seven of the fifteen areas listed in Table 6.13 are Maori land, with four under lease. Only property 11 did not have much land requiring conservation work. Four of these properties contain large areas of Category 3b land. Much of this land would never have been eligible for on-farm conservation assistance when this was available, and the nature of the land meant that conservation work was not a high priority. This is evident on property 20, where the leaseholders undertook substantial of-farm conservation work on better land outside the catchment, but on this area (of which 44% required afforestation), little was done.

There are three areas of Maori land with on-farm conservation works, no.s 2, 13 and 22a. Notably, and in contrast to the untreated properties, these areas comprise better classes of land, and relatively little Category 3b land. These areas were also all farmed by Maori incorporations, through a manager. Property 22a is notable as this was previously leased to a private farmer, the leaseholder of property 22b. During this time 22a underwent substantial erosion conservation plantings. It has largely received all the treatment needed, and in future simply requires maintenance plantings and prunings.

Although it might be expected that leasehold land would have been poorly treated with on-farm soil conservation measures, this is not always the case. Property 22a and 22b indicate that certain leaseholders in the catchment were engaged in on-farm conservation works. In this case, the leaseholder had a personal interest in soil conservation and had earlier worked as a soil conservator in the area.

Similarly, the charitable trust which leased property 20 also undertook conservation plantings extensive (1200 poles per year) on the better half of the farm. In the same way as property 23, conservation plantings using subsidised poles were directed toward land which had a long-term future in pasture if properly treated. Land in Category 3b or greater received no treatment, since subsidies were not available for this land. The leaseholder of property 15 since 1989 has also carried out conservation work on this

property in each year since taking on the lease even though the property has only a limited area requiring treatment.

In each of these cases, the leaseholder has undertaken substantial investment, assisted by the availability of subsidies to treat land, but also involving a cost to themselves which would not be remunerated.

Question 18 addressed the respondents' plans for future on-farm soil conservation works. As with all questions the relevance of such a question varied considerably according to the property concerned. However only two owners stated they had no intention of implementing on-farm conservation works. These were number 18 which is Maori land leased on a five year term, has no history of either conservation works or fertiliser application, and was dominated by scrub; and number 23a which by contrast has an extensive history of fertiliser and conservation works, and was deemed by the current owner (and the lessee) to have sufficient. 23a was also on a year by year lease, and neither leaseholder nor owner planned work in this area.

While part of property 18 was being considered for afforestation, and much of its area contained rough pasture/scrub, it was not the type of dense cover to provide erosion control. While this property remains on a five year lease, it is unlikely to be treated either with forest or on-farm works.

All other respondents indicated they had ongoing plans for soil conservation. The majority of comments centred on the loss of subsidies for soil conservation works, and that they would plant far fewer poles now that these had been removed. Most felt that the subsidies had been a good thing, including those who had not taken advantage of the subsidies while they were available.

Two owners who had made use of the subsidies felt that administration costs of having a soil and water conservation plan operating on the property through the council were excessive. Considerable dissatisfaction was expressed over the availability of poles only at commercial prices. At the time, the District Council was burning poles at its nurseries in the area, evoking some disparaging comments. The reason for burning the poles was in order not to stifle the development of private nurseries, and the fact that with the

removal of subsidies, demand was low. A major portion of the cost of planting poles is also the cost of transport to the site.

The manager of properties 2/4/22a made the comment that pole planting was the "Council's responsibility" and that more would be planted with subsidised poles and transport. The owner of property 12, a well planted property argued that land-holders should be required to conform to a soil and water management plan for their properties, but to assist this, subsidies for erosion control should not be channelled only through forestry, but through on-farm works as well.

Although Table 6.13 shows a large number of properties with pasture without on-farm conservation works, some of these such as properties 19 and 27 require little treatment. Two have recently begun soil and water conservation plans, while others, such as properties 5, 20, 21 and much of 14 are destined for afforestation which should counter the need for on-farm works. The respondent for property 17 also made it clear that regardless of the availability of subsidies, he would continue to treat land systematically. The front area he considered to be nearly complete, and in two to three years would begin on the back block listed in Table 6.13.

Several however have large areas of Category 2, as well as 3b land requiring treatment. Particularly property 18 (already discussed) and properties 1. The owners of the latter property have reduced on-farm conservation works in general with the removal of subsidies, and the area in the catchment has only recently been cleared of scrub. It was considered unlikely that this area would be treated.

Over half the area of property 8 is also Category 2 or greater, but the owner has few plans for its treatment.

6.3.8 Shrubland

While information on areas of forestry and pasture were readily available and could be mapped with reasonable accuracy, areas of native forest and scrub tended to be less well defined. The 1984/85 survey indicated that scrub was present on all properties in the catchment, however, apart from small areas, on most properties it was a subdominant class of vegetation. Identification of precise areas of scrub proved difficult in the present study, since its presence and nature can vary considerably. On some properties scrub

was confined to small patches and along river banks, while in others large areas ranged from a mixture of scrub and pasture of varying heights, to tall closed-canopy kanuka. This study only attempted to identify areas of established dominant scrub, or native bush. Where pasture could be described as "scrubby", this was recorded against the area which was still mapped as pasture.

Appendix III indicates that established manuka or kanuka dominated shrubland can provide a level of erosion protection similar to that of established pines, and has the added advantage of being a permanent cover. Thus where scrub was mapped as the dominant land use, it was assumed that this cover provided a sufficient level of protection. Such protection could not, however, be expected where the scrub present is patchy, of widely varying height and density, and unplanned in relation to the areas where erosion potential is greatest.

Table 6.14 - Properties with Significant Areas of Dominant Scrub

Property	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	
1	18.3	225.3					243.6
13			11.9				11.9
15	7.4						7.4
17	6.9	24.1		11.0			42.0
21	209.6	304.8	99.3	139.2		3.9	756.8
22a	21.1	24.1		9.1			54.3
26		49.5					49.5
Total	***263.3***	***627.8***	***111.2***	***159.3***	***0.0***	***3.9***	***1,165.5***

It is notable that on only three of these properties was scrub covering Category 3b land, and even then, only on one property in any great significance. The forestry company which owns property 21 expressed their plans to clear all scrub on land which was viable for forestry, except for 100 ha which was a declared reserve. The move would involve land being taken out of protective scrub, and planted in productive *P. radiata*.

This was to be done, regardless of whether grants for afforestation were available, since the land was already owned, and the company was not interested in farming part of it. The company did express interest in purchasing further land in the catchment or region for afforestation, but in contrast to its present holdings, such purchases *would* depend on the availability of grant assistance.

In Question 16, respondents were asked to indicate their plans for any scrub they had identified on their properties. Respondents in general preferred to answer this question by stating the policy they maintained for scrub clearance. Most owners did not intend to clear existing scrub in the future, but planned to continue to clear regrowth, a number stating they preferred to leave existing scrub or regrowth in gullies.

Of the properties represented in Table 6.14, respondents for 1, 13 and 15 planned to clear virtually all scrub when time and financial circumstances permitted. On property 1, this clearance was exposing Category 2 land which was unlikely to be treated with on-farm conservation works in the near future. The owner expressed the need to develop land productively before carrying out such work, especially since the subsidies had been removed.

Respondents for properties 17 and 22a (2/4/22a) indicated that they maintained an annual policy to clear all regrowth, but left the established stands. On both these latter properties, these stands incorporate a significant proportion of severely eroding land. Whether the scrub in these areas does in fact provide effective protection on these areas would depend on the particular areas involved. On property 17, some of this scrub lined the river bank, and while well established, clearly provided little protection against washouts of the riverbank which undermine the root system. One of the major problems on this property, and for many along this stream, was the need for bank stabilisation works.

Table 6.15 - Pasture with Extensive Scrub Cover

Property	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	
18	376.2	368.0		200.8			944.9
21	263.8	830.9		198.0		15.2	1308.0
Total	*640.0*	*1198.9*	*0.0*	*398.8*	*0.0*	*15.2*	*2252.9*

Two properties were notable for the predominance of mixed regrowth scrub and pasture, these being properties 18 and the pasture area on 21 (Table 6.15). Both were leased out at the time of survey, and both contain significant areas of Category 3b land, as well as land requiring on-farm conservation works. Property 21, being planned to be afforested and on a year to year lease, was undergoing scrub clearance by the owners prior to

planting. During the early phase of afforestation scrub was cut prior to planting and much of the scrub on pasture is regrowth from this time.

Property 18 by comparison was on a 5 year lease, and comprised several individual and separate blocks of Maori land. The current leaseholder, who had discovered that he also held shares in two of these blocks, speculated that a portion of the property could be afforested if the owners came to that decision.

Several further properties (5, 10, and 14) also incorporated much scrubby pasture but these areas have largely been afforested under the 95% scheme. Under this scheme, scrub was generally only cleared where it was not the established dominant vegetation.

6.3.9 Native Forest

Although detailed information on changes to the area of native forest was not collected, it appeared that little clearance of native vegetation other than manuka and kanuka has taken place in the catchment since 1980. Certainly since the survey in 1984/85, little has altered in this respect. On freehold land, most that was desired cleared had already been cleared, while on leasehold land where the leases were short, there was little incentive to clear further land, especially once the Land Development Scheme was discontinued.

The breakdown of native forest by property and LUC is shown below in Table 6.16.

Over half of the estimated total area of native forest in the catchment is currently either owned or leased by DOC (51.6%). This includes blocks 24b and 9, totalling 1692.5 ha. On these two properties, native forest was the dominant vegetation over the whole of the property. The areas are also two of the three very large blocks of native in the catchment. The third is on property 21, and as will be explained below, is a high priority area for protection.

The areas of native forest account for 284 ha of Category 4 land or 76.9% of this category. This may partly be because the classification of land into this category also takes account of the existing vegetation. Thus identical land with potentially very severe erosion might be classed 4 if under native forest cover, and 3c if under pasture.

Table 6.16 - Breakdown of Native Forest by Property and LUC

Property	*Land Use Categories in Native Forest (ha)*						*Total (ha)*	*% Total Property Area*
	1	*2*	*3a*	*3b*	*3c*	*4*		
4	47.1	1.3	91.9				140.3	18%
6	4.6						4.6	1%
7			24.5				24.5	3%
9	287.5	19.0	195.6			68.2	570.3	100%
11	29.6	119.9		12.5			162.1	38%
12	5.0						5.0	0%
13	4.4	22.0					26.4	3%
14		4.7					4.7	0%
15	17.9	16.3	63.1			17.8	115.1	54%
16	12.6			6.3			18.9	2%
18	24.0	2.4					26.4	3%
19	30.4	94.8					125.3	44%
21	171.9	580.3		101.6		1.2	855.0	17%
22b	17.3		29.7				47.0	25%
23b		2.7					2.7	0%
24b	331.2	18.9	574.4			197.6	1122.2	100%
24c	5.9	12.3					18.1	5%
25		3.8		5.6			9.4	1%
Total	*989.4*	*898.4*	*979.3*	*126.0*	*0.0*	*284.8*	*3278.0*	*19%*
%	*30%*	*27%*	*30%*	*4%*	*0%*	*9%*	*100%*	

For five of these properties, the areas of native forest are less than 10 ha. None of the owners of these areas planned to clear these areas, and only on property 25 was the native forest on Category 3 land. None of the areas were fenced however, so were subject to grazing.

In addition to the current DOC holdings, there are also a number of areas in the catchment which are of interest to the department for their ecological importance. These have been highlighted by the recently completed Protected Natural Area survey of the Waiapu Ecological District.

This survey identifies four areas of priority for protection in the study area[95]. These are classified into priority 1, 2 and 3, the highest priority for protection being areas of priority 1. They include two priority 1 areas and one priority 3 area within the Waiau ecological subdistrict, and one priority 3 area in the Tokomaru subdistrict.

[95] These priority areas do not include areas already protected such as those held or leased by DOC.

Within the Waiau subdistrict, the two priority 1 areas include one very large block of 882.2 ha mainly on property 21, but also extending onto 26.4 ha of property 18. This area was accorded high priority due to its "extensive areas of secondary kanuka forest, covering the full range of hillslope and valley landforms". The DOC did not recommend that this entire area be protected, but a representative reserve incorporating all the major landforms and the areas which incorporated a few remaining Tawa and Rewarewa. Property 21 is owned by a forestry company, and is planned to be fully afforested. The owners indicated that apart from 100 ha which was reserved, their intentions for the remainder of the area was to clear existing vegetation where it was viable to plant pines.

It has been assumed in the fourth table in Appendix VII that all pasture and scrub on property 21 will be cleared for afforestation. The over 850 ha of native forest, which corresponds largely to the above area surveyed by the DOC, has not been included. The future of this area will likely be the result of negotiations between the company and the DOC. The expressed plans to clear all except for a 100 hectare reserve may conflict with the high priority this area has for protection, and the size of the area which DOC would consider an appropriate subset.

The second priority 1 area is smaller (172.0 ha) but "contains the largest remaining remnant of primary hillslope forest in the subdistrict. It is almost entirely located on property 11; Maori land leased through the Maori trustee and grazed by the same lessee as property 18. This lessee indicated that as long as he held the lease, he would continue to graze both areas. For part of property 18 however, which takes in the priority area mentioned above, the owners had a forestry company looking at the possibility of planting it in pines. The option being investigated was clearing the existing vegetation in order to blanket plant. The lessee (also a part owner) indicated that although development costs would be high due to the need for clearance, he considered it likely that afforestation would go ahead.

The priority 3 area in the Waiau subdistrict is located on the boundary of the catchment on property 19, formerly of the Lands and Survey Department, and now a privately owned family farm. It has an area of 129.7 ha of native forest of which 119 ha lie in the catchment. All is presently grazed. The current owner of this property expressed his intention to conserve the existing areas of native forest, but to clear most of the

manuka/kanuka for pasture. Since this priority area is predominantly kanuka in the canopy, the owner intends to clear most of it for pasture. He also expressed his concern that "the rights of the landowner are being eroded".

The only priority area in the study area falling within the neighbouring Tokomaru subdistrict is found on property 4, farmed by a Maori incorporation. It has an area of 210.3 ha, of which approximately 140 ha lies in the catchment. The manager, on behalf of the owners, expressed considerable willingness to allow this block to be protected. The owners had no plans to clear any existing scrub or forest, other than a general policy to prevent regrowth in the open areas. Without protection, however, the block would continue to be grazed as is currently the case.

Together, these four priority areas account for a further 1309 ha or 40% of this class of vegetation in the catchment. As is described above, a large portion of this area is planned for clearance by the current owners.

Outside this area there exists only one further block of over 100 ha, this being on property 15. This property is leased Maori land, and while the lessee had plans to clear a small amount of scrub on the property, he stated that he did not intend to clear the native forest.

One land exchange which has been particularly important in establishing a large area of contiguous native forest is that between the DOC and the Maori owners of a large area of primary native forest which forms part of property 9. The majority of the area of property 9 falls, in fact, outside the study area, this land falling to the seaward side of the high ridge on the eastern boundary of the upper-Hikuwai catchment. As it happens, however, the two areas of land involved in this exchange lie either wholly or largely within the study area.

The area for which Block 9 was exchanged was block 24a. This Block emerged as an area of predominantly flat, fertile Category 1 land partitioned off from property 24 when it was divided into four separate blocks. It contains a small area of Category 3b land (13.8 ha) but over 78% is Category 1. Being close to the river it is subject to flooding, but as this is a relatively rare occurrence, it is still a prime area of land.

This was an arrangement of great mutual benefit to both parties. Block 9 was not previously used for grazing by the owners, and was not planned to be cleared. A large proportion of this block lies on relatively infertile Category 3a land. The owners of both block 9 and neighbouring property 13 expressed praise for the work done by DOC fencing the area and eradicating possums and goats from these areas as far as is possible. The owners of block 9 gain the use of 287 ha of flat fertile land, the majority of which is Category 1, for no extra cost.

For the DOC, since block 9 was already in bush, and lies adjacent to part of block 24b, a much larger and contiguous reserve area was ultimately achieved. Without control of this adjacent area of forest, the task of eradicating possums and goats would have been more difficult due to this large source of reinfestation. The interests of soil conservation are also met, since block 9 incorporate 68 ha of Category 4 land and its management by DOC guarantees that it will remain under native forest cover.

6.4 Attitudes of Respondents

Questions 25 to 35 of the survey sought to gauge the respondents attitudes to farming, the region and their perception of erosion and forestry. They were also questioned as to whether they felt these attitudes had changed after Cyclone Bola. The final three questions of the background characteristics section also returned to this theme.

6.4.1 Attitudes to Farming and to the Region

In response to Question 25, all respondents except for one indicated that if the farm were sold, they would purchase another farm. The owners of two family farms took exception to the question, and stated categorically that they were "not selling". Also the respondents for three large blocks of Maori land stated that selling was not an option to be considered. All five indicated however that they wished to remain farming which was treated as "yes" and the comments noted. One of these (property 7) stated however that while he was not selling the property, hypothetically he would consider purchasing land anywhere. The reason stated was that all areas have their problems, but this particular area meant that he spent a great deal of time and money on such items as long flood-gates which were of limited effect, and constantly being damaged or washed away.

The only negative response to this question came from the trust which leased property 20. For this property it was considered that the trust-members (not the owners) were getting old and less interested in the affairs of the trust so it was unlikely that the lease would be renewed. The owners however had no intention of selling, but were debating whether to fully afforest this property, or to leave part of it in pasture.

Of note was the response of the owners of property 1. While indicating that at present farming was considered to be a good investment by the group and that they would retain areas that were held as Maori land, they envisaged that this would eventually change. Ultimately their decision would be based on what would be the best investment at the time. Thus while this area was traditional to the group, the respondent at least would consider its sale on commercial grounds.

While all farming respondents planned to remain farming somewhere, not all wanted to remain in the district. Nine respondents stated that if the property were sold, they would purchase another property in the same region (not necessarily the same catchment) while six stated they would prefer another region. Two of the latter were representatives of Maori landowners who felt that their decision would be guided by such factors as where would bring the best financial return, or a greater ease of farming.

Reasons for specifically preferring another region included "social reasons", "forestry", "isolation of Gisborne/East Coast", and the belief that "Gisborne will end up a forestry town." The number of generations a farm had been under family ownership did not appear to be a factor influencing this decision.

Three former family farmers/owners of properties 10, 23 and 25, had all purchased properties in the region, and while the two interviewed indicated flexibility in their choice, that family and friends were there and they generally liked the area.

One factor identified by several respondents was the price of land in the region, for the type of farming. Respondents for property 19 and 11/18 would remain in the region because it offered sizeable properties at a price which could not be found elsewhere. Land tended to be rougher, and the life harder than elswhere, but this too had its attractions.

Only two respondents, the owner of properties 8 and 16 expressed a direct commitment to the region. For 16, the expression used was "I was born here, grew up here, and I farm here".

6.4.2 Perception of Severity of Erosion

Most farming respondents stated that they considered erosion in the catchment to be either severe or very severe. Although several wished to acknowledge the range of severity in the area, only two respondents indicated unequivocally that the erosion was "very severe". These were the previous owners of properties 23 and 25, the two properties most severely affected by Cyclone Bola. These two respondents also thought that erosion on their properties was very severe. Three respondents found erosion in the catchment to be "significant but not critical", these being properties 12, 2/4/22a and 15, but all of which were actively involved in and supportive of on-farm conservation.

The following question which referred to how the respondent viewed the "state of erosion on the farm", gained a slightly different response. Again the only respondents to choose "very severe" were the same two respondents as for the previous question. However in this case only four respondents viewed the state of erosion on their own property as being severe. In this case the most favoured response was "significant but not critical", chosen by ten respondents. Several respondents commented that this latter phrase did not match their opinion, preferring "significant but controllable". The feeling was generally that erosion was severe in the catchment, but that most thought that it was controllable on their own property.

Several respondents with properties with extensive erosion, much of which has gone into forestry, including property 5, 14 and 16 did not regard their own properties as having severe erosion, although they did regard there being a severe erosion problem in the catchment.

When asked whether their view on the severity of erosion had changed since the impact of Cyclone Bola, only one responded "yes", although several stated that the cyclone had reinforced their view.

6.4.3 Attitudes to Forestry

Question 29 of the survey asked whether respondents considered forestry to be beneficial to the region, and why/why not. The owner of property 8 was the only respondent to answer categorically "no". He stated his concern that forestry would have a depressing effect on land in pasture, stock numbers, and flow on jobs in the processing, stock handling industries.

Five other respondents were ambivalent toward forestry and went on to discuss the pros and cons as they saw them. The respondents who replied "yes" but with reservations generally cited benefits of forestry as being erosion control, employment, and the development of a viable forestry industry in the region, and the drawbacks as being social.

There was general recognition of the need for forestry to stem the erosion in the catchment, and very strong expressions of the value of the employment being provided to the district. Several were more reticent in citing employment benefits, feeling that the security of forestry jobs that the Forest Service had provided had gone, leaving only insecure and temporary contract work for local people.

When questioned whether they agreed with the minimum recommended land use (Question 31) all respondents concurred with the mapped areas as shown, although the owners of properties 7 and 12 both considered that on-farm soil conservation would suffice on their properties. On property 13/24c, the representative of the ownership group indicated that he agreed with the plan, although the manager who was interviewed separately disagreed, feeling that the Category 3b land on the property could be controlled with on-farm works.

All forestry respondents interviewed except for the owner of property 23, indicated with varying intensity that all land in the catchment should be in pines, and that this was the only sustainable use for this area. All were also interested in acquiring more land in the area provided the purchase price was acceptable or that assistance to plant was available. The owner of property 23, considered that forestry was an excellent use of the land, provided there were green-belts included to minimise the risk of fire. He also argued the

merits of combined farming with forestry, and the ability to graze beneath trees in times of drought, provided tree spacings were not too dense.

In this respect he was critical of the requirements of the current grant scheme, as were the other forestry company respondents.

6.4.4 Effect of Cyclone Bola

Interestingly, while only one respondent thought that his views on the extent and state of erosion had changed subject to Cyclone Bola, seven farming respondents felt that their attitude to forestry in the region had changed, all having become more favourably disposed to forestry. This was the case with the previous owner of badly affected property 23, who considered that Bola had simply reinforced his knowledge that erosion was very severe both in the region and on his property. He let it be known that he was still "anti-forestry" for social reasons but that Bola had left afforestation the only option for his farm. He also felt that ecologically forestry was definitely a good thing for the area.

This view contrasted greatly with the view of the new lessee of the better, and well treated, portion of this farm (23a), who regarded erosion on his area as "not a problem".

All respondents for forestry companies regarded erosion as very severe in the catchment and on their respective properties and maintained this view, and the view that forestry was beneficial for the region, had not altered since Cyclone Bola.

6.4.5 Effects of Forestry on Land Use Decisions

Given the extent of afforestation which has taken place in the catchment, several questions in the survey sought to assess whether this afforestation would affect the decisions of remaining pastoral farmers.

While in response to these questions many respondents expressed concern at the fire risk, at the disruption that logging would cause on the roads, and on the aesthetics of blanket afforestation, few indicated that this would cause them to consider selling the property. Of far greater importance were the presence of immediate neighbours, the community, and the quality of the school, and of the health service. In all cases, respondents who commented on these elements considered these to be very good quality or adequate.

If forestry *per se* was mentioned, then it was only as one factor in the decision, although the other factors cited, tend to be the indirect results of greater forestry.

While it has been stated that the number of family farms remaining in the catchment had over recent years remained constant or increased, this needs to be analysed more closely. On property 23, a farming family (albeit farming a severely eroding farm) has been replaced in the main by an outside forestry entrepreneur, and by a leaseholder who lives in the homestead. The leaseholder is seeking more land to establish a viable farming enterprise, but currently has no security of tenure beyond the current year. There is a great difference between an enterprise of this nature and that which existed before.

Similarly, on other properties the homesteads of former family farms have generally been sold or leased as dwellings, but not by farming families. In the case of property 21, it is lived in by the current leaseholder until the property is entirely afforested. A shepherds cottage on the same property is leased by a forestry worker. On property 14 the homestead was again used as housing for forestry workers.

On property 25, the homestead was sold to a single-parent from Gisborne. These changes are noted by farming families living in the area who were in the past used to a community of farming families or managers, similar to themselves.

A further important factor is that while the study area forms a unified catchment, it is not a unified community. Roads tend to follow ridges around the circumference of the catchment, with occasional driveways, or tracks striking into the interior. From one side to the other can take over an hours drive, and people living on one side may live in a very different environment to others on the other side.

On one road which follows a valley that bisects one end of the catchment, the changes are extremely noticeable. This valley remains almost entirely in pasture and comprises much of the better land in the area. Properties up this road include Nos. 5, 6, 10, 12, and 17. At the beginning of the road lies property 13.

Of these properties, prior to 1993, all were farmed almost entirely in pasture however the decisions of the owners of both property 10 and 5 to sell to outside forestry interests has greatly reduced the grass area. This change has had a noted influence on the other

farmers along the road. Two respondents indicated clearly that the loss of other farmers down the road would greatly affect their decision to stay.

Two farms in the catchment area (properties 7 and 19) found themselves in a particular situation, being almost entirely surrounded by forestry. For the owner of property 7 this was not a problem and he had no plans to sell or move away. The owner of property 19 was concerned that both the 95% scheme and the grant scheme left him with few options. The nature of his property can be seen to be largely stable. The portion which lay inside the study area was largely categories 1 and 2, while that which lay outside, incorporated a substantial area of Category 3a, thus was stable, but of low productivity. The surrounding properties had all been afforested either commercially, or using grant assistance, leaving his property encircled, but ineligible for assistance to afforest.

The owner of property 7 who undertook extensive on-farm plantings indicated that forestry was beneficial to the region on land where no control measures were taken, but that it was detrimental to the community.

The decision on whether or not to stay on the property would depend more however, on the local school and community, rather than on the surrounding forest.

6.3.6 Land Retirement

Question 14 asked whether the owners would consider retiring land on their property if the land were granted relief from rates (as is offered in schemes such as the Queen Elizabeth II Trust, or Nga Whenua Rahui). The majority of respondents indicated that they did not consider this an option. Six respondents responded positively to the question, although most considered this an option only for areas of existing scrub or native forest, rather than for land currently in pasture, regardless of the severity of erosion.

Several owners expressed considerable opposition to taking land out of production in this way. In this sense, the opposition to retiring land was different in nature to opposition encountered to commercial afforestation. The latter appeared to be based on a belief in the superiority of farming over forestry, as a land use, way of life and foundation for the community. Opposition to retiring land however, was based more on the perception that to allow land to revert to native bush, thus going out of production in

a utilitarian sense, would be a retrograde step, perhaps even a betrayal of the work done by previous generations in "developing the land'.

6.4.7 Property Rights

Although a specific question on this was not present in the survey, several respondents made in clear they were concerned at a loss of freeholders' rights to clear vegetation. The owner of property 19 expressed this strongly. He has a significant area of native forest vegetation on his property, the majority located on good classes of land. While stating that he had no plans to clear it, he was concerned that the resource plans of the local council for earthworks and vegetation in the region were impinging on the "rights of landowners".

This owner stated his preference to fence the native forest on his land at his own expense. He was considering placing the land in a trust, and agreed with the need to conserve such areas, but preferred to retain the option. "I'm not going to chop down bush, but I like the option".

6.5 Additional Significant Changes in the Catchment

Along with the growth of forestry in the catchment, the survey highlighted other associated changes of significance.

6.5.1 Stocking rate

In the first section of the questionnaire, respondents were asked to indicate the stock wintered currently and before Cyclone Bola. While some respondents had difficulty responding to this question in exact figures, most described the trend in stock numbers over the period and the cause of any changes.

Property 7 with a long standing history of on-farm plantings had an estimated 51% of its land area affected by slips.[96] While the owner acknowledged the slumping and gullying caused by the cyclone, he considered that the farm was still producing well. His commitment to pole planting had been strengthened by the experience.

---

[96] While this percentage appears very high, it should be remembered that slips have a source area, a trail and a depositional area. The full area of these were generally taken into account when assessments of land area were being made immediately post-Bola, so that such figures tend to greatly overstate the true loss in soil or surface area.

Since that time, he had reduced stock numbers from 8 to 6.6 s.u. per ha, however he made the point that this adjustment was due to adverse weather patterns over recent years (mainly droughts), and an emphasis on quality as opposed to quantity. The reduced stocking rate allowed considerably more flexibility than in the past, and the owner could farm as a one person property with part time help, rather than a two person one.

This trend was common throughout pastoral land in the catchment. Only four properties indicated that there had been little change to stock carried since Bola and none indicated a rise.

Although most other respondents recorded a decline in stock numbers, only three attributed this to the effects of erosion. These were properties 14, 23 and 25, the three most severely affected. Most considered that the cyclone had had an immediate effect, but that their decision to reduce stock numbers was due to other factors, namely the series of dry years, and general farming policy decisions, such as a concentration on producting better quality stock. Most also indicated a decline in fertiliser use in the latter years of the 1980's, which necessitated a drop in stocking rate.

6.5.2 Employment

No detailed information was collected regarding the history of employment in the catchment prior to Cyclone Bola. Anecdotal evidence indicates that the extent of depopulation has been as great here as in other parts of the country. One property in particular, that of 21, once supported a large workforce, including 15 shepherds, several full time fencers, and a cook. The remaining area of pasture is now leased and farmed by one woman. Prior to Cyclone Bola, one of the larger family farms, property 23, had a full-time staff of 5 including a fencer, and cook. Post-Bola this was reduced to 2. This property was one of only three that indicated there had been a drop in staff numbers since Cyclone Bola, and was the only one which attributed the drop to the effects of the cyclone. The other two, properties 7, and 13/24c, attributed lower staff numbers to changing family situation (father retiring), or to reduced stock numbers.

Two properties now employed more people since Cyclone Bola, this being due to farm development, or the general upturn in farming. The majority of respondents said there had been no change.

6.5.3 Growth in Contiguous Area of Forestry

During the course of the study period, there has been the growth of a contiguous area of forestry. Properties 23b, 25, 21, 3, 10, and 24d, and 20 form a band which runs right across the catchment as a continuous forest. Some concern was raised by the new owners of property 23 that the growth of forestry in large uninterrupted blocks posed a serious fire risk to the area. This he cited a part of the reason for his decision not to afforest the better area of land on his property (23a).

6.5.4 Ownership Changes

During the study period there has also been a marked change in land ownership. Land in the hands of private commercial foresters has risen from nil in 1979, to some 13,206 ha, or over 48% of the catchment area. This represents a dramatic change in the space of 13 years. The majority of this area has come from former private farms. The 95% scheme while facilitating the afforestation of land on farms, also facilitated the transfer of land into the ownership of forestry companies based outside the region.

As was alluded to earlier, the amount of public land, represented by Lands and Survey and Port Company holdings, has diminished greatly, along with the sale of forestry rights to the former state forest on property 3. Clearly these changes in ownership mirror the pattern of changes which have occurred throughout the New Zealand economy over the study period as assets have moved from state control to private, and from local ownership to corporate.

CHAPTER SEVEN

Conclusion

7.1 Introduction and Comments on the Study

In the introduction to this study, four objectives were set out to guide the development of the theory and practical research involved. In this concluding chapter, we return to these questions, drawing out and summarising the key lessons learned within each. Before this however, it is clear that there are a number of comments on the way in which this project was approached, which need to be addressed.

The study attempted to covered much ground by beginning with the global questions of economics, the environment and resource allocation, and ending at the specific course of events on the properties in one defined catchment. In this regard, the scope proved too great to do justice to the objectives laid out. It would appear that too many parameters were incorporated and discussed, yet not analysed systematically.

Too many questions were asked in the survey questionnaire, which could not all be addressed in the analysis. Several of the questions included proved to be of limited use to the analysis and have barely been touched on in the discussion. At the same time questions on other very pertinent areas, which might have been asked, were neglected. Such areas neglected include questions on how respondents perceived the imposition of greater controls over the use of their land, and a specific question on the availability of subsidies for on-farm conservation work.

The decision to cast a wide net did not align well with the largely structured survey questionnaire, which defined beforehand the direction to be taken and questions to be asked. Some of the questions asked could have been very useful to a statistical survey, but could not be analysed in this way in this study. While a degree of structure was definitely needed to ensure that all appropriate ground was covered with each respondent, it is likely that an enhanced response could have been gained by less formal or closed questions.

These problems indicate a need for better planning of the type of survey and questionnaire, and the appropriateness of questions.

7.2 Sustainable Development and Sustainable Land Use

The first question this study set out to explore was the meaning of the now widely used terms sustainable development and sustainable land use. This was done in Chapter Two through a review of the emergence of these terms and of the literature with reference to issues of natural resource allocation and land use.

It was shown in this chapter that the terms derive from the contradictions inherent in the conventional economics, and the environmental context in which all economies operate. While these contradictions are widely acknowledged, the precise extent of their implications for economic theory and for resource use by society remain subject to debate. In recent years, considerable advances have been made in incorporating the environmental context into economic calculations. Yet despite this, it is clear that all economic activity has biophysical and entropic consequences which no amount of environmental valuation can incorporate. This is what has been referred to as the lack of an *existence theorem.*

Thus, the answers to such questions as what might be the optimum or acceptable scale of human activity in a global or local ecosystem is not a matter to be determined by either the unfettered workings of the market, or for that matter in economic theory in general, but by ecologically or biophysically principles.

It was also made clear in Chapter Two, that sustainable *development* and sustainable *land use* are very different in scope. The former term, in addition to its ecological and biophysical implications, has taken on a meaning which incorporates some degree of intra-generational equity. This can be seen as a logical extrapolation of the ethics behind inter-generational equity.

The much narrower term, sustainable resource or land use, however, is efficiently divorced from these more politically fraught implications. It is this narrower definition which has been incorporated incompletely into New Zealand legislation in the form of the Resource Management Act 1991. This chapter concluded by agreeing with both Horsely

and Peet, that sustainability in its generic sense, is a broad, ethical goal of society, less a matter for definition than for search, akin to such goals as justice, equity, accountability or efficiency. It is also a matter for survival, and as such stands as a biophysical bottom line, providing a criterion for the definition of a permissible level of resource use or activity.

Perhaps the emerging relationship was best expressed by John Morton (1990:82) when he wrote that "it may no longer be safe to teach our students economics, without a whole preliminary year of ecology."

7.3 Sustainable Land Use and Erosion Prone Pastoral Hill Country

The application of this broad ethical principle to erosion prone pastoral hill country represents a transition in the use of the land resource, as the goals of productivity or efficiency become secondary. It means that a biophysical bottom line for such land needs to be identified. Such a bottom line would define alternatively the upper limit of acceptable use, or the minimum level of protection against erosion which must be provided for. While no amount of planning or study can identify a definitive bottom line since in a coevolutionary world the goal posts are in effect moving, it still falls to planning to identify current limits.

For the East Coast, a system of classification specific to the region exists, based on the country's Land Use Capability system, but with individual units grouped according to similar susceptibility to erosion and recommended treatment. This is the Land Use Category classification. While it was found that this system incorporates in its recommendations, objectives other than pure erosion control and sustainability, it could nonetheless serve as a base plan against which to assess the sustainability of land use.

While the identification of such a plan of minimum protection is based on the biophysical capacity of the resource, the realisation of a pattern of land use consistent with this plan will come about through specific attention to the land-holders in an area, and to the context in which they make decisions of land use and management. In an area where this pattern has been exceeded as an integral part of the established pattern of land use, the transitional period may well be a difficult one.

It was argued that the *de facto* rights of land-holders to erode the productive potential of land as they farm it, given that it causes external costs on others down-stream, on the local council and on future generations, are not justifiable rights, but rather privileges which existed because an alternative was unavailable or unenforceable. This is also the implication of the sustainability principle in the RMA 1991 which put in place a framework which alters this situation.

However, while the prevailing institutional set-up allows land-holders to exceed the minimum level of protection, it does not follow that land-holders should carry the entire cost of transition to a more sustainable pattern of land use.

7.4 Sustainable Land Use Pattern in the Upper-Hikuwai Catchment

The application of Land Use Categories to the upper-Hikuwai catchment revealed large areas of land which carried a recommendation for production/protection forest which continued to be farmed, as well as some areas which carried a recommendation for protection forest only. Similarly areas of land which could have a long term future in pasture if adequately treated with on-farm conservation works, were being farmed without such measures.

When put to individual land-holders, the pattern of land use this indicated was considered by virtually all respondents to be an adequate representation of their own properties. This indicated a convergence in the perception or experience of erosion and erosion control on the ground, and that surveyed by the Council. A few respondents questioned the need for forestry on particular areas, but for two of these properties, the alternative they had been pursuing was close planting with poles, which in one case was effectively creating a poplar forest as opposed to a pine forest.

In general there was good coverage of farming land in the catchment with soil and water conservation plans, but these were limited on areas of Category 3b land or greater, since prior to 1988, the resources required for the afforestation needed on these areas were not available.

7.5 Land Use Change in the Upper-Hikuwai Catchment

In a case study, the task of drawing conclusions from the information gathered is difficult. The data or responses while very relevant to the particular situation or area, are not necessarily extendable to other areas or situations. The case study lacks the statistical parameters of a standard social survey or sample analysis. As a result, there can be a tendency toward the descriptive without the necessary accompaniment of ascribing causes.

In this case, tracing the process of land use change which has occurred in the upper-Hikuwai catchment over the past decade and a half has thrown up several interesting examples of land use change and adaptation in the specific context. Yet to develop from these, recommendations which might be applied in other areas or to the region in general, must necessarily be a more circumspect task.

Nevertheless the catchment was chosen for its incorporation of many features important in the region in general, and there would appear to be general lessons to be learned from the study of this one catchment.

The three different forms of assistance for afforestation have had a major impact on the entry of forestry to the area, the classes of land and properties involved, and the speed at which land was afforested.

During the early 1980s the only means by which land could be afforested other than by commercial companies was through the NZFS. Both local and central government assisted the establishment of plantation forestry in the catchment, through the sale of land to commercial forestry interests, and through state afforestation. But, during this period, this occurred on only three large properties. The East Coast Project did not encourage a more intelligent pattern of land use, but rather the blanket planting of entire properties. No severely eroding land on Maori land, private farms, or leasehold land was afforested.

These properties were limited in ability to undertake such works for a variety of reasons. Farmed properties of a small size were unable to lose land to forestry and remain viable. The capital requirement and length of time to harvest served to prevent private farmers from afforesting anything other than a couple of hectares on their land. As an

investment, such an area would be unlikely to be directed toward land with severe slips, where tree loss would be high, transport difficult and returns limited.

At the beginning of the period, there was one important property break-up into blocks of distinct capacities, but this was notably not due to the East Coast Project, but rather to the regional Land Use Committee, which remained a body dominated by pastoral interests. In order to prevent a quite separate property from being afforested, this committee forced the sale and repurchase of property 24. In doing so, they separated out the more erodible areas from flats, more stable areas and native forest. It was the break up of this property which set the scene for the crosslease of the area of flats for a much larger area of native forest, providing DOC with the largest contiguous forest holding in its ecological sub-district.

For Maori land, much of which comprised blocks too small to be run as single units, most was leased out through the Maori trustee. Owners could not afforest during this period without selling the land, and leaseholders would be unwilling to do so.

By contrast, the provision of major assistance from central and local government to farmers for the afforestation of areas of severely eroding areas on their land *without the need for change of ownership*, clearly assisted the movement of forestry to priority areas on smaller properties. The process of land use change which the 95% scheme facilitated, succeeded in afforesting a significant proportion of Category 3b and 3c land.

The 95% scheme also had the effect of attracting a wider range of forestry interests to the catchment than the existing two large companies. Since none of the family farmers afforesting parts of their land wished to become part-time foresters, even if they possessed the resources to do so, the scheme provided the capital necessary to afforest these areas, and allowed forestry interests to purchase at a price which offered a profitable return.

This scheme was also the first to incorporate sufficient flexibility to assist a change in the pattern of land use, that was not solely blanket-pasture to blanket-afforestation. It allowed a useful distinction between land that clearly had no long-term future in pastoral farming, from areas which had been well treated with soil conservation works, or could be in the future.

There was also scope for negotiation with the works division of the District Council, where land-holders wished for specific concerns to be incorporated - eg preserving safe and accessible accessways, and particular areas of pasture. Although by and large the council would not provide assistance for on-farm conservation works if the land was recommended for forestry, where the area was small, surrounded by more stable land, and the farmer had a proven commitment to soil conservation, some flexibility was allowed, as in the case of properties 7 and 12.

The key advantage of the system was not just the large subsidy provided by central and local government, but also its flexibility. It provided the local Catchment Board with the resources necessary to carry out the forestry works needed on properties where soil and water conservation plans had been in operation, but where forestry could not be carried out. Even so, many landowners found the 5% capital requirement difficult to find.

Within the study area and time-frame, there have been several interesting land exchanges which have had important implications for the land use and vegetation change. These have allowed land to change hands through innovative alterations to tenure and property rights, which incorporate sufficient flexibility to allow a greater diversity of land use, and importantly, a higher degree of tailoring of land use to suit land capability. Such exchanges have facilitated the afforestation of marginal land, the continued pastoral use of Category 1 and 2 land, and the protection of lands containing forest of high conservation value.

While the exchange which saw conservation forest exchanged under a cross-lease arrangement for the area of high value pastoral flats occurred prior to the 95% Scheme, it can clearly be seen that the assistance and flexibility of this scheme was a key element in the exchanges of forestry and pastoral land.

The revised East Coast Project which had only just begun at the time of survey also provided capital assistance for afforestation. The controversy which has surrounded this scheme has revolved around the degree to which it is targeted to capture severely eroding land, the confusion of objectives, and the provision for protective scrub covered land to be cleared for forestry using public moneys. This case study attempted to gauge the interest among the respondents in submitting tenders for the afforestation of areas

under this scheme. These were only estimates of the areas to be tendered and there could be, of course, no indication as to whether the tenders would be successful. It will fall to a different form of analysis than this to assess the impact and targeting of this scheme.

What has emerged in the catchment over the 14 years of the study, is definitely a pattern of land use more consistent with the physical capacity of the land, and more diverse than the previous unbroken pasture. Property divisions have allowed better land to be reserved for pastoral production, while assisting the afforestation of more severely eroding areas. Yet the current grant scheme which targets both Categories 2 and 3 land, as well as allowing the incorporation of up to 40% Category 1 land in order to plant to rational boundaries, provides a very strong advantage to forestry interests. Under this scheme, given that over 53% of all remaining pastoral land in the catchment is Category 2 and greater, the incorporation of up to 40% Category 1 land in a tender, implies that some 88% of remaining pastoral land could potentially be eligible for grant assistance for afforestation.

The effect of this, would be the virtual blanket afforestation of the catchment, and the reduction in pastoral area to a few small isolated blocks, owned by resilient farmers who refuse to leave. The wisdom of such an eventuality must be questioned, for while blanket afforestation would provide protection against erosion, the ecological implications of the extreme reliance on just one species draw attention to the fact that preserving the productive potential and option value of the soil and land, is only one aspect of the implications of sustainability. Ecological integrity is an even more complex and less well understood property of a system, and one which has been under extreme stress in the region since the original clearance of the protective and diverse native forest from the hills.

The inclusion of employment objectives as a key factor in favouring forestry over farming on Category 2 land is also cause for some debate. Evidence does not exist which points to any pronounced difference in total employment associated with either forestry or farming, largely because of the variability to be found within both, and the difficulty in assessing either accurately. In fact where it does exist, it points rather to there being little identifiable difference between the two.

What is evident, is that these two land uses involve entirely different forms of ownership and employment in qualitative terms. Farming has traditionally involved owner-farmers, managers and workers living on the property, as well as annual seasonal labour for specific jobs. Forestry by contrast, tends to involve only casual employment, and on a property basis, is not annual, but occurs in waves according to the particular management regime. On a regional basis the work provided can be considered seasonal and annual as workers and gangs rotate from one forest to another.

There may well be a qualitative judgment to be made here, as to the desirable balance between these two forms of employment, as well as on the industries themselves. Yet this has not been the basis of the decision to fund only forestry for erosion control. Even had this been the case, it would appear wholly inappropriate for government, especially given the current philosophy of the market-led economy, to be making qualitative decisions of this nature for a region and its inhabitants.

With regard to soil conservation works, as a consequence both of local Council planning and requirements, and of farm management decisions, these have been strongly directed toward the better classes of land. Consequently, properties which comprised better classes of land tended to have a good history of soil conservation, while those with poorer classes tended not to have undertaken this work. While in itself this conclusion is not startling, it is useful to note that this finding was common across different types of tenure, whether on Maori land or family farms.

This finding was qualified however by a strong personal element which came through on a number of properties. Several respondents, both leaseholders and owners, undertook substantial on-farm conservation work even where the available subsidies for his work had been withdrawn. Alternatively, several other property owners, and more understandably, leaseholders, had undertaken very little of these kinds of works even while subsidies were available.

Viability of the property would appear to be a major factor governing land use decisions, both on Maori and non-Maori land. For small blocks of Maori land, the obstacles to development are considerable, as an area of less than 400 hectares would scarcely support a manager. Where the owners are very numerous, with many living away from

the region, decision making and consensus on land use change is rendered very difficult. Equally, capital for land development may be difficult to obtain where land cannot be sold, since the normal process of using land as security for a loan or mortgage cannot operate in the same way.

Cyclone Bola was quite clearly a watershed, in more ways than the obvious. During the early 1980s, the first encroachment of forestry into the district was viewed with considerable anxiety by local farmers; an anxiety which appears to have been replaced by resignation among most. While such anxiety remains for some, after Cyclone Bola, most land-holders who had strongly resisted any encroachment of forestry onto their land, and indeed into the district, recognised that such a position was no longer tenable for their particular properties.

The study highlighted the fact that most pastoral farmers had accepted that erosion was severe in the catchment long before Cyclone Bola, the cyclone did change attitudes toward the growth of forestry in the catchment. There is contained in this distinction the implication that prior to the cyclone, farmers accepted the severity of erosion in the area as something they were prepared to live with; simply an aspect of farming in the area.

At the time of survey however, virtually all respondents were clear in their belief in the value of forestry to the region for environmental, employment and income reasons, even though the pastoral farmers lamented the loss of the community of farming families. For many this, and the quality of education and health facilities available were major factors affecting their decision whether or not to remain farming. Several farmers expressed a strong commitment to the district, and to the continuance and improvement of pastoral farming in the area, but even they were concerned at the changes that forestry growth was having indirectly on their community.

Strong evidence emerged from the study to indicate that land use decisions are not based solely on the basis of economic rationality. In several cases, leaseholders took up the option of afforestation or on-farm conservation works involving partial expense on their part, while the long-term benefits would accrue far more to the owners, and to those who benefit from reduced erosion.

Similarly, decisions on whether or not to afforest land were not based solely on enterprise profitability. Some owners remained very resistant to forestry on their land. The changing nature of the community, and the quality of school facilities were dominant themes in the decisions respondents made on their long-term farming future in the region. Most also identified the drawbacks of farming in the area, with its erosion problems, particularly the expense and time required to maintain floodgates and fence lines.

Strong concerns exist with regard to the changing pattern of land use. Clearly this varies with the particular situation of the farm, some being located on the main road, and surrounded still by pasture, while others were enclosed on several, if not all sides by forestry. This was a concern to all remaining pastoral farmers, through not all considered that this could potentially cause them to leave their properties.

Along one road, where two farms have been sold to forestry interests, there is a real likelihood that the remaining three farms, all with substantial and on-going on-farm conservation works, and comprising some of the better areas of farmland in the study area, might all be sold by the current owners. All had been contacted in some way by forestry interests scouting the area with a view to land acquisition. While most were content with farming on their property, the comment made by one respondent "no one wants to be the last cocky up the road" sums up the feeling which existed in this area.

7.6 Public Involvement in Promoting Sustainable Land Use

In the interests of equity, and the identification of sustainable land use as a national goal for the country or society, it appears logical that the degree of environmental protection required should be set on a national basis, to a common standard.

It is highly desirable that objectives such as employment and economic development be integrated with environmental objectives. All of these, however, where they fall to central government funding, need to be pursued on an equitable basis between regions. The East Coast has a long-standing problem of unemployment, but so too, do Rotorua, Northland, and the West Coast of the South Island. It is difficult to justify the pursuance of such objectives with public moneys in one region, and not in these others.

Using similar logic, there is good reason for the East Coast to be treated as a special case, due to the extent and severity of the problem, and the costs of returning to a pattern of vegetation more consistent with the goal of sustainability. On a local scale, however, there are properties and localities in other regions of New Zealand, on which the problems of erosion are equally severe, and for whose owners the costs of treatment or afforestation would be equally inhibitive. Without wishing to downplay the severity of erosion on the East Coast, the exclusion of such areas as these from assistance would not meet the demands of the fair playing field.

It would appear highly desirable that environmental indicators should be applied nationwide, in order that assistance be given fairly, and that the biophysical bottom lines are achieved evenly.

Similarly, the heavy favouring of one land use over another that has emerged in the most recent version of the East Coast Project, finds little support in the government's own espousal of a subsidy-free and competitive environment for the private sector. By providing grant assistance for afforestation on all Category 2 land, as well as up to 40% Category 1 land, which basically requires no conservation works, but no assistance for the maintenance of the land in pasture through on-farm soil conservation, the project has in the words of one respondent "picked a winner".

The potential effect of the project in this one catchment, as was outlined above, is to undermine all pastoral farming in the area, and create one large and contiguous forest. Given the widespread commitment and goodwill among pastoral farmers to conservation works on their land, it would appear imperative that support for on-farm conservation be given equal priority by central government to the support provided for afforestation under the current grant scheme. Under the current institutional set-up, the efficiency of commercial forestry, is being obtained at the expense of alternative land uses.

The reason for the East Coast Project is that the goal of sustainable land use has not been achieved, and it is acknowledged as being unlikely to be achieved without public funding in some form. The form adopted is one which seeks to preserve both economic efficiency and retained competitiveness in the forestry industry. To do this, the scheme has opted to use commercial forestry companies as the vehicle for afforestation. The

study highlighted criticism of the scheme by foresters that planting and thinning regimes required of them are too great. There can be little basis for such claims, since these requirements are based on the empirical data relating to the speed and effectiveness of erosion control, and it is the latter which must remain the overriding objective of assistance given.

There is however justification in the claim that forestry companies are required to achieve a level of protection that is not required of pastoral farmers. Forestry companies have not historically been accorded the same *de facto* rights as have farmers, but have had strong local government restrictions placed on their operations and areas of activity for a wide range of reasons, including environmental ones.

This raises the thorny issue of whether the requirements of a biophysical bottom line based on environmental legislation should be enforced, or at least, how they should be realised. While one farming respondent who had implemented extensive conservation works on his property indicated that pastoral farmers should be required to implement conservation works, it is unlikely that such regulations would be welcomed by all the respondents. In this respect, although not dealt with in detail here, the proposals first suggested for the FARM partnership scheme, based on the highly successful scheme across the Tasman, would appear to have considerable merit in involving the local community in this process, and encouraging the development of local requirements, local inspection and enforcement less through imposed penalties from a regional authority which incite opposition, than through the local community and other land-holders in the area. This would seem to offer a huge step forward in local community responsibility, but one which would itself require some degree of outside resourcing to be successful.

This also adds weight to the call for a return to government assistance for farmers to implement the requirements of a soil and water conservation plan on their properties, during the transition period. Thereafter, maintenance and up-grading of these works should be a manageable requirement placed on the use of land by the local authority. Forestry interests have available assistance for afforestation in this transitional period. It would seem unfair that farming properties do not also receive corresponding assistance, to comply with a societal objective.

There are strong and pressing arguments for government intervention in the region, on environmental grounds, employment grounds, and regional development grounds. Indeed if the principles set out in the RMA 1991 are to be adhered to, then such intervention is vital. However, in the case of both the East Coast Project as it currently stands, and the present absence of support for on-farm soil conservation, these objectives have not been applied even-handedly - neither between competing uses of the land, nor across regions.

Appendix I

Summary of Land Use Capability Unit Classifications

Land Use Capability (LUC) Classes are based on two separate parts; a multifactor inventory, incorporating information on rock type, soil unit, slope, present erosion, and vegetative cover; and a land use capability assessment, which integrates additional information on climate, and the effects of various land uses on similar classes of land. The primary classification divides land into one of eight classes, according to its **overall degree of limitation**. These are then further broken down into subclasses that indicate the **dominant type of limitation**. Within these subclasses is then detailed individual units, that contain a number corresponding to the **recommended management and conservation requirements** for that area.

Land Use Capability Classes

Land Suitable for Cultivation for Cropping:

Class I	Very good land with few limitations to cropping.
Class II	Good land with minor limitations.
Class III	Good land with moderate limitations.
Class IV	Reasonably good land but with severe limitations.

Land Unsuitable for Cultivation for Cropping:

Class V	Land with slight erosion hazard; unsuitable for cultivation.
Class VI	Land with moderate erosion hazard.
Class VII	Land with severe limitation and erosion hazard.
Class VIII	Land with very severe limitations; unsuitable for productive uses.

Source: Poole (1983:21, Table 2).

Subclasses

One of four possible dominant limitations is indicated by a letter. These include erosion (e), wetness (w), soil (s), and climate (c).

Units

Individual units are the most basic classification and map areas of land which share "essentially identical characteristics" (NWASCO, 1988).

Appendix II

Questionnaire for Landholders in the Study Area

RESPONDENT CHARACTERISTICS:

1. Farm

_____

2. Position of respondent:

_____

ie. Owner/farmer, Trustee, Company director, Leaseholder

3. What form(s) of ownership is the property under?

_____

_____

_____

ie.- Freehold, partnership, trust, incorporation, leased, Maori land, or some combination of the above.

4. If lease-hold, describe the nature of the lease, its length, conditions and time to expiry.

_____

_____

_____

5. What is the total area of the property, including land outside the catchment area?

_____

_____

EXISTING LAND USE AND PRODUCTIVITY:

Land Use and Vegetation:

6. Draw in the current land use/vegetation type on the map of farm provided for land on your property **within the boundaries of the Hikuwai catchment.**

7. Specify areas (over 70% of area) in:

	Area (Ha)
- native bush	
- pasture without significant conservation works	
- predominantly regrowth manuka/kanuka	
- forestry	
- pasture treated with on-farm conservation works	
- other _____	
- total	

Pastoral Production:

8. List total stock grazed

		Current	Pre-Bola
- sheep	- ewes wintered		
	- hoggets wintered		
	- rams		
- cattle	- breeding cows		
	- heifers		
	- rising 1yrs		
	- rising 2yrs		
	- rising 3yrs		
- goats	- does		
	- replacements		
	- bucks		
- deer	- hinds		
	- replacements		
	- stags		

9. What fertilizer was applied during the 1992/93 financial year. Give type and quantity.

- Specify area of farm receiving application.

- Briefly give the farm's fertilizer history.

---

10. Production:

- Give quantity and average weights

Year	90/91	91/92	92/93	Average Pre-Bola (Est)
Wool Sold (kg greasy)				
Lambs Sold				
Cattle Sold				
Other - Venison - Velvet - Fibre - Crops				

Forestry:

11. Area afforested - for land within the Hikuwai catchment.

Year Planted	Area (ha)	Block Type	Species Planted	Subsidy	Prior Land-Use

12. Do you plan to tender for grants to afforest remaining areas of category 2 or 3 land on your property?

- If "yes", which areas (indicate on map) and over what period?

---

13. Do you plan to continue a programme of afforestation outside of the forestry establishment grants scheme?

- If "yes", specify areas and time frame.

---

14. If you were relieved of rates, would you consider retiring severely eroding land for restoration of native or diversified protection forest? Comment.

---

15. What proportion of the area in predominantly Manuka and Kanuka would be over 6m in height?

_____

16. What do you plan for the area indicated above of predominantly Manuka/Kanuka? Give approximate areas.

Leave as is - grazed _____

Leave as is - not grazed _____

Clear for pasture _____

Clear for forestry _____

Other (specify) _____

On-Farm Conservation Works:

17. To what extent has farmland within the Hikuwai catchment been treated with on-farm conservation works?

Year	Type	Area (ha)/Number	Subsidized

NB - Type = Willow/poplar plantings
Debris-dams
Other (specify)

18. In the absence of incentives to implement on-farm conservation measures, would you be likely to continue in this activity? Why?

Yes No

_____

_____

- If "Yes", about how many hectares per year?

_____

_____

Farm Development:

19. What is the number of paddocks on the farm and in the catchment area?

    On farm _____

    Within catchment _____

20. Do you plan future development works for the farm?

    Buildings _____

    Paddock subdivision _____

    Tracks _____

    Other (specify) _____

    - Are these works "new investment" or replacement due to erosion damage?

21. What is your annual budgeted expenditure on repairs and maintenance of:

    fences _____

    tracks _____

    dams _____

    buildings _____

    - What proportion of this would you estimate to be due to repair of damage caused by soil erosion?

_____

_____

22. Do you have an estimate of the cost of Cyclone Bola to the property?

_____

_____

_____

_____

EMPLOYMENT:

22. How many workers are employed on the property?

	Number	Hrs per week
Full-time		
Part-time (no.)		
Casual		
Family - Paid		
Family - Unpaid		

23. Do these employees live on the property?

_____

- If "yes", give number of employees and size of families.

_____

_____

24. Had the employment situation altered substantially since cyclone Bola? How?

_____

_____

ATTITUDE:

25. If you were to sell the property (or the lease), would you purchase (or lease) another farm?

_____

- Why or why not?

_____

_____

26. If "yes", where?

Same catchment ☐

Same region (East Coast) ☐

Other (specify) _____ ☐

- Why?

_____

_____

27. How do you view the extent of erosion in the catchment?

Very severe ☐
Severe ☐
Significant but not critical ☐
Not important ☐
Other - _____ ☐

- Comment

_____

_____

28. How do you view the state of erosion on this farm?

Very severe ☐
Severe ☐
Significant but not critical ☐
Not important ☐
Other - _____ ☐

- Has this view changed since cyclone Bola?

_____

_____

29. Do you consider forestry to be beneficial to the region?

Yes No

- Why or why not?

_____

_____

30. Has this view changed since cyclone Bola?

_____

_____

31. Do you agree with the maximum recommended land use for the property as shown?

Yes No

- Why or why not?

_____

_____

_____

32. Would you see a future for the farm as a viable unit given the land use change indicated? Comment.

_____

_____

_____

33. Have you purchased or leased additional land in the catchment?

	Area (ha)	Year
- Leased	_____	_____
- Purchased	_____	_____

- Why was this done?

_____

_____

34. Would you consider purchasing or leasing additional land in the catchment in the future? Why?

Yes No

_____

_____

- Would this be to maintain viability of the farm?

_____

35. What does the term **"sustainability"** mean to you?

_____

_____

_____

_____

QUESTIONS FOR OWNING/FARMING HOUSEHOLDS LIVING IN CATCHMENT:

BACKGROUND CHARACTERISTICS

36. Age of respondent

_____

37. Marital Status

S M D W

38. Family (household) Members

Member	Sex	Age

39. Place of Birth/growing up - Valley ☐
Region ☐
New Zealand ☐
Other ☐

40. Position in Family

_____

41. Do you farm the property yourself?

Self ☐
Leased ☐
Manager ☐
Other _____ ☐

- Have you previously farmed the property yourself?

_____

_____

42. Why did you decide to go farming?

43. How many generations has your (or your spouse's) family farmed/owned this property?

One (first)	☐
Two	☐
Three	☐
Four	☐
More	☐

44. If answered "one" above, when did you purchase the farm?

- Why did you purchase this particular farm?

FINANCIAL POSITION:

45. Which of the following would best approximate the farm business' ratio of debt to equity?

0/100	☐	40/60	☐
10/90	☐	50/50	☐
20/80	☐	60/40	☐
30/70	☐	Other	☐

46. What proportion of the farm's annual income goes to repayment of debts?

Is this level of debt likely to influence your decision whether or not to tender for grants to afforest Class 2 and 3 land on your property, available under the East Coast Forestry Project. Comment.

Approximately what proportion does farm income contribute to total household income?

- What are the other sources of income?

Do you or members of your household have employment off the farm? Give family member(s), type of employment, and the reason for the employment.

Member Job Reason

Which of the following statements best describes your household:

Do without many things you need.	☐
Have the things you need but no extras	☐
Have the things you need and a few extras	☐
Have the things you need and many extras	☐

:IAL SERVICES:

. How do you view the standard of primary education facilities in the area?

Very good Good Fair Poor Very poor

- Why?

---

52. Where do your children receive secondary education?

Ruatoria ☐

Gisborne ☐

Other (specify) _____ ☐

- Why?

_____

_____

53. Do you feel that your family has access to an adequate standard of health services? Comment.

_____

_____

54. How often do you go to:

	Visits/month	Reason
- Tokomaru Bay?	_____	_____
- Tolaga Bay?	_____	_____
- Gisborne?	_____	_____

55. What do you consider to be the main advantages or disadvantages of living in this area (the Uawa river catchment)?

_____

_____

_____

56. Do you see the growth of forestry in the region as affecting your quality of life?

Yes No

- Why?

_____

_____

_____

The recommended land use plan shown is derived from a Land Use Capability Survey carried out in 1984/85 by the former East Cape Catchment Board. Capability units have been grouped together to provide a basis for land use recommendations compatible with the physical characteristics of the land.

This plan would require that **at least** 23% of land in the catchment (category 2 land) afforested either through large scale production/protection forestry or allowed to regenerate in manuka/kanaka and ultimately to forest. It would also see either the application of on farm soil conservation works including debris-dams, gully planting, streambank planting, and slope planting, or afforestation to a further 41% of land in the catchment (category 3 land).

This gives a total of 64% of land in the catchment which in 1994 will be eligible for grant assistance for afforestation under the East Coast Forestry Project.

Would the ultimate area of forestry in the catchment affect your decision to remain farming this property? Comment.

_____

_____

_____

_____

_____

QUESTIONS FOR REPRESENTATIVES OF MULTIPLE OWNERS LIVING IN CATCHMENT:

BACKGROUND CHARACTERISTICS

58. How many members are there in the land owning group?

_____

59. What is the basis of the group? ie. Family, whanau, hapu, iwi.

_____

_____

60. Where does the group originate from/have its Marae or Turangawaewae?

Valley ☐

Region ☐

Elsewhere in New Zealand ☐

Other _____ ☐

61. Is the property traditional land of the ownership group?

_____

62. If answered "no" above, when was the farm purchased?

_____

- Why was this particular farm purchased?

_____

_____

63. Does the group farm the property itself?

Itself - through a manager ☐

Leased out ☐

Other _____ ☐

- Why is this the case?

_____

_____

If not currently farmed by the group:

- Does the group hope to farm the property itself in the future?

NCIAL POSITION:

Which of the following would best approximate the farm business' ratio of debt to equity?

0/100	☐	40/60	☐
10/90	☐	50/50	☐
20/80	☐	60/40	☐
30/70	☐	Other	☐

What proportion of the farm's annual income goes to repayment of debts?

Is this level of debt likely to influence the decision whether or not to tender for grants to afforest Class 2 or 3 land on your property, available under the East Coast Forestry Project. Comment.

How is income from the farm distributed among members of the group?

Does the group own other properties in the region?

What proportion of the total income of the ownership group is derived from the hill country properties in the region?

Appendix III

Summary of Erosion Control Research on Pastoral Hill Country

Protection Forestry

Research into forestry and tree planting for erosion control, has centred on assessment of the degree of protection provided at different ages, planting densities, and management regimes, and in comparison to that provided by other forms of vegetation. Subsequent findings have then provided the foundation for recommended and required management of erosion control plantings.

By far the majority of conservation forestry research has been on *Pinus radiata* since it is this species which is at the forefront of both protection and production forestry in New Zealand, though there have also been significant studies conducted on South Island beech forest. In both cases it is possible to divide research into two broad types: those which research the physical characteristics of trees and their effects on slope stability, and those which attempt to quantify the effectiveness of tree plantings in terms of rates of erosion relative to other vegetation types. It is the latter which is the most relevant to this study, though it is also important to at least briefly look at the physical processes which contribute to erosion control.

The Protective Function of Trees

O'Loughlin (1982) lists a series of ways in which forest cover affects the stability of hill slopes, including such beneficial functions as mechanical reinforcement of the soil by tree roots, modification of soil moisture distribution and soil pore water pressure, and provision of an organic forest floor layer. He also includes, two additional potentially destabilising effects which may be caused by a forest cover. These are an increase in the surcharge on a sloping soil mantle, and the processes of windthrowing and root wedging as may occur under conditions of strong wind. It appears generally considered however, that the beneficial effects of tree roots far outweigh these effects, (O'Loughlin, 1982:328).

In reference to the surcharge, it is evident that a growing stand of trees creates a weight or (surcharge) on the supporting soil, which on a sloping soil, causes an increased shear stress. This increased stress is however accompanied by an increase in the shear strength of the soil, due to the same surcharge. Bishop and Stevens (1964) and O'Loughlin (1974) show by calculation, that the extra stress caused, may be negated by this increase in strength. Moreover, O'Loughlin in his later paper illustrates how "in most situations the total weight of the soil above a potential failure plane far exceeds the weight of a forest crop" (1982:329).

Tree Roots and Slope Stability

Tree roots help to bind soil and rock particles as well as anchoring the soil mantle to its underlying substratum. Where soils are partially or completely saturated, they often derive a high proportion of their strength and stability from root systems (O'Loughlin, 1981, Orwin, 1993) The degree to which this occurs depends on the age of the tree, its root density, and root morphology (Watson, 1990:2). Root systems vary according to species, age and growing conditions, and the latter includes the physical nature of the slope and soil itself.

In an attempt to understand the development of *P. radiata* roots over time, Watson (1990) conducted a study whereby entire root profiles of trees at ages 8, 16, and 25 years, were extracted from the ground in which they had been growing. This was done through a process of hydraulic sluicing, to leave the root system intact and relatively undamaged. Watson concluded from this study, that at age 8, lateral strengthening provided the major stabilising mechanism as the density of the larger structural roots increases in the top metre of soil. In older trees the zone of reinforcement increases in size, and a secondary tier of vertical (sinker) roots develops, however by 8 years he considers that:

> "radiata pine trees have developed a root system of sufficient dimensions to bind the soil to the underlying base and provide significant lateral bonding as roots of adjacent trees overlap. Therefore, rapid-growing radiata pine offers substantial protection against shallow landsliding 8-10 years after planting." (Watson, 1990:4).

Impacts of Trees on Soil Hydrology

The two main processes by which trees influence soil water are transpiration and evaporation (Watson, 1990:2). In transpiration, water extracted from the soil is passed

through leaf stomata to the atmosphere. This has a lowering effect on the water table and accounts for part of the reduced runnoff associated with forests relative to pasture. At Puruki in the central North Island the annual transpiration rate for a closed canopy *P. radiata* forest was found to be 50% of total rainfall (Whitehead and Kelliher, 1991), and though this does not pertain to the East Coast region, it does give and indication of the importance of this process. Jackson (1987) at Mangatu, found that the depth of tree roots of a mature stand of *P. radiata* prevented the stand being affected by moisture deficit, but that the water table remained consistently below the top 2 m of soil over a three year period of study.

The other major reduction arises through the interception of some of the incipient rainfall by the forest canopy, which is then evaporated without ever having reached the soil. This latter not only reduces runnoff, but also limits the amount of water available to saturate the soil. The height of forests also induces air turbulence which can dramatically increase evaporation rates (Kelliher, Whitehead and Pollock, 1992). Kelliher, Marden and Watson (1992:13) calculate an increase in the combined annual evaporation and transpiration from and expected 900 mm under pasture, to 1150 mm under closed canopy forest, from an annual average rainfall of 1350 mm, indicating a rise of 28%. This compares favourably with figures from a study conducted by Pearce *et al.* (1987) at Mangatu Forest, in which they conclude that reforestation reduced runnoff by 30% at c 200 m elevation and by 25% at higher c 800 m elevation relative to levels expected under pasture. Average annual rainfall for these two altitudes was 400 mm and 2500 mm respectively. They also found that the annual period of high moisture content was halved from 6-8 months down to 3-4 months.

These reforested areas were also associated with average rates of movement on active earthflows around 10% of that on similar unforested areas. This remarkable reduction in earthflow movement was not repeated in the case of large gully mass movement complexes. Some of these, including the infamous "Tarndale Slip"[97] cover areas in the tens of hectares, and this study did not find that reforestation of the surrounding land had made a discernible difference to either the pattern or rate of movement. Such areas remain the largest single source of sediment being delivered to the Mangatu River.

Site Occupancy

Tree planting density and subsequent silvicultural regimes have been important issues in the use of *P. radiata* for dual purpose production/protection forestry, since they impact on costs of establishment and management. In purely commercial forests, common tree densities are 200 to 400 stems/ha which may require a planting density of 800 stems/ha. The objectives of such stands differ however from those of dual purpose plantings. Protection forest lays importance on the rapid achievement of "site occupancy" by both the roots and the canopy (Orwin, 1993:42).

An evaluation of tree planting densities for erosion control that "would accommodate regional timber production objectives", was conducted for the Ministry of Forestry by Kelliher *et al.* (1992:4). This study also centred on Mangatu Forest, using data on erosion damage incurred during Cyclone Bola for plantations of varying ages. Additional data was collected concerning rainfall, tree-canopy and root growth, evaporation, soil water and previous erosion studies in the East Coast region. These were then used to develop a model of "site occupancy", defined in the subsequent report as being "equal to 1" where "the perimeters of adjacent root systems or crowns meet", and "less than 1" where "open spaces remain between adjacent trees". This model was used to estimate the degree of root and canopy site occupancy expected in stands planted at different densities and under different management regimes. The study was then able to link slope stability to site occupancy, and from this, to advance recommendations of appropriate planting densities, and thinning and pruning strategies.

On the basis that there is a 100% chance of at least one extreme storm occurring in 10 years, and assuming standard silvicultural regimes[98], the recommendations made by this report were:

- a minimum of about 1250 stems/ha tree planting density for erosion prone areas subject to landsliding;
- higher plant density of about 1500 stems/ha on unstable earthflows to account for periodic tree losses throughout the rotation;

---

[97] In 1915 this slip was only a single, narrow, recently cleared gully in the headwaters of the Waipaoa River. Today it occupies an area of over 50 ha, and continues to expand and to defy all attempts at stabilisation.

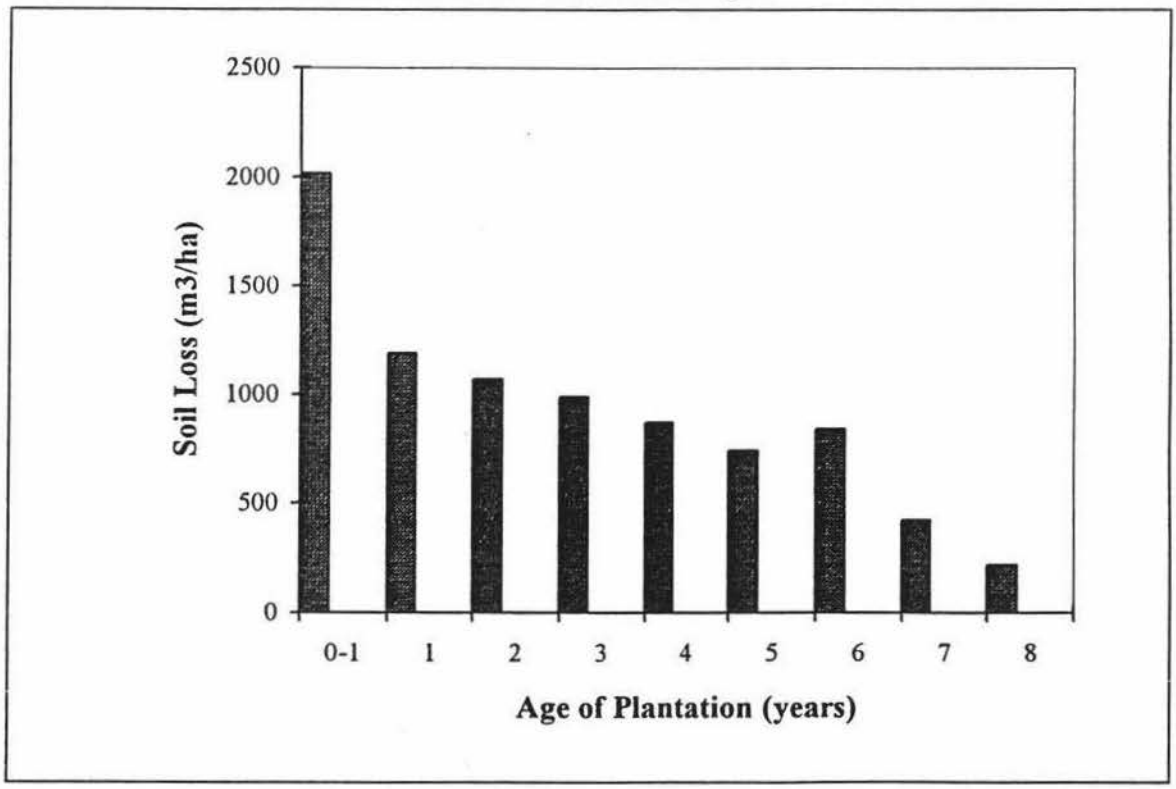
- lower planting densities such as 800 stems/ha are suitable only on sites showing no signs of instability.

The recommended densities of 1250-1500 stems/ha left the site incompletely occupied by roots for a period of about 4 years, which involved a 67% chance of experiencing a severe storm. Canopy site occupancy is achieved at about 7 years. The comparative figures for a density of 800 stems/ha are 6 years and 12 years for the roots and canopy site occupancy respectively.

Plantation Age

Marden *et al.* (1988) in a study conducted in the Uawa catchment following cyclone Bola, examined the relationship between *P. radiata* plantation age and estimated soil loss due to the cyclone. The study is particularly valuable in that 98% of *P. radiata* forest in the catchment at that time was less that 8 years of age.

Figure 1 - Soil Loss from Exotic Forest of Different Ages



Source: Marden et al. (1991, fig. 2).

[98] The assumed regimes involve thinning at tree heights of 5 and 12 metres to densities of 500 and 250 stems/ha respectively.

As could be expected, newly planted stands gave little or no greater protection than equivalent areas of pasture. However on stands in their second to eighth year, average soil loss was halved, and this continued to decline, with stands of 8 years or older showing a 10-fold reduction in soil loss. It was calculated that had the cyclone not hit until 1996, by which time all stands in the catchment would have been over 8 years old, a 77% reduction in soil loss from forested areas could have been achieved (*Conservation Quorum*, 1993:5).

This study agrees with the root structure study discussed above, in that by year 8, pines appear to have achieved the stability expected by Watson. This result is further supported by Phillips *et al.* (1990), who compared landslide density between areas of pasture and forest of different ages. This study also found that pine plantations over 8 years of age provided a level of protection 10 times that of younger stands, while stands of less than 6 years were not found to significantly reduce the frequency of landslides, relative to that expected on areas of similar slope, rock type, and aspect under pasture.

Post Harvest Research

Post-harvest deterioration of *P. radiata* roots has been shown to occur rapidly (O,Loughlin and Watson, 1979), such that by 14 months after cutting, half their tensile strength has been lost. Watson (1990:4) records that by 3 years after harvest, even large (>5cm diameter) roots were "in an advanced state of decay". Nevertheless, tree roots do continue to contribute significantly to slope stability for one to two years following harvest, through structural reinforcement, rather than soil water regulation. In a study in the Maimai catchment near Reefton by O'Loughlin *et al.* (1982), data on landslides was collected for adjacent catchments of similar slope, soil and geology, following one intense storm . In catchments which had been clear-felled 10-12 months earlier, no new landslides were found, while a total of 18 were recorded in areas clear-felled 20-40 months earlier.

Thus, after harvest and even assuming immediate replanting of the site, there exists a period of 5-6 years between the loss of soil reinforcement provided by roots of the former crop, and the point at which growing root systems of the new crop have sufficient site occupancy to replace this reinforcement. During this period, the soil is again vulnerable to erosion. The Maimai study gave rise to a recommendation that riparian

strips 15-20 m wide of indigeneous vegetation be retained to aid bank protection, and to reduce the amount of slip debris entering the channel following harvest of the forest.

It is now some 36 years since the first major conservation forestry plantings began in the East Coast region at Mangatu, and these plantings have only recently begun to be harvested. The results of research into the effects of harvesting and re-establishment of these plantings will have important implications for the future of conservation forestry in the area. Initial monitoring of trial harvested areas at Mangatu have shown no significant increases in slope movement after six years (Marden, 1989) which has been partially attributed to improved planning and harvesting techniques.

Relative Protective Value of Forestry and other Vegetation Types

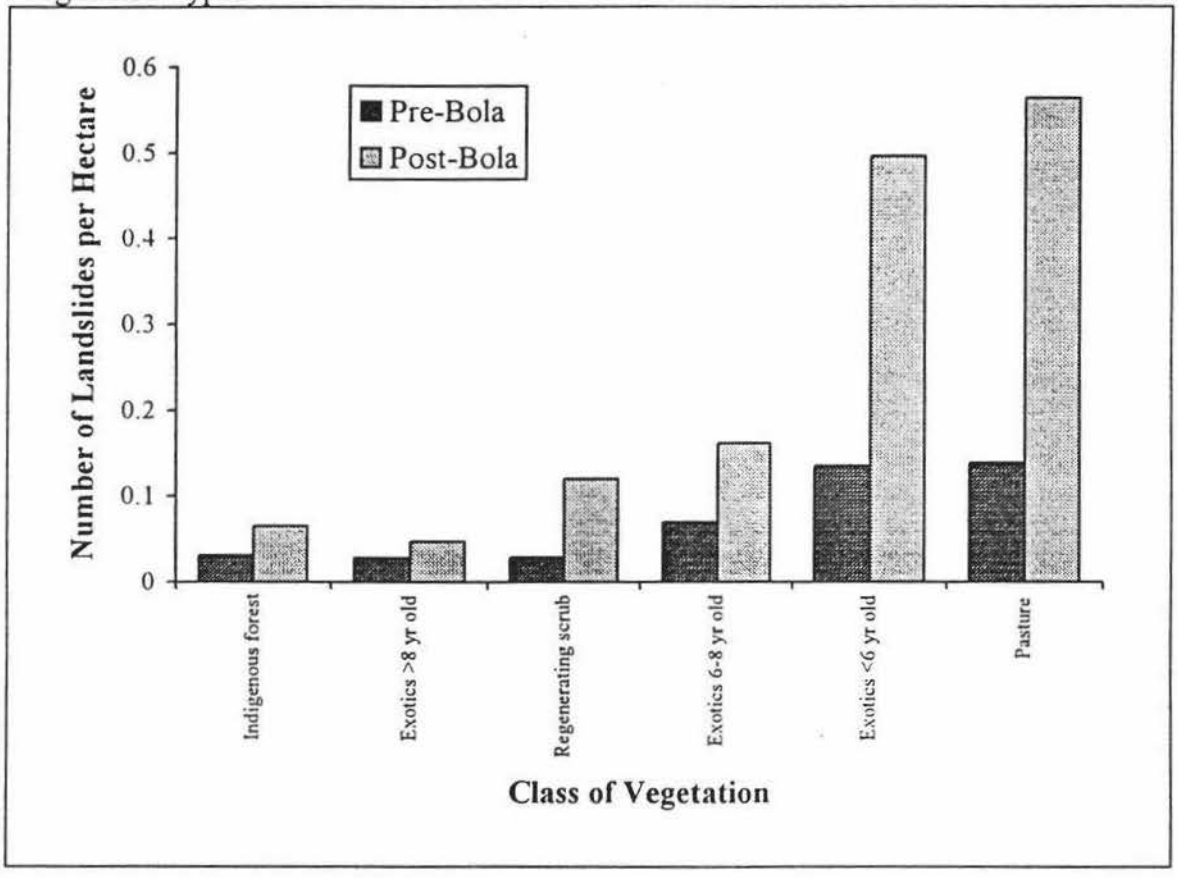
The geomorphology of the East Coast area is such that even under natural indigeneous forest, large earth flows and slumps occur. However this form of vegetation did maintain a largely constant site occupancy by both canopy and roots system, which performed the same binding and hydrological functions as are attributed above to *P. radiata*.

Several studies conducted post-Cyclone Bola have looked at the incidence of erosion which occurred due to the cyclone on land under varied vegetation types. Marden and Rowan (1989) compare information on landslide density before and after Cyclone Bola, with six classes of vegetation. This study looked particularly at tertiary hill country, dominated by shallow soils on steep slopes. The classes included indigenous forest, regenerating scrub, pasture (undifferentiated as to the presence or absence of on-farm conservation works) and exotic forest (predominantly *P. radiata*) split into three age classes, "<6 years", "6-8 years", and ">8 years". The results of this study are illustrated in the graph in figure 2, below.

As can be seen from this graph, Marden *et al.* confirmed a relationship between landslide density and vegetation type. Earlier discussion of the large increase in slope stability in pines over 8 years is again emphasised, as is the poor level of protection afforded by stands less that 6 years, and the importance of the achievement of site occupancy. Indigenous forest and pines over 8 years gave the greatest level of protection both prior to and during Cyclone Bola. Regenerating scrub provided an intermediate level of

protection, but also showed the greatest proportional rise in landslides from pre- to post-Bola. This is however not a complete picture of this class of vegetation since it is noted in this paper that this class included stands of varied age, height, and density. It was considered likely that there existed a relationship between such parameters, though this was not within the scope of the study to assess.

Figure 2 - Comparison of Pre- and Post-Bola Mean Landslide Densities for Different Vegetation Types



Source: Marden and Rowan 1989, Table 1.

In a similar study, but one with an overt economic approach, is found in a series of reports produced by Hicks (1989a, 1989b, 1989c, 1989d). This study included a section which involved the examination of a series of aerial photographs taken along a transect in the Waimata catchment, taken several days after the storm. This transect crossed areas of pasture, pine trees 5-8 years old, and native bush and was representative of "hard" hill country on Tertiary siltstones/sandstones in the region. The study compared levels of siltation or erosion of watercourses, fresh mass movement, and damage to fences and tracks, under these three basic vegetation types. Findings in this study support those above, though it should be remembered that the site of this study is substantially more

stable than that at Mangatu. The young pines greatly reduced the incidence of fresh mass movement relative to that occurring under pasture. This level was slightly higher than that expected under native bush or scrub.

As was found by Pearce *et al.* (1987), pines did not stabilise some old established avalanche scars on steep slopes, and these continued to supply large quantities of debris to water channels. Similar slips were also evident under bush and scrub, however these were found to be less numerous.

A genuine reduction in damage to fences and tracks on areas under pine was also noted, though this appeared to be primarily due to relocation of both away from mid-slopes, to more stable ridges.

Research into the Effectiveness of On-Farm Soil Conservation Measures

The method of using a transect of aerial photographs was also used to assess the value of on-farm soil conservation measures[99] following Cyclone Bola (Hicks 1989c, 1992). In this case the transect lay in the Waihora catchment, along which the predominant land use was pastoral hill country which had been treated to varying degrees with on-farm erosion control works.

The transect was divided into 273 hillside units for which information on whether soil conservation measures had occurred, the species used, type of planting, and percentage of the hillside covered. Also assessed were the "need for", "condition", and "effectiveness" of the plantings on an 8 point scale. Perhaps the most noteworthy findings to arise from this study was that where plantings were present, and had been installed and were "appropriate, sufficient, mature, and healthy", the incidence of erosion was "scarcely greater than has occurred on stable hillsides which do not require plantings" (Hicks 1989c:7). This was unfortunately only the case on some 34% of slopes where plantings had been installed.

[99] On farm soil conservation measures refers here predominantly to "spaced planting of willows and poplars in farm paddocks, paired planting of poplars in hillslope watercourses, and close planting, usually of pines, in active gullies" (Hicks 1989c: 3).

It was concluded that of the 273 units, 220 were erosion prone, but that all except one of these 220 were treatable with on-farm conservation measures *provided* they were installed and maintained adequately.

While many of the mechanisms described above for pines, may contribute to the value of on-farm plantings in controlling erosion, Luckman and Thompson (1990c) identify a lack of empirically based studies which asses the effectiveness of such works. Using knowledge-based systems (see Luckman and Thompson, 1990b) they conducted such a study into erosion control measures on earthflow and gully erosion sites.

On the basis of existing evidence, Luckman and Thompson conclude that many erosion problems can be controlled by farm conservation measures or afforestation is feasible. They do identify a need for more case studies of particular treatments on particular sites, to establish more precise guidelines on such attributes as tree spacings. Such a database would allow greater targeting of treatments, and ultimately a better degree of site erosion control while avoiding the expense of overly conservative treatments.

Luckman and Thompson, also make a case that on-farm soil conservation measures have been under-rated. They cite the potential advantages of on-farm soil conservation as being less expensive, permitting a more regular income, able to be more finely "tuned", and of greater aesthetic appeal, than blanket afforestation with exotic species, generally *P. radiata.*

Appendix IV

Land Use Categories for Properties in the Upper-Hikuwai Catchment

Property	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
1	25.3	365.8	6.7				397.8
2	231.1	178.4		1.2			410.7
3	692.5	1622.6		448.0		28.0	2791.1
4	282.6	225.1	161.3	121.5			790.5
5	320.7	199.2		147.0			666.9
6	315.1	243.7		48.3			607.1
7	319.7	331.8	39.4	109.5		1.4	801.8
8	70.5	69.6		12.9			153.0
9	287.5	19.0	195.6			68.2	570.3
10	124.7	565.5		136.3			826.5
11	250.3	155.2		21.7			427.2
12	899.5	342.6		33.1			1275.2
13	468.0	480.2	11.9	23.7			983.9
14	356.7	495.0		550.5			1402.2
15	92.0	40.6	63.1			17.8	213.5
16	391.2	165.9		150.3	188.3	6.1	901.8
17	514.7	294.2		33.0			841.9
18	400.1	370.4		200.8			971.3
19	168.5	106.9	7.2				282.6
20	89.3	241.5		235.1			565.9
21	1224.0	2557.2	325.4	823.1		31.1	4960.8
22a	112.1	116.2		27.7			256.0
22b	152.6	2.0	29.7	2.1			186.4
23a	256.1	57.6		13.8			327.5
23b	120.6	573.4		321.4			1015.4
24a	240.1	42.9		1.0		2.9	287.0
24b	331.2	9.0	534.4			247.6	1122.2
24c	33.9	165.6	80.7	51.0			331.2
24d	486.8	670.8	387.1	68.0		16.5	1629.1
25	276.0	474.2		161.8			912.0
26	42.4	84.4					126.8
27	67.1		32.0				99.1
Total	*9742.9*	*11326.5*	*1874.4*	*3749.3*	*188.3*	*419.6*	*27134.5*

Appendix V

LUC Breakdown by Land Use and Vegetation for Properties in the Upper-Hikuwai Catchment

Property	*Land Use and Vegetation*	*Land Use Category Area (ha)*						*Total (ha)*
		1	*2*	*3a*	*3b*	*3c*	*4*	
Catchment	Total	9639.8	11279.3	1914.4	3743.4	188.3	369.3	27134.5
	Pasture	5607.8	4468.2	210.8	1599.4	70.8	25.4	11982.5
	Native Bush	989.4	898.4	979.3	126.0	0.0	284.8	3278.0
	Shrubland	256.4	634.7	111.2	159.3	0.0	3.9	1165.5
	Forest	2786.2	5278.0	613.2	1858.6	117.5	55.2	10708.6
1	Total	25.3	365.8	6.7	0.0	0.0	0.0	397.8
	Pasture	7.0	140.5	6.7				154.2
	Native Bush							
	Shrubland	18.3	225.3					243.6
	Forest							
2	Total	231.1	178.4	0.0	1.2	0.0	0.0	410.7
	Pasture	231.1	178.4		1.2			410.7
	Native Bush							
	Shrubland							
	Forest							
3	Total	692.5	1622.6	0.0	448.0	0.0	28.0	2791.1
	Pasture							
	Native Bush							
	Shrubland							
	Forest	692.5	1622.6		448.0		28.0	2791.1
4	Total	282.6	225.1	161.3	121.5	0.0	0.0	790.5
	Pasture	195.9	194.2	69.4	108.7			568.2
	Native Bush	47.1	1.3	91.9				140.3
	Shrubland							0.0
	Forest	39.5	29.7		12.8			82.0
5	Total	317.3	202.1	0.0	147.5	0.0	0.0	666.9
	Pasture	139.9	81.6		32.4			253.9
	Native Bush							0.0
	Shrubland							0.0
	Forest 1981	1.6			11.4			13.0
	1993	175.8	120.5		103.7			400.0
6	Total	315.1	243.7	0.0	48.3	0.0	0.0	607.1
	Pasture	204.6	115.4		20.5			340.5
	Native Bush	4.6						4.6
	Shrubland							0.0
	Forest 1981		3.1		3.9			7.0
	1985	1.2	16.0		13.8			31.0
	1993	104.7	109.2037		10.1			224.0

Property	*Land Use and Vegetation*	*Land Use Category Area (ha)*						*Total (ha)*
		1	*2*	*3a*	*3b*	*3c*	*4*	
7	Total	319.7	331.8	39.4	109.5	0.0	1.4	801.8
	Pasture	319.7	331.8	14.9	109.5		1.4	777.3
	Native Bush			24.5				24.5
	Shrubland							0.0
	Forest							0.0
8	Total	70.5	69.6	0.0	12.9	0.0	0.0	153.0
	Pasture	70.5	69.6		12.9			153.0
	Native Bush							0.0
	Shrubland							0.0
	Forest							0.0
9	Total	287.5	19.0	195.6	0.0	0.0	68.2	570.3
	Pasture							0.0
	Native Bush	287.5	19.0	195.6			68.2	570.3
	Shrubland							0.0
	Forest							0.0
10	Total	124.7	565.5	0.0	136.3	0.0	0.0	826.5
	Pasture							0.0
	Native Bush							0.0
	Shrubland							0.0
	Forest	124.7	565.5		136.3			826.5
11	Total	250.3	155.2	0.0	21.7	0.0	0.0	427.2
	Pasture	220.7	35.3		9.2			265.1
	Native Bush	29.6	119.9		12.5			162.1
	Shrubland							0.0
	Forest							0.0
12	Total	899.5	342.6	0.0	33.1	0.0	0.0	1275.2
	Pasture	890.5	342.6		33.1			1266.2
	Native Bush	5.0						5.0
	Shrubland							0.0
	Forest 1982	2.0						2.0
	1983	2.0						2.0
13	Total	468.0	480.2	11.9	23.7	0.0	0.0	983.9
	Pasture	463.6	458.2	0.0	23.7			945.6
	Native Bush	4.4	22.0					26.4
	Shrubland			11.9				11.9
	Forest							0.0
14	Total	356.7	495.0	0.0	550.5	0.0	0.0	1402.2
	Pasture	272.8	352.3		422.6			1047.6
	Native Bush		4.7					4.7
	Shrubland							0.0
	Forest 1989	29.8	28.2		81.5			139.5
	1992	22.7	17.4		20.3			60.4
	1993	31.4	92.4		26.2			150.0

Property	*Land Use and Vegetation*	*Land Use Category Area (ha)*						*Total (ha)*
		1	*2*	*3a*	*3b*	*3c*	*4*	
15	Total	92.0	40.6	63.1	0.0	0.0	17.8	213.5
	Pasture	66.7	24.3					91.0
	Native Bush	17.9	16.3	63.1			17.8	115.1
	Shrubland	7.4						7.4
	Forest							0.0
16	Total	391.2	165.9	0.0	150.3	188.3	6.1	901.8
	Pasture	285.3	145.0		144.0	70.8	6.1	651.3
	Native Bush	12.6			6.3			18.9
	Shrubland							0.0
	Forest - existing	29.1	20.9					50.0
	1989	64.2				117.5		181.7
17	Total	514.7	294.2	0.0	33.0	0.0	0.0	841.9
	Pasture	514.7	253.2		22.0			789.9
	Native Bush							0.0
	Shrubland		31		11.0			42.0
	Forest		10.0					10.0
18	Total	400.1	370.4	0.0	200.8	0.0	0.0	971.3
	Pasture/scrub	376.1	368.0		200.8			944.9
	Native Bush	24.0	2.4					26.4
	Shrubland							0.0
	Forest							0.0
19	Total	168.5	106.9	7.2	0.0	0.0	0.0	282.6
	Pasture	138.1	12.1	7.2				157.3
	Native Bush	30.4	94.8					125.3
	Shrubland							0.0
	Forest							0.0
20	Total	89.3	241.5	0.0	235.1	0.0	0.0	565.9
	Pasture	67.7	152.1		174.4			394.2
	Native Bush							0.0
	Shrubland							0.0
	Forest 1988	20.0	59.9		43.1			123.0
	1991	1.6	29.5		17.6			48.7
21	Total	1224.0	2557.2	325.4	823.1	0.0	31.1	4960.8
	Pasture/scrub	263.8	830.9		198.0		15.2	1308.0
	Native Bush	171.9	580.3		101.6		1.2	855.0
	Shrubland*	209.6	304.8	99.3	139.2		3.9	756.8
	Forest1980/82	119.8	174.2	226.1	79.6		2.2	602.0
	1987	64.1	93.2		42.6		1.2	201.0
	1988	127.5	185.4		84.7		2.4	400.0
	1989	61.9	89.9		41.1		1.1	194.0
	1990	84.8	123.3		56.3		1.6	266.0
	1991	74.3	108.0		49.3		1.4	233.0
	1992	8.9	13.0		5.9		0.2	28.0
	1993	37.3	54.2		24.8		0.7	117.0

Property	*Land Use and Vegetation*	*Land Use Category Area (ha)*						*Total (ha)*
		1	*2*	*3a*	*3b*	*3c*	*4*	
22a	Total	112.1	116.2	0.0	27.7	0.0	0.0	256.0
	Pasture	91.0	92.1		18.6			201.7
	Native Bush							0.0
	Shrubland	21.1	24.1		9.1			54.3
	Forest							0.0
22b	Total	152.6	2.0	29.7	2.1	0.0	0.0	186.4
	Pasture	135.3	2.0		2.1			139.4
	Native Bush	17.3		29.7				47.0
	Shrubland							0.0
	Forest							0.0
23a	Total	256.1	57.6	0.0	13.8	0.0	0.0	327.5
	Pasture	256.1	57.6		13.8			327.5
	Native Bush							0.0
	Shrubland							0.0
	Forest							0.0
23b	Total	120.6	573.4	0.0	321.4	0.0	0.0	1015.4
	Pasture							0.0
	Native Bush		2.7					2.7
	Shrubland							0.0
	Forest 1989	8.8	34.4		32.8			76.0
	1990	6.0	18.6		36.5			61.0
	1991		12.0		41.0			53.0
	1992	105.8	505.7		211.2			822.7
24a	Total	240.4	42.9	0.0	1.0	0.0	2.7	287.0
	Pasture	240.4	42.9		1.0		2.7	287.0
	Native Bush							0.0
	Shrubland							0.0
	Forest							0.0
24b	Total	331.2	18.9	574.4	0.0	0.0	197.6	1122.2
	Pasture							
	Native Bush	331.2	18.9	574.4			197.6	1122.2
	Shrubland							
	Forest							
24c	Total	33.9	165.6	80.7	51.0	0.0	0.0	331.2
	Pasture	28.0	153.4	80.7	51.0			313.0
	Native Bush	5.9	12.3					18.1
	Shrubland							
	Forest							
24d	Total	486.8	670.8	387.1	68.0		16.5	1629.1
	Pasture							0.0
	Native Bush							0.0
	Shrubland							0.0
	Forest 1983	180.8	355.9	200.9	40.8		11.8	790.2
	1984	10.1	12.0	122.4			4.7	149.2
	1985	295.9	302.8	63.8	27.2			689.7

Property	*Land Use and Vegetation*	*Land Use Category Area (ha)*						*Total (ha)*
		1	*2*	*3a*	*3b*	*3c*	*4*	
25	Total	276.0	474.2	0.0	161.8	0.0	0.0	912.0
	Pasture	18.6						18.6
	Native Bush		3.8		5.6			9.4
	Shrubland							0.0
	Forest 1988	8.7	101.3		43.7			153.7
	1993	248.6	369.0		112.6			730.2
26	Total	42.4	84.4	0.0	0.0	0.0	0.0	126.8
	Pasture	42.4	34.9					77.3
	Native Bush							0.0
	Shrubland		49.5					49.5
	Forest							0.0
27	Total	67.1	0.0	32.0	0.0	0.0	0.0	99.1
	Pasture	67.1		32.0				99.1
	Native Bush							0.0
	Shrubland							0.0
	Forest							0.0

Appendix VI

Detailed LUC Breakdown for Land Exchanges

Table 1 - Land Exchange between Properties 5 and 6

Property	*Land Use and Vegetation*	*Land Use Category Area (ha)*						*Total (ha)*
		1	*2*	*3a*	*3b*	*3c*	*4*	
5 (a + b)	Total	317.3	202.1	0.0	147.5	0.0	0.0	666.9
	Pasture	139.9	81.6		32.4			253.9
	Native Bush							0.0
	Shrubland							0.0
	Forest 1981	1.6	0.0		11.4			13.0
	1993	175.8	120.5		103.7			400.0
5a Pasture	Total	76.5	53.6	0.0	0.0	0.0	0.0	130.1
	Pasture	76.5	53.6		0.0			130.1
	Native Bush							0.0
	Shrubland							0.0
	Forest 1981							0.0
	1993							0.0
5b Forest	Total	240.8	148.5	0.0	147.6	0.0	0.0	536.8
	Pasture	63.4	28.0		32.4			123.8
	Native Bush							0.0
	Shrubland							
	Forest 1981	1.6			11.4			13.0
	1993	175.8	120.5		103.7			400.0
6 (a + b)	Total	315.1	243.7	0.0	48.3	0.0	0.0	607.1
	Pasture	204.6	115.4		20.5			340.5
	Native Bush	4.6						4.6
	Shrubland							0.0
	Forest 1981		3.1		3.9			7.0
	1985	1.2	16.0		13.8			31.0
	1993	104.7	109.2		10.1			224.0
6a Pasture	Total	223.4	138.5	0.0	38.2	0.0	0.0	400.1
	Pasture	204.6	115.4		20.5			340.5
	Native Bush	4.6						4.6
	Shrubland							0.0
	Forest 1981		3.1		3.9			7.0
	1985	1.2	16.0		13.8			31.0
	1993	13.0	4					17.0
6b Forest	Total	91.7	105.2	0.0	10.1	0.0	0.0	207.0
	Pasture							0.0
	Native Bush							0.0
	Shrubland							0.0
	1993	91.7	105		10.1			207.0

Property	*Land Use and Vegetation*	*Land Use Category Area (ha)*						*Total Area (ha)*
		1	*2*	*3a*	*3b*	*3c*	*4*	
5 New (5b+6b)	Total	332.5	253.7	0.0	157.6	0.0	0.0	743.8
	Pasture	63.4	28.0		32.4			123.8
	Native Bush							0.0
	Shrubland							0.0
	Forest 1981	1.6			11.4			13.0
	1993	267.5	225.7	0.0	113.8	0.0	0.0	607.0
6 New (6a+5a)	Total	299.9	192.1	0.0	38.2	0.0	0.0	530.2
	Pasture	281.1	169.0		20.5			470.5
	Native Bush	4.6						4.6
	Shrubland							0.0
	Forest 1981		3.1		3.9			7.0
	1985	1.2	16.0		13.8			31.0
	1993	13.0	4					17.0

Table 2 - Division of Property 23

Property	*Land Use and Vegetation*	*Land Use Category Area (ha)*						*Total Area (ha)*
		1	*2*	*3a*	*3b*	*3c*	*4*	
23 (a + b)	Total	376.7	631.0	0.0	335.2	0.0	0.0	1342.9
	Pasture	256.1	57.6		13.8			327.5
	Native Bush		2.7					2.7
	Shrubland							0.0
	Forest	120.6	570.7		321.4			1012.7
23a	Total	256.1	57.6	0.0	13.8	0.0	0.0	327.5
	Pasture	256.1	57.6		13.8			327.5
	Native Bush							0.0
	Shrubland							0.0
	Forest							0.0
23b	Total	120.6	573.4	0.0	321.4	0.0	0.0	1015.4
	Pasture							0.0
	Native Bush		2.7					2.7
	Shrubland							0.0
	Forest 1989	8.8	34.4		32.8			76.0
	1990	6.0	18.6		36.5			61.0
	1991		12.0		41.0			53.0
	1992	105.8	505.7		211.2			822.7

Appendix VII

Annual Afforestation by Property and LUC in the Upper-Hikuwai Catchment

Table 1 - Years 1980 to 1993

Year	*Property*	*Land Use Categories Afforested (ha)*						*Property Total*	*Annual Total*	*Running Total*
		1	*2*	*3a*	*3b*	*3c*	*4*			
Prior	16	29.1	20.9					50.0	50	50
1980	Total	178.4	382.6	75.4	116.1	0.0	6.3		758.9	808.9
	3	138.5	324.5		89.6		5.6	558.2		
	21	39.9	58.1	75.4	26.5	0.0	0.7	200.7		
1981	Total	180.0	385.7	75.4	131.5	0.0	6.3		778.9	1587.8
	3	138.5	324.5		89.6		5.6	558.2		
	5	1.6			11.4			13.0		
	6		3.1		3.9			7.0		
	21	39.9	58.1	75.4	26.5	0.0	0.7	200.7		
1982	Total	180.4	382.6	75.4	116.1	0.0	6.3		760.9	2348.7
	3	138.5	324.5		89.6		5.6	558.2		
	12	2.0						2.0		
	21	39.9	58.1	75.4	26.5	0.0	0.7	200.7		
1983	Total	321.3	680.4	200.9	130.4	0.0	17.4		1350.4	3699.1
	3	138.5	324.5		89.6		5.6	558.2		
	12	2.0						2.0		
	24d	180.8	355.9	200.9	40.8		11.8	790.2		
1984	Total	148.6	336.6	122.4	89.6	0.0	10.3		707.4	4406.5
	3	138.5	324.5		89.6		5.6	558.2		
	24d	10.1	12.0	122.4			4.7	149.2		
1985	Total	297.1	318.8	63.8	41.0	0.0	0.0		720.7	5127.2
	6	1.2	16.0		13.8			31.0		
	24d	295.9	302.8	63.8	27.2			689.7		
1986	Total	0.0	0.0	0.0	0.0	0.0	0.0		0.0	5127.2
1987	Total	64.1	93.2	0.0	42.6	0.0	1.2		201.0	5328.2
	21	64.1	93.2	0.0	42.6	0.0	1.2	201.0		
1988	Total	156.3	346.6	0.0	171.5	0.0	2.4		676.8	6005.0
	20	20.0	59.9		43.1			123.0		
	25	8.7	101.3		43.7			153.7		
	21	127.5	185.4	0.0	84.7	0.0	2.4	400.0		
1989	Total	166.2	192.1	0.0	172.9	117.5	1.1		649.8	6654.8
	14	29.8	28.2		81.5			139.5		
	16	64.2				117.5		181.7		
	17		10.0					10.0		
	20	1.6	29.5		17.6			48.7		
	23b	8.8	34.4		32.8			76.0		
	21	61.9	89.9		41.1		1.1	194.0		

Year	*Property*	*Land Use Categories Afforested (ha)*						*Property Total*	*Annual Total*	*Running Total*
		1	*2*	*3a*	*3b*	*3c*	*4*			
1990	Total	90.8	141.9	0.0	92.8	0.0	1.6		327.0	6981.8
	23b	6.0	18.6		36.5			61.0		
	21	84.8	123.3		56.3		1.6	266.0		
1991	Total	113.8	149.7	0.0	103.1	0.0	1.4		368.0	7349.8
	4	39.5	29.7		12.8			82.0		
	23b		12.0		41.0			53.0		
	21	74.3	108.0	0.0	49.3	0.0	1.4	233.0		
1992	Total	137.4	536.1	0.0	237.4	0.0	0.2		911.1	8260.9
	14	22.7	17.4		20.3			60.4		
	23b	105.8	505.7		211.2			822.7		
	21	8.9	13.0		5.9		0.2	28.0		
1993	Total	722.6	1310.8	0.0	413.6	0.0	0.7		2447.7	10708.6
	5	175.8	120.5		103.7			400.0		
	6	104.7	109.2		10.1			224.0		
	10	124.7	565.5		136.3			826.5		
	14	31.4	92.4		26.2			150.0		
	25	248.6	369.0		112.6			730.2		
	21	37.3	54.2		24.8		0.7	117.0		
Grand Total		*2757.1*	*5257.1*	*613.2*	*1858.6*	*117.5*	*55.2*	*10658.6*	*10708.6*	*10708.6*

Table 2 - Projections for 1994 to 1997

Year	*Property*	*Land Use Categories Afforested (ha)*						*Property Total*	*Annual Total*	*Running Total*
		1	*2*	*3a*	*3b*	*3c*	*4*			
1994	Total	207.1	353.9	24.8	136.7	0.0	4.8		727.4	727.4
	5	63.4	28.0		32.4			123.8		
	6	15.2	24.7		11.0			51.0		
	12	10.1	17.2		9.0			36.3		
	21	118.4	283.9	24.8	84.3	0.0	4.8	516.2		
1995	Total	271.9	695.9	24.8	462.2	70.8	4.8		1530.4	2257.7
	14	115.3	341.3		372.5			829.0		
	16	30.4	64.0			70.8		165.2		
	17	7.9	6.7		5.4			20.0		
	21	118.4	283.9	24.8	84.3	0.0	4.8	516.2		
1996	Total	118.4	283.9	24.8	84.3	0.0	4.8		516.2	2774.0
	21	118.4	283.9	24.8	84.3	0.0	4.8	516.2		
1997	Total	118.4	283.9	24.8	84.3	0.0	4.8		516.2	3290.2
	21	118.4	283.9	24.8	84.3	0.0	4.8	516.2		
Grand Total		*715.7*	*1617.7*	*99.3*	*767.5*	*70.8*	*19.1*		*3290.2*	*3290.2*

Appendix VIII

LUC Breakdown of Pasture Remaining on Properties in the Upper-Hikuwai Catchment which have Land Requiring Afforestation

With the exception of two properties with only minor amounts (see Table 5), the LUC breakdown of all properties with erodible land in pasture is given in the following tables for the end of the years 1979, 1987, 1993 and 1997.

Table 1 - Pasture on 19 Properties with Land Requiring Afforestation at the End of 1979.

Property	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
2/4/22a	557.6	494.4	69.4	141.3			1262.6
3	692.5	1622.6		448		28	2791.1
5	317.3	202.1		147.5			666.9
6	310.5	243.7		48.3			602.5
7	319.7	331.8	14.9	109.5		1.4	777.3
8	70.5	69.6		12.9			153.0
10	124.7	565.5		136.3			826.5
11/18	596.8	403.3		210.0			1210.0
12	894.5	342.6		33.1			1270.2
13/24c	491.6	611.6	80.7	74.7			1258.6
14	356.7	490.3		550.5			1397.5
16	349.5	145.0		144.0	188.3	6.1	832.9
17	514.7	263.2		22.0			799.9
20	89.3	241.5		235.1			565.9
21	842.5	1672.1	226.1	582.3		26.0	3349.0
23a	256.1	57.6		13.8			327.5
23b	120.6	570.7		321.4			1012.7
24d	486.8	670.8	387.1	68		16.5	1629.2
25	276.0	470.4		156.2			902.6
Total	***7668.0***	***9468.6***	***778.1***	***3454.9***	***188.3***	***78.0***	***21635.9***
Mean	***403.6***	***498.3***	***41.0***	***181.8***	***9.9***	***4.1***	***1138.7***

Table 2 - Pasture on 17 Properties with Land Requiring Afforestation at the End of 1987

Property	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
2/4/22a	557.6	494.4	69.4	141.3			1262.6
5	315.7	202.1		136.1			653.9
6	309.3	224.6		30.6			564.5
7	319.7	331.8	14.9	109.5		1.4	777.3
8	70.5	69.6		12.9			153.0
10	124.7	565.5		136.3			826.5
11/18	596.8	403.3		210.0			1210.0
12	890.5	342.6		33.1			1266.2
13/24c	491.6	611.6	80.7	74.7			1258.6
14	356.7	490.3		550.5			1397.5
16	349.5	145.0		144.0	188.3	6.1	832.9
17	514.7	263.2		22.0			799.9
20	89.3	241.5		235.1			565.9
21	658.5	1404.8		460.1		22.6	2546.0
23a	256.1	57.6		13.8			327.5
23b	120.6	570.7		321.4			1012.7
25	276.0	470.4		156.2			902.6
Total	*6297.9*	*6888.8*	*164.9*	*2787.6*	*188.3*	*30.1*	*16357.6*
Mean	*370.5*	*405.2*	*9.7*	*164.0*	*11.1*	*1.8*	*962.2*

Table 3 - Pasture on 14 Properties with Land Requiring Afforestation at the End of 1993

Property	*Land Use Category Area (ha)*						*Total*
	1	*2*	*3a*	*3b*	*3c*	*4*	*(ha)*
2/4/22a	518.1	464.7	69.4	128.5			1180.6
5 New	63.4	28.0		32.4			123.8
6 New	281.1	169.0		20.5			470.5
7	319.7	331.8	14.9	109.5		1.4	777.3
8	70.5	69.6		12.9			153.0
11/18	596.8	403.3		210.0			1210.0
12	890.5	342.6		33.1			1266.2
13/24c	491.6	611.6	80.7	74.7			1258.6
14	272.8	352.3		422.6			1047.6
16	285.3	145.0		144.0	70.8	6.1	651.3
17	514.7	253.2		22.0			789.9
20	67.7	152.1		174.4			394.2
21	263.8	830.9		198.0		15.2	1308.0
23a	256.1	57.6		13.8			327.5
Total	*4892.2*	*4211.6*	*164.9*	*1596.3*	*70.8*	*22.7*	*10958.5*
Mean	*349.4*	*300.8*	*11.8*	*114.0*	*5.1*	*1.6*	*782.8*

4 - Pasture on 11 Properties with Land Requiring Afforestation at the End of

ty	Area in Pasture by Land Use Categories (ha)						Total
	1	2	3a	3b	3c	4	(ha)
1	518.1	464.7	69.4	128.5			1180.6
	189.3	90.7		9.5			289.5
	319.7	331.8	14.9	109.5		1.4	777.3
	70.5	69.6		12.9			153.0
	596.8	403.3		210.0			1210.0
	880.4	325.4		24.1			1229.9
	491.6	611.6	80.7	74.7			1258.6
	157.5	11.0		50.1			218.6
	254.9	81.0		144.0		6.1	486.0
	499.9	253.4		16.6			769.9
	256.1	57.6		13.8			327.5
	4234.9	*2699.9*	*164.9*	*793.7*	*0.0*	*7.5*	*7900.9*
	385.0	*245.4*	*15.0*	*72.2*	*0.0*	*0.7*	*718.3*

5 - Pasture on Properties with Minor Areas of Land Requiring Afforestation

ty	Land Use Categories (ha)						Total
	1	2	3a	3b	3c	4	(ha)
	135.3	2.0		2.1			139.4
	240.4	42.9		1.0		2.7	287.0
	375.7	*44.9*	*0.0*	*3.1*	*0.0*	*2.7*	*426.4*

Bibliography

Aldwell, P.H.B. *Some Social and Economic Implications of Large-scale Forestry in Waiapu County,* FRI Bulletin No. 75 (Rotorua: New Zealand Forest Research Institute, 1984).

Anderson A. Grant (ed.) *The Land Our Future - Essays in Land Use and Conservation in New Zealand* (Auckland: Longman Paul, 1980).

Anon. "Soil and water conservation and human priorities." *Soil and Water* 3 (1986):5-6.

Anon. *Ecologically Sustainable Development Working Groups. Final Report Agriculture.* (Canberra: Commonwealth of Australia Press, 1991).

Barbier, Edward. "The concept of sustainable economic development" *Environmental Conservation* 14 (1987):101-110.

Barney, G.O., *The Global 2000 Report to the President of the US* (Oxford: Pergamon Press, 1980).

Basher, L.R.; Floate, M.J.S.; and Watt, J.P.C. "Biophysical sustainability - working with nature" in Paul Henriques (ed.), *Sustainable Land Management,* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):77-84.

Batie, Sandra S. "Sustainable development: challenges to the profession of agricultural economics." *American Journal of Agricultural Economics* December (1989):1083-1101.

___ "Sustainable Development: Concepts and Strategies" in G.H. Peters and B.F. Stanton (ed.s), *Sustainable Agricultural Development: The Role of International Co-operation* (Aldershot: Dartmouth, 1992).

Birdsall, Nancy; and Steer, Andrew for the World Bank. "Act now on global warming - but don't cook the books." *Finance and Development* March (1993).

Bishop, D.M.; and Stevens, M.E. *Landslides on Logged Areas in S.E.Alaska.* USDA Forest Service Research Paper NOR-1 (1964).

Blaikie, Piers; and Brookfield, Harold. *Land Degradation and Society* (London: Methuen, 1987)

Blakely, Roger. "Strategies for agriculture in the 1990's: Environmental impacts and sustainability." *Strategies for Agriculture in the 1990's* Papers presented at the Australian Agricultural Economics Society New Zealand Branch Annual Conference, 29-30 June 1990, pp. 1-21.

chke, Paul. "Soil conservation in the big wide world - Report of a visit to New South Wales, September-October 1992." *New Zealand Soil News* 14 (1993):29-30.

chke, P.M.; Dickinson, K.J.M.; and Roper-Lindsay, Judith. "Defining sustainability - is it worth it?" in Paul Henriques (ed.), *Sustainable Land Management.* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):181-186.

chke, Paul M.; Trustrum, Noel A.; and DeRose, Ron C. "Ecosystem processes and sustainable land use in New Zealand Steeplands." *Agriculture, Ecosystems and Environment* 41 (1992):153-178.

st, Richard. "Treaty of Waitangi and environmental law" in Christopher D.A. Milne (ed.), *Handbook of Environmental Law* (Wellington: Royal Forest and Bird Protection Society, 1992):246-253.

erup, Esther. *The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure* (Chicago: Aldine, 1965).

Population and Technological Change: A Study of Long-Term Trends (Chicago: University of Chicago Press, 1981).

y, Janet Evelyn. *"The Sleeping Giant" - The East Coast 1945 - 1975: Regional Problems and Regional Responses.* MA Thesis, Massey University (1983).

mley, Daniel W. *Property Rights and the Environment: Natural Resource Policy in Transition.* Ministry for the Environment, April (1988).

ih-King, Dennis. "Forestry and district planning schemes: what was all the fuss about?" in M.M. Roche and R. Hodder (ed.s), *Social and Economic Perspectives of Forestry and Agroforestry.* Proceedings of the Forestry Section of the 56th ANZAAS Congress (Palmerston North: New Zealand Forest Service, 1987):263-278.

:tel, Frederick H. "Agricultural structure and rural ecology: toward a political economy of rural development." *Sociologia Ruralis* 20 (1980):44-61.

dwell, Lynton Keith. *Between Two Worlds: Science, the environmental movement and policy choice* (Cambridge: Cambridge University Press, 1990).

mpbell, A. "Community participation - a new frontier in land management" in Paul Henriques (ed.), *Sustainable Land Management.* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991) pp.18-27.

mpbell, D.A. *Down to the Sea in Slips.* Soil Conservation and Rivers Control Bulletin No. 5 (Wellington: SCRCC 1947).

rley, M.; and Christie, I. *Managing Sustainable Development* (London Earthscan, 1992).

Carpenter, R.A. "Biophysical measurement of sustainable development." *Economic Policies for Sustainable Development.* Asian Development Bank (October 1990).

Cavana, R.Y.; and Glass, B.P. "Economic analysis of selected special-purpose species regimes." *New Zealand Journal of Forestry Science* 15,2 (1985):180-194.

Chisolm, A.; and Dumsday, R. (eds.) *Land Degradation: Problems and Policies* (Cambridge: Cambridge University Press, 1987).

Cline, William R. "Give greenhouse abatement a fair chance." *Finance and Development* March (1993).

Coase, Ronald. "The problem of social cost." *The Journal of Law and Economics* 3 (October 1960):1-44.

Colby, Michael. "Environmental management in development: The evolution of paradigms." *World Bank Discussion Paper No. 80* (1990).

Commoner, Barry. *The Closing Circle* (New York:Bantam Books, 1972).

Conservation Division of the Gisborne District Council. *Conservation Quorum,* Issues 1-8.

Conway, G.R. "Agroecosystem analysis." *Agricultural Administration* 20 (1985):31-55.

___ "The properties of agroecosystems." *Agricultural Systems* 24 (1987):95-118.

Conway, G.R.; and Barbier, E. "After the green revolution: sustainable and equitable agricultural development." *Futures* 20,6 (1988).

Costanza, Robert (ed) *Ecological Economics: The Science and Management of Sustainability* (New York: Columbia University Press, 1991).

Cronin, Karen, for Ministry for the Environment. *Ecological Principles for Resource Management* (Wellington: Ministry for the Environment, 1988).

Cuff, J.R.I. *Soil Conservation, Achieving Sustainable Land Use in New Zealand - A Review of Soil Conservation in New Zealand* (Timaru: South Canterbury Catchment Board, 1988).

Cumberland, Kenneth B. *Soil Erosion in New Zealand* (Wellington: Soil Conservation and Rivers Control Council, 1944).

Day, Diana. "Sustainable development - the only way out of land degradation." *Australian Journal of Soil and Water Conservation* 2 (1989):17-18.

Daly, H.E. (ed) *Towards a Steady State Economy* (San Francisco: Freeman, 1973).

___ "Introduction" in H.E. Daly (ed.), *Towards a Steady State Economy* (San Fransisco: Freeman, 1973a):1-36.

"The steady state economy: towards a political economy of biophysical equilibrium and moral growth" in H.E. Daly (ed.), *Towards a Steady State Economy* (San Francisco: Freeman, 1973b):149-174.

"Sustainable growth: an impossibility theorum" in Herman E. Daly and Kenneth N. Townsend (ed.s), *Valuing the Earth - Economics, Ecology, Ethics* (Cambridge, Massachusetts: MIT Press, 1993a):267-273.

, Herman E. and Townsend, Kenneth N. (ed.s). *Valuing the Earth - Economics, Ecology, Ethics* (Cambridge, Massachusetts: MIT Press, 1993).

;avel, John; and Tucker, Richard (ed.s). *Changing Pacific Forests: Changing Perspectives on the Forest Economy of the Pacific Basin* (Durham, North Carolina: Forest History Society, 1992).

ırtment of Lands and Survey. *The Land Utilisation Survey of Gisborne East Coast Region.* Department of Lands and Survey New Zealand (1964).

ırtment of Scientific and Industrial Research - New Zealand (DSIR). *Cyclone Bola/1.* DSIR Extension Information, Alpha 63 (1988).

ose R.C.; Trustrum, N.A.; and Blaschke, P.M. "Geomorphic change implied by regolith - slope relationships on steepland hillslopes, Taranaki, New Zealand" in M.J. Crozier and P. Williams (ed.s), *Geomorphology of Unstable Regions* Catena 18 (1991).

glas, G.B.; Trustrum, N.A.; and Brown, I.C. "Effect of soil slip erosion on Wairoa hill country pasture production and composition." *New Zealand Journal of Agricultural Research* 29 (1986):188-192.

;un, A.K. "Externalities, property rights and power." *Journal of Economic Issues* 17 (1983):667-680.

Cape Catchment Board. *Soil Conservation Effectiveness Survey* (Gisborne: East Cape Catchment Board, 1986).

Cape Catchment Board and Regional Water Board. *Waihora Catchment Cyclone Bola Storm Survey* (Gisborne: East Cape Catchment Board, 1988).

ıolm, E.P. *Losing Ground: Environmental Stress and World Food Problems* (London: Pergamon Press, 1978).

ɛl, J.Ronald. "Introduction: the ethics of sustainable development" in J Ronald Engel and Joan Gibb Engel (ed.s), *Ethics of Environment and Development: Global Challenge, International Response* (London: Belhaven 1990).

ich, Paul W. *The Population Bomb* (New York: Ballantine Books, 1968).

ich, Paul; Erlick, Anne; and Holdren, John P. "Availability, entropy, and the laws of thermodynamics" in Herman E. Daly and Kenneth N. Townsend (ed.s),

Valuing the Earth - Economics, Ecology, Ethics (Cambridge, Massachusetts: MIT Press, 1993).

Eyles, G.O.; and Newsome, P.F. "A national perspective on sustainable land use." *Proceedings of the New Zealand Association of Soil and Water Conservation* 21-26 August (1988):61-66.

___ "A soil conservation approach to sustainable land use" in Paul Henriques (ed.), *Sustainable Land Management.* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):216-220.

___ "Physical resource mapping as a basis for sustainable farm development" in Brian A. Ponter (ed.), *Sustainable Integrated Rural Development: Defining and Modelling.* Proceedings of the First Regional Workshop of the ASEAN - New Zealand Inter-Institutional Linkages Programme, Serdang, Malaysia (1991):161-173.

Eyles, G.O.; and Trustrum, Noel A. "Physical resource issues leading towards sustainable agriculture" in Ralph E.H. Sims (ed.), *Moving Towards Sustainable Agriculture.* Proceedings of a Workshop, Massey University, 31 July to 1 August 1991. No page numbers.

Fisher, D.E. "The Resource Management Legislation of 1991: A juridical analysis of its objectives" in Briar Gordon (ed.), *Resource Management* (Wellington: Booker and Friend, 1991).

Fookes, Tom. "Social and economic matters." *Resource Management Ideas No 3* (Wellington: Ministry for the Environment, 1992).

Foran, Barney. "Rethinking the drylands." *Terra Nova* March (1991):27-28.

Forestry Council. *Forestry as a Land Use,* Bulletin No.6, (Wellington: Forestry Council,1980).

Forest Research Institute. "Tree roots and slope stability." *What's New in Forest Research No. 104* (1981).

Forest Research Institute. "Contribution of tree roots to slope stability." *What's New in Forest Research No. 196* (1990).

Fowler, D.E.; and Meister, A.D. *Rural Planning and Forestry: Formulation of Policy at County Level.* Discussion Paper in Natural Resource Economics No. 7, Department of Agricultural Economics and Farm Management, Massey University (1983).

Frankel, Z. *Regional Economic Change 1973-83* (Wellington: Ministry of Works and Development, Town and Country Planning Division, 1982).

Frechette, K.S. "Environmental ethics and global imperatives" in Robert Repetto, (ed.), *The Global Possible* (New Haven: Yale University Press, 1986):97-123.

day, Laurie; and Laskey, Ronald (eds) *The Fragile Environment - The Darwin College Lectures* (Cambridge: Cambridge University Press, 1989).

on, Hugh. "FARMing Futures." *Terra Nova* March (1991):20-21.

ge, M.; and Black, R.D. *Slope Stability and Geological Investigations at Mangatu State Forest*, New Zealand Forest Service, F.R.I. Technical Paper 66 (1979).

braith, John Kenneth. *The Affluent Society* (London: Hamilton, 1958).

_ *The New Industrial State* (London: Hamilton, 1967).

jart, Benno. "Counterdevelopment: A position paper." *Community Development Journal* 16,2 (1981):88-96.

lopin, Gilberto C.; Gutman, Pablo; and Maletta, Hector. "Global impoverishment, sustainable development and the environment: a conceptual approach." *International Social Science Journal* 121 (1989):375-398.

dyne, Alison. "Broken hills .... and broken promises." *Conservation Quorum* August (1991):8-9.

rard, Ian. "The impact of commercialisation of soil and water conservation - the New Zealand experience." *Australian Journal of Soil and Water Conservation* 3, 4 (1990):8-13.

ɔrgescu-Roegen, Nicholas. "Selections from 'Energy and Economic Myths'." reprinted in Herman E. Daly and Kenneth N. Townsend (ed.s), *Valuing the Earth: Economics, Ecology, Ethics* (Cambridge: MIT Press, 1993): 89-112.

ma, Messaye. "Macropolicy and the environment: a framework for analysis." *World Development* 20, 4 (1992):531-540.

borne District Council (GDC). *Land Use and Erosion Control Reports - Pre and Post Bola* (1988).

_ *Vegetation Removal and Earthworks - A Proposed Regional Plan.* Environment and Planning Department (August 1992).

_ *Proposed Regional Policy Statement for Gisborne* (February 1994).

sby, G.P. "A review of the concept of sustainable management as applied to New Zealand" *Journal of the Royal Society of New Zealand* 21 (June 1991):61-81.

udie, Andrew. "The changing human impact." in Laurie Friday and Ronald Laskey (ed.s), *The Fragile Environment - The Darwin College Lectures* (Cambridge: Cambridge University Press, 1989).

ulet, Denis. *The Cruel Choice: A New Concept in the Theory of Development.* (Cambridge, Mass.: Centre for the Study of Development and Social Change, 1971).

Gow, Lindsay J.A. *Report of the Sustainable Management Task Group: The Concept of Sustainable Management of the Environment* (Wellington: Ministry for the Environment, 1992).

Grant, A.P. "Hawkes Bay flood, April 1938." *Proceedings of the New Zealand Institute of Engineers* 25 (1938-39):55-64.

Grant, P.J. "Climate, erosion and vegetation." *New Zealand Journal of Ecology* 12 Supplement (1989):131-144.

Griliches, Z. "Hybrid corn: An exploration in the economics of technical change." *Econometrica* 1957, 25:501-522.

___ "Hybrid corn and the economics of innovation." *Science* 1960, 132:275-280.

Hall, J.R.deZ. "Water Control Works in the Gisborne East Coast Region." *Soil and Water* June (1977):12-13.

Hannam, Ian. "Pursuing Sustainable Development: Soil Conservation in New South Wales." *Australian Journal of Soil and Water Conservation* 3 (May 1990):13-19.

Hardin, Garrett "The tragedy of the commons" reprinted in Herman E. Daly and Kenneth N. Townsend (ed.s), *Valuing the Earth - Economics, Ecology, Ethics* (Cambridge, Massachusetts: MIT Press, 1993a):127-143.

Haystead, A. Organic farming survey." *Soil and Health* 14 (1987):8-12.

Hayward, John A. "Where to from here? Competitive markets and conservation" *Soil and Water* 3 (1986):2-4.

___ "Social dimensions of sustainability" in Ralph E.H. Sims (ed.), *Moving Towards Sustainable Agriculture.* Proceedings of a Workshop, Massey University, 31 July to 1 August 1991. No page numbers.

Henderson, J.; and Ongley, M. *The Geology of the Gisborne and Whatatutu Subdivisions, Raukumara Division.* Bulletin No. 21, Geological Survey Branch, Department of Mines (1920).

Henriques, Paul (ed.). *Sustainable Land Management.* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991).

Herbert, John. *Comments on the East Coast Forestry Project.* Internal Forest Research Institute, Rotorua (1992).

Hicks, D.L. *Upstream Versus Downstream Damage during Large Storms: Some evidence from Cyclone Bola* Technical Record PN 1 (Aokautere: DSIR Soil Conservation Centre, 1989a).

___ *Storm Damage to Bush, Pasture and Forest: A comparison from Cyclone Bola* Technical Record PN 2 (Aokautere: DSIR Soil Conservation Centre, 1989b).

_ *Soil Conservation in the Waihora Catchment, East Coast: An assessment in the wake of Cyclone Bola* Technical Record PN 3 (Aokautere: DSIR Soil Conservation Centre, 1989c).

_ *Economic Impact of Farm Conservation of Hill Country: Some information from Cyclone Bola.* Technical Record PN 4 (Aokautere: DSIR Soil Conservation Centre, 1989d).

_ "Storm on a Hill." *Terra Nova* April (1991):51-52.

_ "Impact of soil conservation on storm damaged hill grazing lands in New Zealand." *Australian Journal of Soil and Water Conservation* 5.1(1992):34-40.

l, H. "Denudation as a Factor of Geological Time." *Transactions and Proceedings of the New Zealand Institute,* Volume XXVIII (1895).

lway, T. *Introduction to Research.* (Boston: Houghton Mifflin Company, 1965).

lmberg, J.; Bass, S.; and Timberlake, L. *Defending the Future - A Guide to Sustainable Development* (London: Earthscan, 1991).

rsley, Peter. "Intrinsic values and the law" *Terra Nova* April (1991):37-38.

_ "New Zealand's environmental reforms: innovative features and unresolved issues" in Ronnie Harding (ed.), *Ecopolitics V,* Proceedings of the Conference held at the University of New South Wales, Sydney, Australia, 4-7 April 1991:360-367.

warth, Richard B.; and Norgaard, Richard B. "Intergenerational resource rights, efficiency and social optimality." *Land Economics* 66, 1 (1990):1-11.

ıfschmidt, Maynard M.; James, David E.; Meister, Anton D.; Bower Blair T.; and Dixon, John A. *Environment, Natural Systems, and Development - An Economic Valuation Guide* (Baltimore: John Hopkins University Press, 1983).

ınter, G.G.; and Blaschke, P.M. *The New Zealand Land Resource Inventory Vegetation Cover Classification* Water and Soil Miscellaneous Publication No 101 (Wellington: National Water and Soil Conservation Authority, 1986).

erd, J.E., "Agriculture's search for sustainability and profitability." *Journal of Soil and Water Conservation* 45 (1990):18-23.

CN - International Union for the Conservation of Nature. *World Conservation Strategy* (Gland, Switzerland: IUCN, UNEP, WWF, 1980).

ckson, Kenneth E. "Forest policy and trade: the New Zealand experience" in John Dargavel, and Richard Tucker (ed.s), *Changing Pacific Forests: Changing Perspectives on the Forest Economy of the Pacific Basin* (Durham, North Carolina: Forest History Society, 1992):126-138.

Jackson, R.J. "Soil water content studies on mature *Pinus radiata* forest and recently clearfelled plots - Mangatu Forest." Forest Research Institute Contract Report (1987, unpubl.).

Jacobs, Michael. *The Green Economy - Environment, Sustainable Development and the Politics of the Future* (London: Pluto Press, 1991).

Jacobs, P.; and Munro, D.A. (ed.s), *Conservation with Equity: Strategies for Sustainable Development* (Cambridge: International Union for Conservation of Nature and Natural Resources, 1987)

Johnson, R.; and Sinner, J. "The road to Rio: reflections on the UNCED summit." *Papers presented at the Seventeenth Annual Conference of the New Zealand Branch of the Australian Agricultural Economics Society* (1992):125-132

Jones, K.L. "Polynesian settlement and horticulture in two river catchments of the Eastern North Island, New Zealand." *New Zealand Journal of Archaeology*, 8 (1986):5-32.

Kaplan, Paul F.; Fraser, S.; and Garret, E.M. *Social Aspects of Productivity: Hill-country Sheep and Beef Farms in the Mangamahu Valley.* Massey University, Department of Sociology (1988).

Kelliher, F.M.; Marden, M.; and Watson, A.J. *Stability of Land and Tree Planting Density, East Coast, North Island.* Forest Research Institute Contract Report: FWE 92/13 (1992).

Kelliher, F.M.; Whitehead, D.; and Pollock, D.S. "Rainfall interception by trees and slash in a young *Pinus radiata* D. Don stand." *Journal of Hydrology* 131 (1992):187-204.

Khosla, A. "Alternative strategies in achieving sustainable development" in P. Jacobs and D.A. Munro (ed.s), *Conservation with Equity: Strategies for Sustainable Development* (Cambridge: International Union for Conservation of Nature and Natural Resources, 1987):191-208.

Kuschel, G. (ed) *Biogeography and Ecology in New Zealand* (Den Hague: Dr W. Junk b.v., 1975).

Lambert, M.G.; Trustrum, N.A.; and Costall, D.A. "Effect of soil slip erosion of seasonally dry Wairarapa hill pastures." *New Zealand Journal of Agricultural Research* 27 (1984):57-64.

Leach, Brian. "Better farm productivity now widely seen as good for landcare in W.A." *Australian Journal of Soil and Water Conservation* 6 (Feb 1993):9-12.

Lélé, Sharachchandra M. "Sustainable development: a critical review." *World Development* 19, 6 (1991):607-621.

Leopold, A. *A Sand County Almanac* (New York: Oxford University Press, 1949).

ɜey, R.G.; and Lancaster, K. "The general theory of second best." *Review of Economic Studies* (1957).

kie, Stewart; and Martin, Peter. "The history of soil erosion in the Hunter Valley - lessons for other catchments." *Australian Journal of Soil and Water Conservation* 6 (Feb 1993):17-22.

ɡ, Norman. "From paradigm lost to paradigm regained" in N. Long and A. Long (eds) *Battlefields of Knowledge: The Interlocking of Theory and Practice in Social Research and Development* (London: Routledge, 1992):16-46.

vdermilk, W.C. "Conquest of the land through seven thousand years." *Agricultural Information Bulletin* 99, US Department of Agriculture SCS (1935).

vrance, Richard. "Research approaches for ecological sustainability." *Journal of Soil and Water Conservation* Jan/Feb (1990):51-54.

vrance, R.; Hendrix, P.F.; and Odum, E.P. "A hierarchical approach to sustainable agriculture." *American Journal of Alternative Agriculture* 1 (1986):169-173.

ɜkman, P.G.; and Thompson, R.C. *Monitoring and Evaluating the Effectiveness of Measures to Control Erosion in the East Cape Region, New Zealand. Part 1 - Description of site conditions and treatments'* DSIR Land Resources Technical Record 23, (November 1990a).

_*Monitoring and Evaluating the Effectiveness of Measures to Control Erosion in the East Cape Region, New Zealand. Part 2 - Knowledge Based Systems,* DSIR Land Resources Technical Record 24, (November 1990b).

_*Monitoring and Evaluating the Effectiveness of Measures to Control Erosion in the East Cape Region, New Zealand. Part 3 - Effectiveness Assessments.* DSIR Land Resources Technical Record 25, (November 1990c).

Caskill, L.W. *Hold this Land - A History of Soil Conservation in New Zealand* (Wellington: A.H. and A.W. Reed, 1973).

ɜClean, I. "The future for New Zealand agriculture: economic strategies for the 1980's." *Agricultural Strategy Paper No. 2.* Department of Agricultural Economics and Farm Management, Massey University (Wellington: New Zealand Planning Council, 1978).

ɜCormick, J. *The Global Environmental Movement* (London:Belhaven Press, 1989).

ɜFadgen, B.G. "Late Holocene Depositional Episodes in Coastal New Zealand." *New Zealand Journal of Ecology* 12 Supplement (1989):145-149.

ɜGlone, M.S. "The Polynesian settlement of New Zealand in relation to environmental and biotic changes." *New Zealand Journal of Ecology* 12 (1989, Supplement):115-129.

McIntosh, I.S. *An Analysis of the Land Development Encouragement Loan Scheme.* Research Paper No 2/81, Economics Division, Ministry of Agriculture and Fisheries (Wellington: MAF, 1981).

McMains, Harvey J. and Wilcox, Lyle. *Alternatives for Growth* (Cambridge, Massachusetts: Ballinger Publishing Company, 1978).

McWaters, Vivia. "Farm planning and landcare in N.E. Victoria." *Australian Journal of Soil and Water Conservation* 5 (May 1992):8-12.

Maiava, Susan. "A third paradigm: the emergence of populism as a philosophy of development." *AERDD Bulletin* 26 (March 1989):3-8.

Makin, Kevin; and Gillman, Campbell. *Regional Social Impact Review - East Cape* (Wellington: State Services Commission Social Impact Unit, 1987).

Marden, M. *East Coast forests - a special case.* Forest Research Institute Report (1989)

Marden, M.; Phillips, C.; and Rowan, Donna. "Declining soil loss with increasing age of plantation forests in the Uawa Catchment, East Coast Region, North Island, New Zealand" in Paul Henriques (ed.), *Sustainable Land Management.* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):358-361.

Marden, M.; and Rowan D. *Protective Value of Vegetation on Tertiary Terrain before and after Cyclone Bola, East Coast, North Island, New Zealand* unpublished report,Manaaki Whenua-Landcare Research, Gisborne (1989).

Markandya, A.; and Pearce, D. "Natural environments and the social rate of discount" in *Project Appraisal* 3 (1988).

Mazengarb, Colin; and Gregory, Geoff. "Mapping the East Coast's unstable foundations." *Terra Nova* April (1991):53-54.

Meister, A.D. "'More market', planning, forestry and farming: antagonism or symbiosis?" *New Zealand Forestry* May (1987):28-31.

Meister, A.D.; and Weber, J.A. "Encouraging sustainability in agriculture: institutional and measurement considerations." in Ralph E.H. Sims (ed.), *Moving Towards Sustainable Agriculture.* Proceedings of a Workshop, Massey University, 31 July to 1 August 1991. No page numbers.

Miller, R.C. "Paper presented to an environmental summit hosted by Gisborne District Council, 24 April 1990. Unpublished.

___ "Introduction to the Gisborne region" in Paul Henriques (ed.), *Sustainable Land Management.* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):489-492.

ıe, Christopher D.A. "Resource Management Act 1991" in Christopher D.A. Milne (ed.), *Handbook of Environmental Law* (Wellington: Royal Forest and Bird Protection Society, 1992):32-95.

ıe, Christopher D.A. (ed). *Handbook of Environmental Law* (Wellington: Royal Forest and Bird Protection Society, 1992).

ıstry for the Environment. *Report of the Sustainable Management Task Group: " The Concept of Sustainable Management of the Environment".* (Wellington: Ministry for the Environment, 1992).

istry of Agriculture and Fisheries (MAF). *The FARM Partnership - A Pilot Programme for Sustainable Land Management in Northern Hawkes Bay, Gisborne and East Cape* MAF Policy Paper 101. (Wellington: Ministry of Agriculture and Fisheries, 1990).

Sustainable Agriculture - A Policy Proposal MAF Policy Paper 106. (Wellington: Ministry of Agriculture and Fisheries, 1991).

Sustainable Agriculture MAF Policy Position Paper 1 (Wellington: Ministry of Agriculture and Fisheries, 1993).

istry of Forestry (MoF). *A Guide to the East Coast Forestry Project* (Wellington: Ministry of Forestry, 1992).

A Guide to the East Coast Forestry Project 1993 (Wellington: Ministry of Forestry, 1993).

The Forestry Sector in New Zealand (Wellington: Ministry of Forestry, 1993).

istry of Regional Development (MoRD). *Officials Committee Report: East Coast Project Review* (Wellington: Ministry of Regional Development, 1988).

ıistry of Works and Development (MoWD). *East Coast Planning Study: Forestry Development Options* (Wellington: Ministry of Works and Development, 1979).

East Coast Project Review (Wellington: Ministry of Works and Development Water and Soil Directorate, 1987).

han, E.J. *Introduction to Normative Economics* (New York: Oxford University Press, 1981)

ldenhauer, W.C., and Hudson, N.W. (ed.s). *Conservation Farming on Steeplands* (Ankeny, Iowa: Soil and Water Conservation Society and World Association of Soil and Water Conservation, 1988).

lloy, L.F.; and Forde, B.J. *Land Alone Endures: Land Use and the Role of Research* Department of Scientific and Industrial Research Discussion Paper No. 3 (Wellington: DSIR, 1980).

Moore, D.J. (ed.). *Catchment Management for Optimum Use of Land and Water Resources: Documents from an ESCAP Seminar. Part 2 - New Zealand Contributions.* Water and Soil Miscellaneous Publications No. 46. (Wellington: National Water and Soil Conservation Organization, 1982).

Moran, Warren. "The farm equity cycle and enterprise choice." *Geographical Analysis* 20,1 (1988):84-91.

Moran, Warren; Blunden, Greg; and Greenwood, Julie. "The role of family farming in agrarian change." *Progress in Human Geography* 17,1 (1993):22-42.

Morton, John. "How patient this star?" in *The Proceedings of Te Ara Tika - The Way Ahead*, a Christian Symposium on New Zealand's Future, sponsored by the Roman Catholic and Anglican Bishops of New Zealand, Wellington 1990: 77-87.

Murphy, Brian D. "Economic principles in land use allocation" in Anderson A. Grant (ed.), *The Land Our Future - Essays in Land Use and Conservation in New Zealand* (Auckland: Longman Paul, 1980):31-41.

Myers, Norman. "The future of forests" in Laurie Friday and Ronald Laskey (ed.s), *The Fragile Environment - The Darwin College Lectures* (Cambridge: Cambridge University Press, 1989).

Naess, Arne. *Ecology, Community and Lifestyle: outline of an ecosophy* (Cambridge: Cambridge University Press, 1989).

National Water and Soil Conservation Organisation (NWASCO). *Wise Land Use and Community Development - Report of Technical Committee of Inquiry into the Problems of the Poverty Bay - East Cape District of New Zealand* (Wellington: NWASCO, 1970).

___ "New Zealand Land Resource Inventory." *Streamland,* Bulletin No. 69 (1988).

Negus, Tim. "Community Landcare Technicians - The Untapped Human Resource." *Australian Journal of Soil and Water Conservation* 6 (Feb 1993):13-16.

Newsome, P.F.J. *The Vegetative Cover of New Zealand.* (Wellington: Ministry of Works and Development, 1987).

New Zealand Ecological Society. *Sustainability - A Statement by the New Zealand Ecological Society* (Christchurch: NZES, 1990).

Norgaard, Richard B. "Coevolutionary development potential." *Land Economics* 60 (1984):160-173.

___ "Environmental economics: An evolutionary critique and a plea for pluralism." *Journal of Environmental Economics and Management* 12 (1985):382-394.

___ "Thermodynamics and economic concepts as related to resource-use policies: synthesis." *Land Economics* 62 (1986).

_"Sustainability: the paradigmatic challenge to agricultural economics" in G.H. Peters and B.F. Stanton (ed.s), *Sustainable Agricultural Development: The Role of International Co-operation* (Aldershot: Dartmouth, 1992):92-101.

_*Development Betrayed: The End of Progress and the Coevolutionary Revisioning of the Future* (London: Routledge, 1994).

wak, Peter J. "The adoption of agricultural conservation technologies: economic and diffusion explanations." *Rural Sociology* 52.2 (1987):208-220.

kley, P.; and Marsden, D. *Approaches to Participation in Rural Development* (Geneva: ILO, 1984).

Conner, Martin. "On sacred cows and the roles of the economist." *Economics of Institutional Change with Particular Reference to the Management of Natural Resources*. Papers presented to a workshop held at Lincoln College, 10 February 1989 (Wellington: Ministry for the Environment 1991):31-65.

Loughlin, C. "The effect of timber removal on the stability of forest soils." *New Zealand Journal of Hydrology* 13.2 (1974):121-134.

Loughlin, C. "Forest land use and its contribution to and control of erosion examples from New Zealand and Malaysia." *Catchment Management for Optimum Use of Lnad and Water Resources: Documents from an ESCAP Seminar. Part 2 - New Zealand Contributions.* Water and Soil miscellaneous publication No.46 (1982):327-340.

Loughlin, C.L.; Rowe, L.K.; and Pearce, A.J. "Exceptional storm influences on slope erosion and sediment yield in small forested catchments, North Westland, New Zealand." In E.M. O'Loughlin and L.J. Bren (ed.s), *The First National Symposium on Forest Hydrology, Melbourne, Australia,* The Institution of Engineers, Australia, National Conference Publication No. 82/6 (1992):84-91.

Loughlin, C.; and Watson, A.J. "Root-wood strength deterioration in radiata pine after clearfelling." *New Zealand Journal of Forestry Science* 9 (1979):284-293.

Loughlin, C.; and Ziemer, R.R. "The importance of root strecgth and deterioration rates upon edaphic stability in steepland forests" in R.H. Waring (ed.), *Carbon Uptake and Allocation in Subalpine Ecosystems as a Key to Management.* (Corvallis, Oregon: IUFRO, 1982):70-78.

Neil, Paul. *The Land Development Encouragement Loan Scheme.* Research Report 80/2, Rural Banking and Finance Corporation (Wellington: RBFC, 1980).

Riordan, Timothy J. *Environmentalism* (London: Pion Limited, 1981).

_"The politics of sustainability." in R. Kerry Turner (ed.), *Sustainable Environmental Management,* (Boulder CO: Westview Press, 1988):29-50.

Oliver, William Hosking. *Challenge and Response: a study of the development of the Gisborne East Coast Region* (Gisborne: East Coast Development Research Association, 1971).

Orwin, Joanna. "Forestry: sustaining the land." *Terra Nova* June (1991):34-35.

___ "Closed canopy culture." *NZ Forest Industries* July (1993):42-43.

Page, Talbot. "Sustainability and the problem of valuation." in Robert Costanza (ed.), *Ecological Economics: The Science and Management of Sustainability* (New York: Columbia University Press, 1991):58-74.

Parliamentary Commissioner for the Environment. *Gisborne District Council Environmental Management: A Systems and Processes Review* (Wellington: Parliamentary Commissioner for the Environment, 1990).

Paxton, George K. "Do we have a moral obligation to practice a sustainable agriculture?" *Journal of Sustainable Agriculture* 1 (1990):81-96.

Park, G. "Natures forests and the long-term economy of the farm" in Paul Henriques (ed.), *Sustainable Land Management.* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):332-335.

Peacock, Dave. "Hill country hopes." *Terra Nova,* December (1990):43-44.

Pearce, A.J.; Black, R.D.; and Nelson, C.S. "Lithologic and weathering influences on slope form and process, Eastern Raukumara Range, New Zealand." International Association of Hydrological Sciences Publication No. 132 (1981):95-122.

Pearce, A.J.; O'Loughlin, C.L.; Jackson, R.J.; and Zhang, X.B. "Reforestation: on-site effects on hydrology and erosion, eastern Raukumara Range, New Zealand." *Forest Hydrology and Watershed Management.* Proceedings of the Vancouver Symposium, August 1987. pp. 489-497.

Pearce, David (ed) *Blueprint 2 - Greening the World Economy* (London: Earthscan, 1991).

Pearce, David; Markandya, Anil; and Barbier, Edward B. *Blueprint for a Green Economy* (London: Earthscan, 1989).

Pearce, David W.; and Turner, R Kerry. *Economics of Natural Resources and the Environment* (Hertfordshire: Harvester Wheatsheaf, 1990).

Pearson, R.Grant; and Corbet, Phillip S. "Efficiency in New Zealand Agriculture" in Anderson A. Grant (ed.), *The Land Our Future - Essays in Land Use and Conservation in New Zealand* (Auckland: Longman Paul, 1980):149-164.

Peet, John. *Energy and the Ecological Economics of Sustainability* (Washington: Island Press, 1992).

:t, John; and Gray, Don. "Efficiency." *Environment meets economics: 1986 Debate Series* (Wellington: Environmental Council and Ministry for the Environment, 1987):21-28.

llips, C.; Marden, M.; and Pearce, A.J. "Effectiveness of reforestation in prevention and control of landsliding during large cyclonic storms." *Proceedings of XIX IUFRO Conference,* Montreal, Canada, August 1990:340-349.

nter, Brian A. (ed.) *Sustainable Integrated Rural Development: Defining and Modelling.* Proceedings of the First Regional Workshop of the ASEAN - New Zealand Inter-Institutional Linkages Programme, Serdang, Malaysia (1991).

_ "Sustainability, subject to preference and community." in Ralph E.H. Sims (ed.), *Moving Towards Sustainable Agriculture.* Proceedings of a Workshop, Massey University, 31 July to 1 August 1991. No page numbers.

ole, A.L. *Forestry in New Zealand* (Auckland: Hodder and Stoughton Ltd, 1969).

_ *Catchment Control in New Zealand* (Wellington: National Water and Soil Conservation Organisation, 1983).

verty Bay Catchment Board (PBCB). *Report on Land Use Planning and Development Study* (Gisborne: Poverty Bay Catchment Board, 1978).

octer, R. "Treasury may bring the market to town planning." *National Business Review* April 18 (1986).

ijk, Roel. "Agricultural adaptations in a Bas-Languedoc village." *Sociologia Ruralis* 14,2 (1984):133-148.

iiggan, John. "Land degradation: behavioural causes" in A. Chisolm and R. Dumsday (ed.s), *Land Degradation: Problems and Policies* (Cambridge: Cambridge University Press, 1987):203-212.

indall, Alan. *Resource Economics 2nd Edition. An Economic Approach to Natural Resource and Environmental Policy* (New York: John Wiley and Son, 1987).

ipson, G.L. Flora of New Zealand - Vegetation of New Zealand, Book 2 (Massey University: Department of Ecology, 1992).

isch, G. *Wildlife and Wildlife Habitat in the East Cape Region.* Department of Conservation Regional Report Series Number 12. (Rotorua: Department of Conservation, 1989).

ees, William E. "The ecology of sustainable development." *The Ecologist* 20.1 (1990):18-23.

eeve, I. and Kaine, G. "Ecosystem-coupled markets: A policy approach for sustainable land management" in Paul Henriques (ed.), *Sustainable Land Management,* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):227-234.

Repetto, Robert. *The Global Possible* (New Haven: Yale University Press, 1986).

___ *World Enough and Time - Successful Strategies for Resource Management* (New Haven: Yale University Press, 1986).

Reynolds, Russ and Moore, Walter. "Sustainable resource use: a challenge for agriculture" Paper presented to *Annual Conference of the New Zealand Branch - Australian Agricultural Economics Society,* Blenheim 29-30 June 1990:1-14.

Rhoades, R.E. *Evolution of Agriculutral Research and Development since 1950: Toward and Integrated Framework.* (London: IIED, 1989).

Ristson, C. *Agricultural Economics: Principles and Policies* (London: Crosby Lockwood Staples).

Rickson, R.; Saffigna, P.; Vanclay, F.; and McTainsh, G. "Social bases of farmers' responses to land degradation" in A. Chisolm and R. Dumsday (ed.s), *Land Degradation: Problems and Policies* (Cambridge: Cambridge University Press, 1987):187-200.

Robertson, Graeme. "Community involvement in land conservation - the Western Australian experience." *Australian Journal of Soil and Water Conservation* 2 (1989):19-23.

Roche, M.M. "The New Zealand timber economy, 1840-1935." *Journal of Historical Geography* 16 (1990):295-313.

Roche, Micheal M. "Privatizing the exotic forest estate: the New Zealand experience" in John Dargavel and Richard Tucker (ed.s), *Changing Pacific Forests: Changing Perspectives on the Forest Economy of the Pacific Basin* (Durham, North Carolina: Forest History Society, 1992):139-154.

Roche, M.M.; and Hodder, R. (ed.s). *Social and Economic Perspectives of Forestry and Agroforestry.* Proceedings of the Forestry Section of the 56th ANZAAS Congress (Palmerston North: New Zealand Forest Service, 1987).

Salmon, Guy; and Blakely, Roger. "Balance." *Environment meets economics: 1986 Debate Series* (Wellington: Environmental Council and Ministry for the Environment, 1987):29-35.

Salmon, J.T. "The influence of man on the biota." in G. Kuschel (ed.), *Biogeography and Ecology in New Zealand* (Den Hague: Dr W. Junk b.v., 1975).

Samuelson, Paul and Nordhaus, William. *Economics.* 12th Edition (New York: McGraw Hill, 1985).

Seckler, David. "Economic costs and benefits of soil and water conservation programmes." in P. Blaikie and H. Brookfield (ed.s), *Land Degradation and Society* (London: Methuen, 1987):84-96.

s, D and Joy, L. (eds) *Development in a Divided World* (Middlesex: Penguin, 1971).

olin, C. "L'absorption de l'agriculture dans le mode de production capitaliste" in M.C. Tavernier, C. Gervais and C. Servolin (ed.s), *L 'Univers Politique des Paysans* (Paris: Armand Colin, 1972).

ey, K. for Planning and Development Committee. *Report of the Planning and Development Committee. Inquiry into Planning for Flood Mitigation* (Wellington: Government Printer, 1989).

;, Ralph E.H. (ed.). *Moving Towards Sustainable Agriculture*, Proceedings of a Workshop, Massey University, July 31-August 1 (1991).

ɔn, Julian, and Kahn, Herman *The Resourceful Earth - A Response to Global 2000* (Oxford: Basil Blackwell, 1984).

ɔson, P. "Sustaining genetic integrity through restoration using local plant provenances" in Paul Henriques (ed.), *Sustainable Land Management.* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):336-346.

ɔson, Phillip. "Sowing the Seed at Tairawhiti." *Terra Nova* June (1991):36-37.

h, Kevin. "Protection." *Forest & Bird* (August 1993):17-21.

ɛrbaum, Peter. "Economics, environment and land use policy." *Ceres 115 - The FAO Review* 20.1 (1987):15-20.

ngett, Jo. "Converting Darth Vader" *Terra Nova* March (1991):23-24.

l, Kevin W. "Sustainable agriculture: a rural resource user?" in Ralph E.H. Sims (ed.), *Moving Towards Sustainable Agriculture.* Proceedings of a Workshop, Massey University, 31 July to 1 August 1991. No page numbers.

"Achieving sustainable resource use in the rural sector: directions for the future" in Paul Henriques (ed.), *Sustainable Land Management,* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):207-211.

ens, Robert D. and Jabara, Cathy L. *Agricultural Development Principles: Economic Theory and Empirical Evidence* (Baltimore: John Hopkins University Press, 1988).

on, J. "The political economy of sustainable land use" in Paul Henriques (ed.), *Sustainable Land Management.* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):314-317.

ıffield, S.R. "Transitional design" in Paul Henriques (ed.), *Sustainable Land Management,* Proceedings of International Conference on Sustainable Land Management, Napier, New Zealand (1991):318-322.

Tavernier, M.C., Gervais, C. and Servolin, C. (ed.s). *L'Univers Politique des Paysans* (Paris: Armand Colin, 1972).

Thornton, O.G. "Extraordinary flood discharges in some streams near Gisborne on 19th February 1938." *Proceedings of the New Zealand Society of Civil Engineers* 25 (1938-39):65-72.

Tietenberg, Tom. *Environment and Natural Resource Economics 3rd Edition*, (New York: Harper Collins, 1992).

Todaro, Michael P. *Economic Developement in the Third World - Fourth Edition* (Essex: Longman Group UK Ltd., 1992).

Trotter, Craig. "Cyclone Bola: The inevitable disaster." *New Zealand Engineering* July (1988):13-16.

Trustrum, N.A., Blaschke, P.M., DeRose, R.C., and West, A.W. *Regolith Changes and Pastoral Productivity Declines following Deforestation in Steeplands of North Island, New Zealand.* Transaction of the 14th International Soil Science Congress, Kyoto, Japan, August 1990. Section I:125-130.

Trustrum, N.A., and Page, M.J. *An Assessment of Sustainable Land Use in a Region Subject to Subtropical Cyclones: The Aftermath of Cyclone Bola in the Tutira Area* Research Project Plan and Discussion Document. (Aokautere: DSIR Soil Conservation Centre, 1988).

Turner, B.L. and Meyer, W.B. "Land use and land cover in global environmental change: considerations for study." *International Social Science Journal* 130 (1991):669-680.

Turner, R.K. "Sustainability, resource conservation and pollution control." in R.Kerry Turner (ed.), *Sustainable Environmental Management* (Boulder CO: Westview Press, 1988):5-29.

United Nations Development Programme (UNDP). *Human Development Report 1991* (New York: Oxford Undiversity Press, 1991).

United Nations Environment Programme (UNEP). *State of the Environment 1991* (United Nations, 1991)

Valentine, Ian. "Sustainability in agriculture." in Ralph E.H. Sims (ed.), *Moving Towards Sustainable Agriculture.* Proceedings of a Workshop, Massey University, 31 July to 1 August 1991. No page numbers.

Varnes, D.J. "Slope movement types and processes." in R.I. Shuster and R.J. Krizek (ed.s), *Landslides: Analysis and Control Special Report 176* Transportation Research Board, National Acadamy of Sciences, Washington D.C. (1978).

Vine, Ronald. "Blue line country (1)." *New Zealand Farmer,* 9 April (1970a):4-7.

_ "Blue line country (2): The land and its problems." *New Zealand Farmer,* 23 April (1970b):11-14.

_ "Blue line country (3): Trees or trees plus grass?" *New Zealand Farmer,* 13 May (1970c):11-15.

ılsh, A.Crosbie (ed). *Development that Works! Lessons from Asia-Pacific* Monograph No. 3, Development Studies, Massey University (1993).

ılton, Trevor. "East Coast futures." *New Zealand Journal of Agriculture* 122,1 (1971):39-47.

ırd, J.C., and Beanland R. *Contributions to a National Set of Environmental Indicators to be Monitored at a Regional Level.* Information Paper No 36, Centre for Resource Management, Lincoln University (1992).

ıring, R.H. (ed.) *Carbon Uptake and Allocation in Subalpine Ecosystems as a Key to Management.* (Corvallis, Oregon: IUFRO, 1982).

ırren, Bill. *Imperialism: Pioneer of Capitalism.* (London: NLB and Verso, 1980).

ıtts, Muriel. "What have we done to the land?" *Greenpeace* 1991:6-8.

_ *Ecological Agriculture in New Zealand.* Greenpeace submission to Ministry of Agriculture and Fisheries on MAF Policy Paper 106, (1991).

ɔbber, D., Rivers, M.J., Buchan, D., and Rayner, T. for MAF Policy. *Cyclone Bola: Agricultural Assistance Scheme: Social and Economic Impact Study.* MAF Policy Technical Paper 90/1, (Wellington: MAF Policy, 1989).

ɔber, J.A., and Meister, A.D. "Managing natural resources, institutional change and sustainability in New Zealand." *Strategies for Agriculture in the 1990s* Agricultural Policy Proceedings No. 15, Centre for Agricultural Policy Studies, Massey University (1990).

ɔbster, Andrew. *Introduction to the Sociology of Development - Second Edition* (Hampshire: Macmillan Education Ltd., 1990)

hitehead D., and Kelliher, F.M. "Modelling the water balance of a small *Pinus radiata* catchment." *Tree Physiology* 9 (1991):77-33.

illiams, Paul. "From forest to suburb: the hydrological impact of man in New Zealand" in Anderson A. Grant (ed.), *The Land Our Future - Essays in Land Use and Conservation in New Zealand* (Auckland: Longman Paul, 1980):103-124.

orking Party on Sustainable Land Management. *South Island High Country Review* (April 1994).

orld Commission on Environment and Development (WCED). *Our Common Future* (Oxford University Press, 1987).

World Resources Institute and International Institute for Environment and Development, *World Resources: 1988-1989* (New York: Basic Books, 1988)

Yapp, T. "The costs of degradation to the community: issues and estimates." *Australian Journal of Soil and Water Conservation* 2,3 (August 1989):32-36.

Young, David. "Wes Jackson: Genetic Philosopher." *Terra Nova* March (1991):30-31.

___ "Spirit of place." *Terra Nova* December (1990):40-42.