detailed analysis of the relation between the site index values and environmental parameters in the NZLRI could be a fertile source of information, complementing more detailed studies such as those by Hunter and Gibson 1984.

TABLE 3: Areas in the North and South Island requiring erosion control forestry

SITE INDEX m	NORTH ISLAND Area (ha)	% of the site index group	SOUTH ISLAND Area (ha)	% of the site index group
>29	1,860,400	31%	—	
25-29	281,600	10%	344,400	38%
20-24	362,200	35%	284,300	7%
15-20			47,200	2%
	98,800	70%		
<15			300,200	23%
	2,603,000		976,100	

Acknowledgements

Acknowledgement is made to members of the NZLRI mapping team who prepared the database, especially to M. Page and G. Hunter who correlated the North and South Island data, foresters of the New Zealand Forest Service who provided the site index data and to L. Rowan who provided the computer analyses.

REFERENCES

Fletcher, J.R. 1981: Land Use Capability Extended Legend of the Taranaki-Manawatu Region. New Zealand Land Resource Inventory, 1:63,360. National Water and Soil Conservation Organisation, Wellington, New Zealand.

Hunter, I.R.; Gibson, A.R. 1984: Predicting *Pinus radiata* Site Index from Environmental variables. New Zealand Journal of Forestry Science 14(1): 53-64.

King Country Land Use Study 1978: Technical reports. Department of Lands and Survey, Land Use Series No 3.

Kirkland, A. 1981: Needs and Opportunities for Future Planting. New Zealand Forestry Conference, Wellington. 41 pp.

Mountfort, C.J. 1979: *Pinus radiata* site index/altitudinal relationship for forests established on pumice soil. *In*: Elliot, D.A. (ed) "Mensuration for Management Planning of Exotic Forest Plantations". FRI Symposium No. 20, NZ Forest Service 1979, p. 217-226.

National Water and Soil Conservation Authority, 1975-79: New Zealand Land Resource Inventory Worksheets, 1:63,360. National Water and Soil Conservation Organisation, Wellington.

Noble, K.E. 1985: Land Use Capability Classification of the Southern Hawkes Bay-Wairarapa Region: A Bulletin to accompany New Zealand Land Resource Inventory Worksheets. Water and Soil Miscellaneous Publication No. 74, 127 pp.

Soil Conservation and Rivers Control Council, 1971: Land Use Capability Survey Handbook (2nd Edition). Ministry of Works and Development, Wellington, New Zealand.

Page, M.J. 1985: Correlation of North Island regional LUC units from the New Zealand Land Resources Inventory. Water and Soil Miscellaneous Publication No. 75, 108 pp.

Discount rates and forestry decisions

Jeanette Fitzsimons

ABSTRACT

Net Present Value analysis, also known as Cost-Benefit analysis, has serious deficiencies as a framework for decision-making in forestry. It is argued that high discount rates do not reflect true social time preferences and lead to resource waste and disregard for the future. The principles of sustainability, end-use needs, and cultural and spiritual values are suggested as more useful, and neglected, tools in planning projects with very long-term implications.

Economists have been telling me all my life that things I want to see accomplished, and which are generally agreed to be useful, are "not economic". I have reached the conclusion that if a project obviously makes sense in terms of resources, energy and human effort, and is "not economic", then it is the economic analysis which is wrong. I do not wish to argue for a discount rate of 10%, 5%, or 2% — but for a wider frame of reference and different criteria for making decisions.

Economics makes assumptions which are not always true in the real world, and which can lead to bad decisions. Some of them are:

- Price reflects value to society. This is now rarely true, in a world of constant government intervention in the market, manipulation of consumers by advertising, and the transition from a "free" resource provided by nature (virgin forests) to a planted one.
- Benefits which cannot be quantified are often acknowledged but must be left out of any numerical calculation. To include them in the criteria for decision making involves balancing a mix of precise numbers from the economic analysis with the qualitative analysis of other aspects. There is no scientific way of approaching this balancing.

"We need a broader definition of wealth, which includes the biological, social and cultural wealth on which economic wealth is based. These are fundamental not just to quality of life, but to survival. They will eventually have enormous economic effects, but in the meantime, economics cannot measure them."

- Economics cannot deal with absolutes. It assumes everything has a replacement price, which is simply not true of the most fundamental resources in a finite world.
- It assumes the reason for forestry is to make money for the investors rather than to ensure a supply of appropriate timbers for the future.

We need a broader definition of wealth, which includes the biological, social and cultural wealth on which economic

The author, Jeanette Fitzsimons, tutors part-time in Environmental Studies at Auckland University, researches and writes on matters relating to Energy and the Environment, and grows special-purpose timbers which will probably not mature until after she is dead. This paper was originally prepared for a Forest Research Institute seminar in Rotorua in 1982.

wealth is based. These are fundamental not just to quality of life, but to survival. They will eventually have enormous economic effects, but in the meantime, economics cannot measure them.

What does a high discount rate tell us about social values?

— We are more important than our children, but of much less value than our grandparents. Does anyone really believe this? (Fortunately our grandparents did not apply this logic to us.)

— Discounting leads to design for early obsolescence, minimum durability, and therefore a waste of materials and energy. It leads to decisions like the recent abandonment of the Auckland trolley bus order, in favour of diesels with a lower capital cost but half the lifetime. Because the capital cost was amortised over the first 12 years in both cases, the extra 18 years which the trolleys would last had no effect on the analysis.

— It leads to the devaluing of old things — our society already tends to be contemptuous of old buildings, machinery, technology, ideas, people.

"People do not usually act to maximise financial return. They do not buy the cheapest car capable of getting them where they need to go, or the most fuel-efficient. If people were strongly influenced by short-term financial return they would not have children — at least from choice."

— A high discount rate does not reflect *real* personal values. It is common to say the *social* time perference is longer than the individual. But it is usual for people in our society to save, even to sacrifice, for the benefit of their children, even if they do not live to see the benefits. This means *either* collective social values are *more* short-sighted than personal ones, and we are happy to live with the contradiction, *or* that those setting policy are out of step with the real values of society.

People do not usually act to maximise financial return. They do not buy the cheapest car capable of getting them where they need to go, or the most fuel-efficient. If people were strongly influenced by short-term financial return they would not have children — at least from choice.

Economic implications of using discounting

1. Calculations of net present value for forestry projects result in a series of very precise numbers. This generates a confidence which is quite misplaced, as the numbers may be very precise but not at all accurate. The margin of error in the basic numbers fed in to such a calculation may be greater than the differences in NPV.

   To achieve results such as are shown in Table 2, we must work with data like Table 1. The fact is, we do not know what the relative prices of pine and kauri will be in 80 years, and we do not know what the various management operations will cost. To be accurate in these numbers we would need to know the future relativities between capital, energy and labour inputs; future developments in technology; new diseases, new chemicals, and changes in cost of existing ones; changes in overseas markets, including the effect on our trade of a war in the Northern Hemisphere; the future direction of the New Zealand economy, and therefore the local demand for raw materials. We must not allow exact economic analysis, producing precise numbers, to obscure the fact that we are only making value judgements anyway.

   The further into the future the costs and benefits occur, the greater their uncertainty. This encourages short payback projects, where uncertainty is less, and could be used as an argument for high discount rates. However, another approach to uncertainty would be to increase diversity and flexibility, avoiding putting all our eggs in one basket. Countless stable and long-lived ecosystems prove the principle that diversity gives strength.
2. Whether one approaches the problem of setting the discount rate via social time preference or opportunity costs of capital, it should surely have *some* relationship to interest rates, as both are expressions of the same social expectation. Real interest rates have been unusually high during 1985, but are not usually sustained at 10% above the inflation rate. If there are private firms which consistently make 10% real, one needs to ask to what extent this is

TABLE 1: Operations and costs in radiata pine and kauri management (from Barton and Horgan, 1980)

Operation	*Years Carried Out*	*Per Time Cost of Operation ($/ha)*
RADIATA PINE		
Site preparation	0, 26, 52	252
Planting, fertilizing, releasing	1, 27, 53	207
Aerial chemical release	2, 28, 54	35
Dothistroma pini spray	3, 29, 55	15
Thin to 750 stems/ha. Prune 0-2 m	5, 31, 57	240
Prune 2-4 m. *D. pini* spray	7, 33, 59	125
Thin to 300 stems/ha (waste)	8, 34, 60	85
Prune 4-6 m.	9, 35, 61	90
Aerial fertilizer	10, 36, 62	113
Annual charges	1-76	54
Returns: 629 m^3 sawlogs at $15/$m^3$	25, 51, 77	9435
47 m^3 pulpwood at $2.85/$m^3$		134
KAURI		
Site preparation	0	100
Planting	1	400
Releasing and fertilizing	1-2	130
Releasing	3	75
Releasing	5	75
Thinning/releasing	20	100
Aerial fertilizer	40	120
Release regeneration	45	75
Annual charges	1-79	60
Returns: 200 m^3 at $60/$m^3$		12 000

TABLE 2: Discounted returns ($/ha) for radiata pine and kauri plantations (from Barton and Horgan, 1980)

Forest	*Discount Rate 2*	*4*	*6*	*8*	*10*
Kauri:					
Costs	3 272	2 249	1 750	1 470	1 292
Return	2 511	541	120	27	6
Net return	-761	-1 708	-1 630	-1 443	-1 286
Pine:					
Costs	4 062	2 704	2 029	1 653	1 408
Return	11 337	5 320	2 811	1 593	958
Net return	7 275	2 616	782	-60	-450

achieved by subsidies from the public sector. Beyond the short term, interest rates on fixed-term deposits tend to *decrease* for longer periods. The opportunity cost of investment is rarely, for most investors, anything like 10% real.

3. Discounting emphasizes the return on capital, but capital is not the only input. Net energy yield or return per hectare of land might well be more important if one took a resource management approach.
4. The narrow framework of this kind of analysis may ignore other economic constraints. Thus discounting favours growing pine for as many uses as possible, rather than hardwoods. Huge quantities of pine fence posts are produced, requiring the addition of more than their own value in imported, non-renewable metals. Discounting may make the growing of ground-durable fence posts "uneconomic", but does the analysis include the effect on the New Zealand economy of importing a greater value of copper, chrome and arsenic?
5. Many other benefits of forestry are not valued, either because one cannot put a number on their $ value, or because the benefits occur too far into the future. These include soil and water protection, wildlife, cultural identity, the preservation of indigenous gene pools — and all of them will eventually matter *economically* as well as for other reasons.

"Net present value analysis is too simplistic to make long-term decisions. We need an infinitely more complex computer, capable of taking *all* factors into account. Fortunately the distinguishing mark of our species is that we have been endowed with just such a computer, and when it is working properly the print-out is called common sense."

What other possible decision-making frameworks are there?

NPV analysis is too simplistic to make long-term decisions. We need an infinitely more complex computer, capable of taking *all* factors into account. Fortunately the distinguishing mark of our species is that we have been endowed with just such a computer, and when it is working properly the print-out is called common sense.

A decision-making approach based on common sense or "need" would ask first:

1. What are we going to need wood for, and what sort of wood will be most suitable for these uses? How much, and of what sort, for house framing, furniture, turning, boat building, telegraph poles, fence posts, paper pulp, fuel? This would decide the mix of exotic and natives, hardwoods and softwoods.

   As Barton & Horgan (1980) point out, a finely built sideboard, made of pine and stained mahogany, is a bit like making coffee out of acorns!
2. Secondly, in what direction will/should (depending on whether one is predicting or planning) the New Zealand export industry develop? Small-scale, high-value processing of quality timbers, especially indigenous, for unique New Zealand products, minimising freight costs and competition from other countries? Or large-scale, lower value, lower skill, pulp, logs or timber, and high-powered marketing to persuade the rest of the world to be like us — eat lamb and butter and build in pine?
3. Thirdly, in what ways can a public forestry industry contribute to social wellbeing? Is its role limited to earning a profit for the taxpaying public, or can it also contribute by providing satisfying employment, regional development, and a varied landscape? One accepts that private forestry companies are formed for the purpose of making a profit on shareholders' funds, and that is their priority. But the Government represents all facets of society, not just its desire for profit. I don't expect my tax money to earn me a profit — I expect it to be used wisely to provide for social needs.

Another decision-making approach could be based on an *Ecological or Environmental Perspective.*

This viewpoint classifies resources as renewable or non-renewable, and management principles are based on achieving a sustainable yield of the first category, and minimising the throughput of the second. It also recognises the possibility of moving a resource from the renewable category into the non-renewable, by mismanagement, as has already happened with the Blue Whale, the Chatham Island rock lobster, and most native forests, with the possible exception of South Island beech. It can also happen to soil fertility and drinkable ground water, which are both irreplaceable on any timescale we can use.

From this viewpoint, soil is a fundamental, limited resource — *any* loss of quality or quantity leaves us permanently *impoverished*, regardless of how much money we have made out of exploiting it. From this perspective one could not *contemplate* discounting the future value of soil conservation. In fact an environmental perspective would suggest that discount rates should be *negative* when applied to conservation of a non-renewable or depleting resource. Maui gas will appreciate as future generations have to do without oil; clean water and virgin native forests will be more valued than now as they become more scarce (through pollution or logging) or the number of water-users or trampers grows; soil fertility will become more valuable in proportion as it is lost by erosion, urbanisation, or short-sighted farming (or forestry) practices. Negative interest rates are in fact accepted all the time by people involved with biological systems. Every time we harvest a crop and store it for the winter, knowing that some of it will rot or go mouldy, we accept that survival in the future is more important than feasting today.

A second environmental principle is matching quality to end-use. According to this principle, you don't use electricity or oil to warm water to temperatures that can be achieved by sunlight; nor do you use rimu for concrete boxing or other native woods you have no intention of replanting, for beer carton liners. As you can gather from these examples, this principle is "most honoured in the breach" in New Zealand.

A third principle is that environmentalism seeks ultimate causes and follows things through to ultimate destinations. It warns us we don't know much yet about the long-term effects on the soil of radiata pine, and that we know more about the sustainability of indigenous species than exotics. It doesn't regard the fence post question as finished when the pine is tanalised, but wonders about the ultimate destination of the copper, chrome and arsenic which will be in the environment for ever. Instead of blaming the disastrous famine in the Sahel a decade ago on a long-term drought cycle or overgrazing by stupid nomads, the ecological perspective traces it back to the planting of peanut cash crops many miles to the south, on the so-called "marginal" or "waste" land which had been the safety margin for the grazing herds in dry years.

Some say the environment *is* the economy, and all environmental degradation will show up eventually as economic loss. In the long-term this is true, but to deduce from it that the principles of economics, properly applied, can take care of the environment, is to ignore the short horizons of economics and the very long lead-times of environmental destruction. By the time depletion of ozone, marine pollution, or damage from persistent pesticides are having a recognisable effect on the economy, it is too late to stop the problem becoming much worse. The economics of logging

virgin forests are like the economics of whaling — it is always most profitable to exploit to extinction in order to maximise the return on capital while the machinery lasts, then to reinvest in another resource altogether. High discount rates will always favour killing the golden goose.

It is probable that sustained yield of native forests is unachievable as long as the discounting philosophy is widely held. Theoretically, the sustainable yield from anything but the simplest monoculture is difficult enough to establish. The techniques of actually extracting that yield without damaging the future yields, even by indirect means, are even more difficult. If those organising the logging believe in discounting the future, the chances that they will take adequate care to prevent damage to future trees, at greater present cost, are very slight. To let a discount rate — even a little one — anywhere near a forest one is trying to manage in perpetuity, is asking for trouble.

There is a third stand point, from which one can evaluate forestry decisions — a *Spiritual and Cultural Perspective.*

"We have used up a priceless resource, that has taken thousands of years to establish, in a little over 100 years. Most of it was burned, left to rot, or used for inappropriate purposes. We have a colossal *nerve* to evaluate the forests we leave the future, in terms of net *present* value!"

This is the least respectable approach to making decisions in our society, but I shall not attempt to justify it — one either shares it or one doesn't. The questions here are: do we have a right, as only one part of the web of life, to extinguish species and ecosystems which have taken millions of years to evolve; to replace exquisitely varied systems which exist nowhere else with monocultures from outside? To be more human-centred about it, do we care about our national identity as New Zealanders? Making and using things of indigenous timbers, and cultivating the trees from which they come, affirm our sense of place and local culture. So do the wildlife and understorey plants associated with NZ forests. Much of the richness and variety of local landscapes has been lost already to pasture, sheep and pines. Many people don't want to be part of a Coca Cola world where surroundings, products and experiences are the same in New York, Tokyo, Zaire and Rotorua.

We have used up a priceless resource, that has taken thousands of years to establish, in a little over 100 years. Most of it was burned, left to rot, or used for inappropriate purposes. We have a colossal *nerve* to evaluate the forests we leave the future, in terms of net *present* value!

To put that in an economics framework, let's look again at the cost-benefit analysis of kauri production forestry. The costs of establishing the next kauri forest are not really part of that project at all. They are part of the last one, which was profitable because it externalised the costs of re-establishing the forest after logging. It would perhaps be reasonable to regard the costs of the second rotation as starting at year 20, when thinning begins, in order to make the forest more suitable for fast timber production. The harvest then comes only 60 years away, and the costs of re-establishing the forest come between the years 60 and 80, when they are of little consequence if one is discounting the future.

This approach, of course, cannot be applied to exotic plantations, whether pine or hardwoods, because the forest must be planted in the first place, and is therefore a cost against the first rotation. However, if the point at which one enters the forestry cycle is with the inheritance of a mature forest, then it can be argued that the first generation of logging is only complete when the forest has been re-established.

Reference

Barton, I.L.; Horgan, G.P., 1980. Kauri forestry in New Zealand: A protagonists' view. New Zealand Journal of Forestry 25: 199-216.

Consultants recognised by the N.Z. Institute of Foresters

as at 1st July 1986

General Forest Consultants

Mr I.L. Barton	Hunua, R.D.3, Papakura. Auckland.
Mr K.C. Chandler	P.O. Box 2246, Rotorua.
Mr P.D. Clark	P.O. Box 1127, Rotorua.
Mr P.C. Crequer	P.O. Box 169, Taupo.
Mr W.J. Ellis	P.O. Box 169, Taupo.
Mr B. Everts	P.O. Box 13382, Christchurch.
Mr J.G. Groome	P.O. Box 13382, Christchurch.
Mr J.E. Henry	16 Oleander Point, Pakuranga, Auckland.
Mr J.E. Keating	P.O. Box 25-222, St Heliers, Auckland.
Mr A.T. Larsen	P.O. Box 7058, Wellesley Street, Auckland
Mr Ross Lockyer	P.O. Box 190, Kerikeri, Bay of Islands.
Mr R.S. Macarthur	The Grove, R.D. 1, Picton.
Mr W.K.J. McCallum	24 Huntley Ave, Grafton, Auckland.
Prof. P.J. McKelvey	9 St Clio Street, Christchurch.
Mr P.F. Olsen	P.O. Box 1127, Rotorua.
Mr A.I. Page	Tahere Farm, Pataua North Road, R.D. 5, Whangarei.
Mr J.G. Rawson	16 Wolfe Street, Whangarei.
Mr A.N. Sexton	2/170 King Edward Avenue, Bayswater, Takapuna, Auckland 9.
Mr J.J.K. Spiers	108 Iles Road, Rotorua.
Mr Ross Usmar	2/4 Pinehill Cres., Pinehill, Auckland 10.
Mr F.P. Wallis	P.O. Box 516, Gisborne.
Mr G.S. Watt	P.O. Box 1127, Rotorua.
Mr J.L. Wilson	P.O. Box 169, Taupo.

Specialist Forest Consultants — chosen field

Mr T. Fraser	Forest Valuations/Economics P.O. Box 2246, Rotorua.
Dr J.M. Harris	Timber Developments and Wood Science 12 Summervale Drive, Christchurch 8.
Mr P.W. Hyam	Export Market Development P.O. Box 29099, Christchurch 4.
Dr A.J. McQuire	Timber Processing and Utilization C/- Aspec Timber Services, P.O. Box 2004, Rotorua.
Mr W.J. Wendelken	Environmental Aspects and Land Use 206 Cockayne Road, Ngaio, Wellington.

General Forest Consultants are recognised as having a wide range of professional skills. Specialist Forest Consultants are recognised to practise in the area specified.

Application for Recognition as a General Forest Consultant:
Peter Allan Keach, 385 Childers Road, GISBORNE Location: New Zealand only.