CALCULATION OF CAPITAL CHARGES FOR SALINITY MANAGEMENT PLANS: QUESTIONS OF INTERGENERATIONAL EQUITY IN A RESOURCE MANAGEMENT SETTING. [1*]

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Four methods of calculating capital financing charges are compared. The suitability of the different schedules of charges is discussed on the basis that the Benefit: Capital Charge ratio should be generally constant throughout the life of the project if each generation is to pay its fair share of resource management costs. In the case where the value of benefits remains fairly constant, it is shown that <u>Current Cost Accounting</u> methodology produces a schedule of charges that is inequitable as it requires early ratepayers to subsidise those in the future. This is particularly so where the benefit: cost ratio of the project is close to unity when in the critical initial stage of the project participants will find the implementation of the plan is unaffordable. <u>Interest and Sinking Fund</u> or an <u>Amortised Loan</u> repayment schedule are suitable methods where benefits are constant. Where resources are still degrading towards a point in the future when amelioration will be necessary, or if the value of benefits increases with time as may be the case in environmental projects, a program of <u>Serial Investments</u> may be appropriate.

The implementation of Salinity Management Plans will involve execution of projects spanning a periods of 30 to 50 years. The plans are the initial phase of sustainable resource management under the Victorian Government land and water management strategy *SALT ACTION: JOINT ACTION*. As the projects span more than one generation, an essential criterion for choosing an appropriate schedule of charges for financing capital works is intergenerational equity for rate payers.

[1*] The views expressed in this paper do not necessarily reflect the view of the Department of Agriculture, Victoria.

(A generation may be defined as one step in a continuous succession. For example, the life of a government, or the period of tenure authorising management or stewardship.) This criterion should apply whether the ratepayer is a landholder, local community member or general taxpayer involved in a cost sharing arrangement for implementation of a salinity management plan. Where there is a fairly constant stream of benefits generated by salinity management projects, as in the usual case, it is equitable to levy a generally constant schedule of real charges.

The examples calculated in this paper compare four different methods of scheduling interest and principal payments for a $1 million asset constructed at the beginning of a 30 year project life. The interest rate used in the comparison is 4% real.[2]

The schedule of interest and loan repayment instalments or sinking fund contributions is set out in Table I and graphed in figures 1, 2, 3 and 4. All methods used arrive at a stream of charges with a Net Present Value of $1 million. That is, all methods repay the loan and pay interest on monies outstanding. So the books are balanced in an accounting sense.

Comparison of Accounting Methods.

1. Rate of Return and Straight Line Depreciation. (Current Cost Accounting Methodclogy)[3]

Repayment is by equal annual instalments calculated by dividing the principal by the life of the loan.

Interest is charged on the principal outstanding. As the principle reduces with time , so do the interest payments.

2. Interest and Sinking Fund.

Repayment is made by equal annual contributions to a sinking fund[4] which will yield the full amount at the end of the loan period.

Interest is paid on the full amount of the loan over the life of the loan.

3. Amortized Loan.

Repayment is achieved by amortizing principal using the surplus of each equal annual instalment remaining after the payment of interest.

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[2] Accounting for inflation is a secondary operation necessary for setting nominal charges but is of no importance in this comparison.

[3] See Donnet (1982) for a description and example of Current Cost Accounting Methodology. As already stated inflation is of no importance in this comparison as it is made in constant dollar terms. What is important is the use of straight line depreciation as the basis for scheduling loan repayment and the resultant intertemporal inequality in interest charges.

[4] See Appendix VI in Chisholm and Dillon (1988).

Interest is charged on the principal outstanding.

Total annual charge is identical with Interest and Sinking Fund.

4. Interest and Serial Investment.

Repayment is facilitated by making an annual investment which, when compounded over the remaining period of the loan, will yield that year's share of principal.[5]

Interest is paid on the full amount of the loan over the life of the loan.

Interest and Sinking Fund (I&SF) is the only method which produces equal annual charges for both interest and principal. Rate of Return Straight Line Depreciation (ROR) loads interest payments toward the early part of the loan while Interest and Serial Investment (ISI) loads capital charges toward the end.

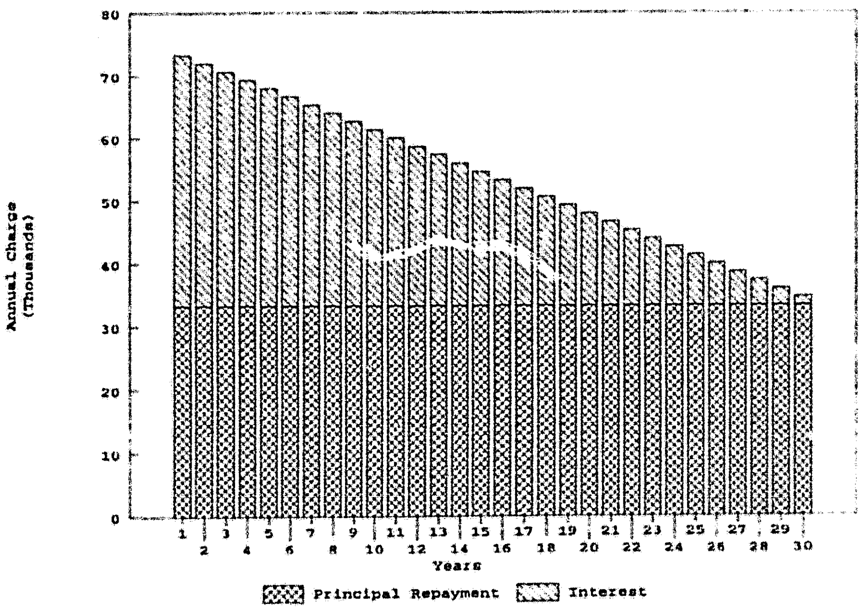

Figure 1: Schedule of interest and principal payments for a $1 million loan at 4% over 30 years using **Rate of Return and Straight Line Depreciation.**

[5] The amount to invest each year can be determined using Appendix II in Chisholm and Dillon.

Table I: Comparison of charging methods for capital costs for a $1 million project of 30 year life at a discount rate of 4%.

	RATE OF RETURN & STRAIGHT LINE DEPRECIATION		INTEREST AND SINKING FUND		AMORTIZED LOAN		INTEREST AND SERIAL INVESTMENT	
YEAR	INT	PRIN	INT	PRIN	INT	PRIN	INT	PRIN
1	40000	33333	40000	17830	40000	17830	40000	10688
2	38667	33333	40000	17830	39287	18543	40000	11116
3	37333	33333	40000	17830	38545	19285	40000	11561
4	36000	33333	40000	17830	37774	20056	40000	12023
5	34667	33333	40000	17830	36971	20859	40000	12504
6	33333	33333	40000	17830	36137	21693	40000	13004
7	32000	33333	40000	17830	35269	22561	40000	13524
8	30667	33333	40000	17830	34367	23463	40000	14065
9	29333	33333	40000	17830	33428	24402	40000	14628
10	28000	33333	40000	17830	32452	25378	40000	15213
11	26667	33333	40000	17830	31437	26393	40000	15821
12	25333	33333	40000	17830	30381	27449	40000	16454
13	24000	33333	40000	17830	29284	28547	40000	17112
14	22667	33333	40000	17830	28142	29688	40000	17797
15	21333	33333	40000	17830	26954	30876	40000	18509
16	20000	33333	40000	17830	25719	32111	40000	19249
17	18667	33333	40000	17830	24435	33395	40000	20019
18	17333	33333	40000	17830	23099	34731	40000	20820
19	16000	33333	40000	17830	21710	36121	40000	21653
20	14667	33333	40000	17830	20265	37565	40000	22519
21	13333	33333	40000	17830	18762	39068	40000	23420
22	12000	33333	40000	17830	17199	40631	40000	24356
23	10667	33333	40000	17830	15574	42256	40000	25331
24	9333	33333	40000	17830	13884	43946	40000	26344
25	8000	33333	40000	17830	12126	45704	40000	27398
26	6667	33333	40000	17830	10298	47532	40000	28493
27	5333	33333	40000	17830	8397	49433	40000	29633
28	4000	33333	40000	17830	6419	51411	40000	30819
29	2667	33333	40000	17830	4363	53467	40000	32051
30	1333	33333	40000	17830	2224	55606	40000	33333
SUM	620000	1000000	1200000	534903	734903	1000000	1200000	599457
TOTAL		1620000		1734903		1734903		1799457
NPV	423599	576401	691681	308319	485670	514330	691681	308319
TOTAL		1000000		1000000		1000000		1000000

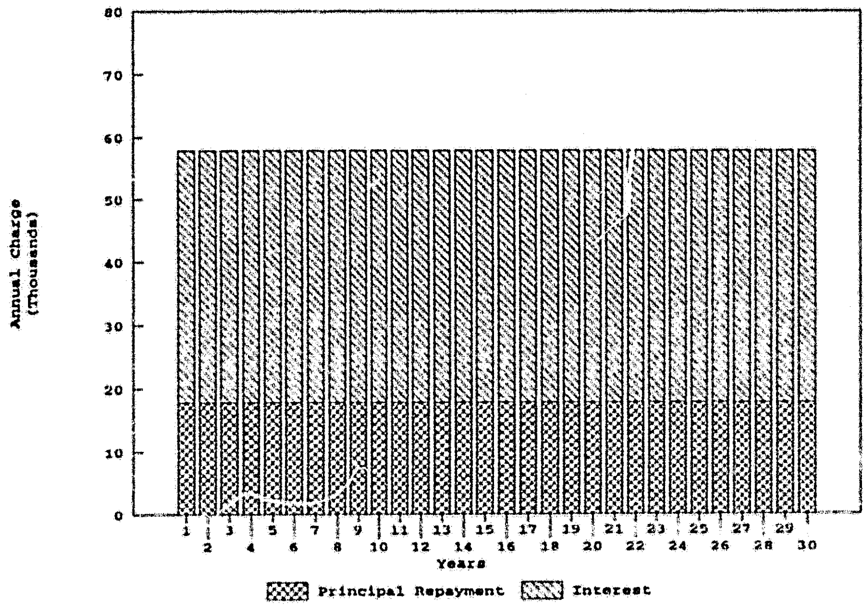

Figure 2: Schedule of interest and principal payments for a $1 million loan at 4% over 30 years using **Interest and Sinking Fund.**

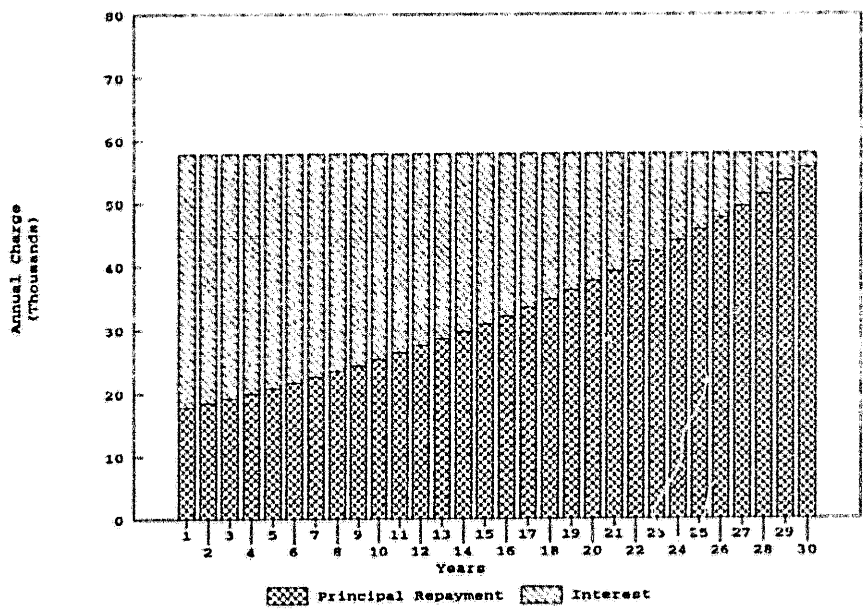

Figure 3: Interest and principal components of loan instalments for an **Amortized Loan** for $1 million at 4% over 30 years.

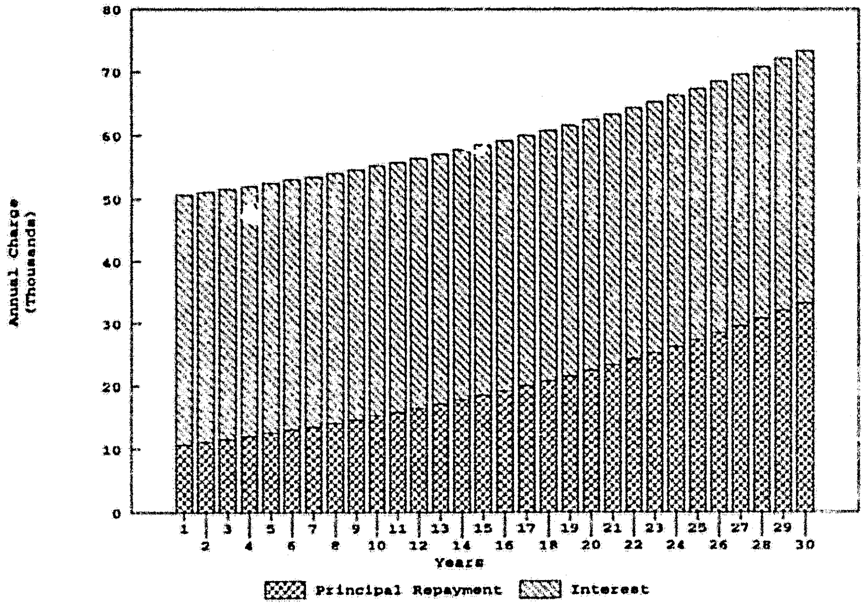

Figure 4: Schedule of interest and principal payments for a $1 million loan at 4% over 30 years using **Interest and Serial Investment.**

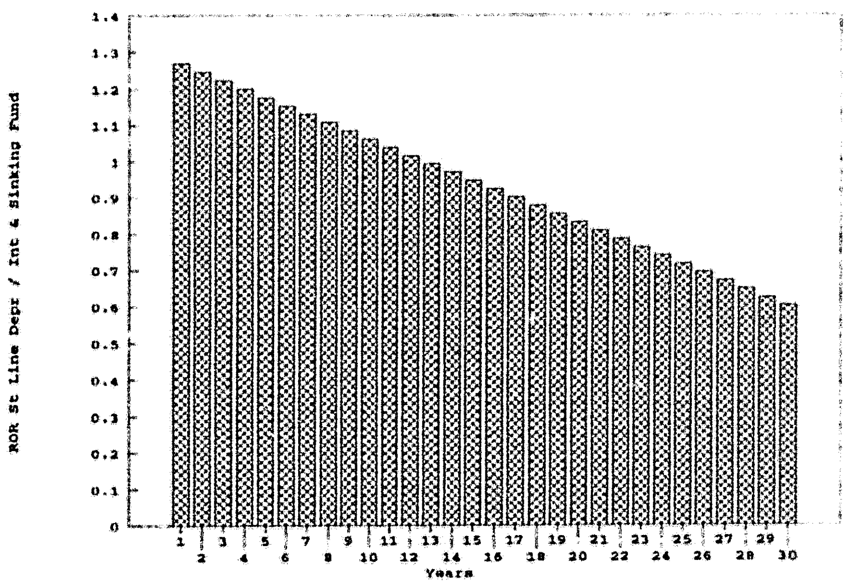

Figure 5: Ratio of charges calculated using ROR to charges calculated using I&SF.

Equity and Sustainability.

Using ROR the debt servicing commitment of the early generation of taxpayers is overstated to the degree illustrated in Figure 5. It is inequitable to expect one generation to subsidise the environmental management responsibilities of another. This is particularly so when the benefit: cost ratio of the project is close to unity as is the case in many salinity management plan projects. If ROR charges are used, rate payers early in the project life are subsidising future ratepayers and may be receiving less benefit than they pay for. Thus at the critical initial stage of the project participants will find the plan is unaffordable.

As ROR is incompatible with the intergenerational equity basis of sustainability, its use for calculation of charges in sustainable resource use programs should be discontinued.

A program of serial investments may be appropriate where the capacity of the environment to absorb "waste" is being consumed at a constant rate, such as in rising watertables . Each year's accession will bring forward by one year the time for remedial action (or reduced resource productivity). To offset this future external effect, an investment could be made at the end of year one that would compound over the intervening period to pay the annual mitigation charge the year when the watertable begins to affect productivity. And so on. An interventionist common property approach would require an appropriate institutional framework (Quiggin 1991a) to set charges and manage investment. A good understanding of the natural processes involved is also necessary (Edwards 1989). A rational approach would avoid much of the institutional and informational cost of intervention by simply imposing the pragmatic proviso that sufficient profit is wisely re-invested to ensure the maintenance or increase in productive capital (Smith 1776, Donnet 1982). Thus macro-economic policy impinges on sustainability (Tweeten 1989). Quiggin (1991b) has calculated a range of plausible discount rates necessary to maintain growth in consumption. However sufficient knowledge of the rate of resource degradation would be needed to estimate the prudent level of provision for depreciation. Either approach requires investment in productive projects which emphasises the important role of the economist in *ex ante* project evaluation.

An interesting recent proposal for capital asset management in large infrastructure systems is the concept of "renewals" accounting. The system is considered as an asset to be maintained in perpetuity and any capital works necessary for continued operation of the system are expensed as maintenance items. Such a methodology appears to suffer from several important shortcomings. Firstly, if reconstruction of assets is lumpy in time the annual charges will also be lumpy. Such a distribution of charges is inequitable. So we are still left with the essential problem of how to calculate a fair and equitable stream of charges for capital that equates with the present cost of the project. And secondly, because the system is blessed with perpetual life, there does not appear to be any need to evaluate reconstruction projects other than perhaps a comparison of costs of various options rather than a benefit:cost analysis. As proposed, "renewals" appears to offer a *carte blanc* for a renewal of the poorly evaluated engineering imperialism discussed by Musgrave (1974).

Conclusions.

Interest and Sinking Fund is the only method which produces an even stream of capital charges (interest and principal). The method should be adopted for calculation of capital charges for sustainable resource management projects. The use of Rate of Return Straight Line Depreciation accounting for capital charges for sustainable resource management projects should cease.

Under the equity constraints of sustainable resource management, the capacity to finance mitigation of the external effects of agriculture expected to occur in the future should derive from productive re-investment, rather than consumption, of some of the surplus from current production.

References

Chisholm A H and Dillon J L (1988) *Discounting and other interest rate procedures in farm management*, Professional Farm Management Guidebook No. 2, Faculty of Economic Studies, University of New England, Armidale.

Donnet R J (1982) *Understanding real and nominal interest rates and rates of return on capital,* Bulletin No. QB82009, Queensland Department of Primary Industries. Brisbane, 7-8.

Edwards G (1989) 'Big Problems Facing Small Societies', *Aust. J. Ag. Econ.*, 33(2), 71-87.

Musgrave W F (1974) *Some Comments on the Evaluation of Benefit-Cost Analysis,* Paper presented to Queensland Branch of Australian Economics Society, Information Circular 74/11, Queensland Department of Primary Industries. Brisbane.

Quiggin J (1991a) 'Salinity mitigation in the Murray river system', *Rev. Marketing and Ag. Econ.* 59 (1) 53-65.

Quiggin J (1991b) *Discount rates and sustainability*, Seminar presented at La Trobe University, Department of Economics, Australian National University, Canberra.

Smith A (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations*, Strahan and Cadell, London, 337. In Heilbroner R L (1986) *The Essential Adam Smith*, Oxford University Press, 238.

Tweeten L (1989) 'The Economic Degradation Process', *Am. J. Ag. Econ.* 71(5), 1102-1111.