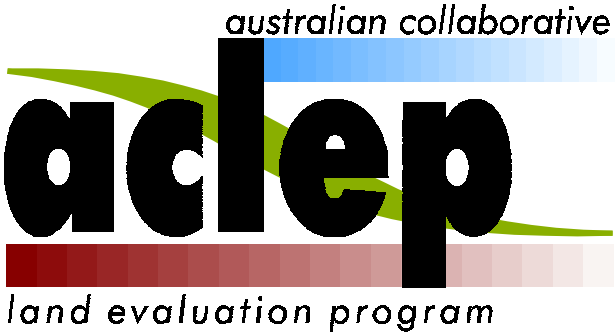

The Development of an Economic Framework and Instruments for Assessing the Benefits and Costs of Land Resource Assessment in Australia

Final Report to

Australian Collaborative Land Evaluation Program (ACLEP)

November 1996

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EXECUTIVE SUMMARY

ACIL was commissioned under the Australian Collaborative Land Evaluation Program (ACLEP) to develop an economic framework and instruments for assessing the benefits and costs of land resource assessment in Australia. ACIL was also asked to advise on the characteristics of land resource assessment activities which tend to favour cost effective outcomes.

ACIL's approach has been to view land resource assessments as *investments* in knowledge. Like any investment, they involve up-front costs, an expectation of benefits flowing from the use of the products of the assessment and some uncertainty. Benefit-cost analysis is a tool developed for assessing the merits of investment opportunities. At its simplest level, the approach poses the question of whether the set of benefits which flow from the investment can reasonably be expected to exceed the set of corresponding costs or, almost equivalently, could the resources be otherwise deployed in a more valuable way. To ask this question is reasonably uncontroversial. The complexities and controversy lie in the methods brought to bear in answering the question.

ACIL is proposing a framework for benefit-cost assessment which takes into account most of the difficulties which arise with the evaluation of land resource assessment activities, at least to the extent of providing a structure within which the key issues are raised and can be addressed. The framework is complex, reflecting the complexities inherent in benefit-cost evaluations applied to land resource assessment. However, not all elements of the framework are required for a typical evaluation and ACIL believes that the framework is applicable to the types of programs involved, in many cases with only modest levels of effort needed to underpin conclusions about whether benefits are likely to exceed costs and the likely order of magnitude of the difference. Elements have been incorporated into the framework which:

- take into account both uncertainties regarding the uses made of the data and uncertainties about whether, or how rapidly, strategic responses flow from use of the data;
- allow quantification of intangible benefits and costs, such as loss of amenity or other environmental impact;
- recognise the value that can be associated with reduction in the risk of serious loss, even if this involves reductions in expected benefits;
- allow for the effects of time flow of benefits and costs;
- can treat as benefits any costs which are avoided as a result of using the information (for example, land degradation avoided) as well as benefits actively created;
- are careful to treat benefits and costs as the *incremental* benefits and *incremental* costs which flow from the investment;
- provide standard classifications of objectives, uses and outcomes as part of a structured approach to drawing out likely or actual benefits as a precursor to quantification;
  - one lesson to emerge from the review has been that a lot of information can be harnessed through the structured prompting of those experienced in LRA and its applications; and
- recognise a strategic role of land resource assessment in building an appreciation of the value of using land resource assessment as a planning tool, and hence encourages its own demand for information.

This last point is emphasised in the paper. ACIL argues that these 'generic benefits' of land resource assessment are probably now large in relation to the region-specific benefits which flow from a *fresh* small scale (such as 1:100,000) survey. This raises the important issue of the appropriate balance of public sector resourcing between undertaking more such studies and seeking to facilitate the better use of the information already generated and the development of increased incentives for

private investment in land resource assessment as an integral part of planning.

Precise quantification of these generic benefits is extremely difficult — it requires attribution to LRA activities of a component of the substantial changes which have occurred in the planning culture in recent years when many other factors have had a role to play. Equally, however, it seems difficult to argue against the proposition that access to LRA information, a growing list of *ex post* analyses of earlier land use decisions which entailed costs which could have been avoided with better use of LRA information, and the progressive use of LRA information within planning processes have not encouraged a substantial, or substantially more rapid, shift in planning cultures.

The evidence certainly suggests that some land resource assessment activities have been cost effective. Specific characteristics which favour cost effectiveness include:

- The study is purpose driven, because this is likely to increase the prospects for rapid conversion of the information into a flow of benefits. Low likelihood of implementation or an extended period between gathering the data and actually implementing a strategic response based on the data are two of the key reasons why many investments in information are often not cost effective.
- The work involves value adding to a range of studies already completed to improve accessibility and use at lower user cost. This is because of the benefits of 'leveraging' off a large number of surveys, with an associated expanded user base, to deliver a larger block of benefits and because the costs of such value adding (such as in the case of the digitising of the Atlas of Soils) can be modest. Examples of such activities include digitising, integration across surveys or with other 'layers' of the lands database, development of models based on the data etc.
- The work draws on the *ex post* experience of existing surveys and problems which have arisen because of inadequate use of the surveys to encourage greater demand for sound use of land resource assessment data. Again, this expands the application base of the

survey and can be expected also to identify, and possibly provide funding for, more purpose driven surveys with their associated benefits.

- The work encourages private sector suppliers of land resource assessment services to identify and pursue commercial opportunities in expanding the market for these services. In other words, these suppliers might become principal marketers of the products and generators of fresh demand. The reasons for this are the same as for the last point.

ACIL is inclined to the view that future land resource assessment activity might involve a progressive shift into more work in these sorts of areas, even at the expense of some of the resources now being directed at survey work. It is already the case that most of the survey work is clearly purpose driven, but an even stronger emphasis on mechanisms for converting the survey effort into tangible benefits may sensibly become a prerequisite to agreement to future surveys. Considerable value adding and marketing activities have also been undertaken, but it is not so clear that decisions on these matters have been well integrated into the total LRA planning process, nor that they are seen as substitutes for, rather than add-ons to, some further survey work.

The benefit-cost framework could sensibly be used in support of these activities by demonstrating not just the aggregate benefits available, but also the scope for generating commercial savings — to developers, councils, financial institutions and land owners — that could underpin the development of a more commercially oriented land resource assessment industry in which government funding was directed at strategic gaps. In some cases, institutional changes — including regulatory imposts and/or charges for risks which are borne by the community — may be needed to facilitate the provision of appropriate commercial incentives to invest in and use land resource information more efficiently.

Specific guidelines are presented to help in the selection of LRA activities to be

funded where funds and other resources are scarce. Soundly based professional judgment will remain a key ingredient in any such prioritising, but the cost-benefit framework offers powerful tools to guide these decisions if the primary objective is to maximise the net benefits created as a result of using the available resources.

It is important still to recognise that the framework is heavily constrained by data limitations. The two major areas of weakness are confidence in the coverage of users and uses and the ability to map out the land planning processes and outcomes which would have occurred if the specific LRA activity had not been undertaken. ACIL recommends that ACLEP direct serious attention at using the framework as a basis for progressively developing a database which will permit more powerful inferences to be drawn in the future — and hence support better targeting of land resource assessment activities. This strategy might sensibly be based around a combination of more systematic market research, possibly linked to sale / provision of products, and a standard information system mounted through the Internet, allowing key data regarding objectives and expected outcomes to be provided at the early stages of a study, with progressive augmentation as actual experience in use of the data emerges.

The complexities of the issues involved, and the data limitations, caution against too mechanical approach to cost-benefit evaluation of LRA activities. However, a simplified version of the framework which lends itself to reasonably systematic application is also presented. This version of the framework is likely to be of greatest value in guiding LRA personnel in planning and vetting their activities and in developing broad priorities. In the case of high cost LRA activities where the case for investment is not clear from the use of this version of the framework, more detailed evaluation using the broader framework tailored to the specific characteristics of the activity may be appropriate.

For illustrative purposes, the framework has been aplied to three Land Resource Assessment case studies:

- Upper South East Salinity Study, South Australia;
- Gosford — Lake Macquarie 1:100,000 study; and

- Digital Atlas of Australian Soils.

These case studies are illustrative rather than representative. In other words, they show how the framework can be applied, but cannot be used as the basis for infering benefits of LRA programs as a whole.

Hence one must be careful in quoting net present values of benefits and benefit:cost ratios from these studies. That said, findings can be expected to show the sorts of assumptions needed, and the way in which findings can be presented.

- For the Upper South East Salinity study, ACIL has estimated net benefits as a function of the probability of implementation of drainage options[1]
  - If there is probaiblity p_ALL of all drainage schemes being implemented, then the net present value[2] of benefits, comprising changes in production, tourism and risk management values but excluding environmental amenity, is (at least) \$0.051m; + p_ALLL * \$2.25m. The benefit:cost ratio is 3.38 + p_ALL * 112.5;
  - If there is probability p_C&S of Central and Southern Schemes, net present value of benefits (as above) is (at least) \$0.051m - p_C&S * \$0.15m of the schemes were implemented in 1998, but would have been (at least) \$0.051m + p_C&S * \$5.25m had the schemes been implemented in 1993. Corresponding benefit:cost ratios are 3.38 - p_P&S * 7.5 (1998) and 3.38 + p_C&S * 262.5 (1993);

1 See Box 4.1.3.

2 In 1993 dollars, at 7% discount over 30 years.

- Had the LRA study not gone ahead, net benefits of P_S * $5.1m would have arisen from implementation with probability P_S of the Southern Scheme.

In summary, the LRA study was cost effective if the probability of building all drainage schemes (given that the LRA study was carried out) is sufficiently greater than the probability of building just the Southern Scheme (had no LRA study been carried out).

- For the Gosford-Lake Macquarie study, ACIL has estimated net benefits as a function of <u>when</u> the study was carried out -
  - Given that the survey was done in the late 1980s, the net present value[3] of benefits is (at least) $6.8m, with a benefit:cost ratio of 44;
  - alternatively, had LRA data been collected only as needed, net present value of benefits would have been $6.3m, with a benefit cost ratio of 17;

  In summary, many of the benefits of the original LRA study could have been obtained from more focussed, specific purpose surveys. However, the actual survey had additional benefits in terms of economics of scale in information.
- For the Digital Atlas of Australian Soils, ACIL has estimated (some) benefits from digitising in 1990 .

3 In 1993 dollars, at 7% discount over 30 years.

- net present value of benefits are at least $0.5m, with a benefit:cost ratio of at least 10.

1. INTRODUCTION

ACIL Economics and Policy Pty Ltd (ACIL) was commissioned under the Australian Collaborative Land Resource Assessment Program (ACLEP) to develop an economic framework and instruments for assessing the benefits and costs of land resource assessment in Australia.

Assessing benefits and costs of LRA is a challenging task — indeed some may even challenge that it is feasible.

ACIL's aim in bringing an economic framework for assessing benefits and costs of LRA activity has been to describe a framework which is of practical use, while recognising that its application raises issues which are still subject to debate in the economics and public policy literature. This report handles the balance by:

- Chapter 2 having a lengthy discussion of ACIL's economic framework, with references to the literature for more detail on a number of issues;
- Chapter 3 presenting a much shorter set of guidelines on how to apply the framework, subject to the preceding discussion;
- Chapter 4 documenting the application of guidelines to three case studies; and
- Chapter 5 making some overall concluding remarks.

Those who wish to go straight to the set of guidelines in Chapter 3 are encouraged to use the reference material in Chapter 2 in support of any statements of benefits or costs.

1.1 Background to the study

This report is not intended to be a comprehensive review of land resource assessment — this has been done already[4]. As well there is an extensive literature on how to undertake land resource assessment, and an extensive body of information on actual results of land resource assessment.

This report is about a framework for assessing the value of investing in all this information. To some extent the framework is applicable to activities other than land resource assessment. However, it is described here in the context of land resource assessment.

Box 1.1 What is land evaluation?

Traditional land evaluation practice can be described as the process of estimating the potential of land for alternative kinds of land use (Dent and Young 1981). This process involves comparing the land resources on offer with the requirements of a specific land use to determine the overall potential. When the land being assessed supports existing uses, land evaluation is applied usually to both present and alternative uses so that valid comparisons can be made.

Land evaluation commonly provides a ranging of land types according to either a performance measure such as yield or according to a comparison of inputs and outputs required for successful production. This involves establishing a physical boundary to distinguish suitable from unsuitable land for each alternative use. The boundary is determined at the point beyond which productivity had become unacceptable and/or tolerable land degradation levels have been exceeded.

More recently, land evaluation has sought to provide a resource data set which is sufficiently flexible and robust to be used in predicting not only yield, but also for generating quantitative information on the impact of various land uses on the environment. The latter implies the ability to predict run-off and deep drainage as well as the level of solutes and sediment generated by different land use practices. Hence land evaluations can provide a basis for determining land management practices which facilitate sustainable land usage. They can also be used to assess the impact of land uses on other parts of the environment.

Source: ACLEP, 1995, Agricultural Land Evaluation in Australia — A Review, CSIRO Division of Soils

[4] McKenzie N J, 1991, *A Strategy for Coordinating Soil Survey and Land Evaluation in Australia*, CSIRO Division of Soils Divisional Report No. 114

1.2 Key contributors

The Australian Collaborative Land Evaluation Program (ACLEP) is a joint approach to land resource assessment across Australia, involving Federal, State and Territory agencies with responsibility for land resource assessment. ACLEP's role is to:

- set standards for all aspects of LRA;
- provide a forum for communication; and
- encourage the application of research.

This project was carried out under contract to CSIRO Division of Soils, as facilitator of ACLEP. ACIL is grateful for guidance provided also by members of the Working Group on Land Resource Assessment, comprising members of state agencies, shown in Box 1.2.

Box 1.2: Working Group on Land Resource Assessment

State/Territory		Agency
NSW	•	Department of Land and Water Conservation
VIC	•	Industry and Resource Information &
	•	Centre for Land Protection Research, Department of Natural Resources and Environment
QLD	•	Resource Management, Department of Natural Resources
WA	•	Department of Agriculture
SA	•	Primary Industries SA
TAS	•	Department of Primary Industries and Fisheries
NT	•	Department of Land, Planning and Environment
Commonwealth	•	Australian Geological Survey Organisation &
Department of Primary Industries	•	National Resource Information Centre, Bureau of
Resource and Energy	•	Sciences & Land Resources Division

1.3 Structure of project undertaken by ACIL

The project comprised the following phases:

1. Preparation of scoping paper, and presentation at a workshop of the LRA Working Group on 23 November 1995, in Toowoomba.
2. Survey of 16 LRA projects, the results of which are contained in a separate report, *Responses to ACIL Survey for Australian Collaborative Land Evaluation Progress, (ACLEP).*
3. Follow up visits with selected areas:
   - BRS, in relation to the Atlas of Australian Soils
   - Land Resources Unit of Primary Industries, South Australia
4. Workshop in Gosford with a number of users of LRA information, particularly to Gosford-Lake .Macquarie 1:100,000 study
5. Testing of parts of the framework, in discussion with members of the Working Group.
6. Preparation of a number of draft reports.
7. Presentation of the framework to a workshop of the LRA Working Group in July 1996, in Alice Springs.
8. Finalisation of Report

1.4 Terms of Reference

The objectives of the study as specified in the project brief were:

- identify the key qualities of successful land resource assessment studies;
- document the economic benefits and costs of good quality land resource assessment;

- develop an appropriate approach for evaluating the economic merits of land resource assessment.

Actual project objectives set out in Schedule A to the contract dated 16 November 1996 are as follows:

1. ACLEP to identify suitable NRA/economists to undertake the preparation of a discussion paper which examines the critical issues related to developing a conceptual framework for the analysis of the long term benefits of land resource assessment.
2. ACLEP in collaboration with the consultants and State/Territory agencies, will collect and collate the appropriate information to develop a set of case studies to document the benefits and costs of LRA.
3. The consultant will prepare a scoping paper outlining the critical issues and a proposed approach for the development of an economic framework for assessing the costs and benefits of land resource assessment in Australia.
4. The consultant will develop and test an economic framework and instruments for assessing the benefits and costs of land resource assessment in Australia.
5. The consultant will coordinate the collation and presentation of a set of case studies in the format of the framework. A number of nominated incomplete or new projects will be used as a reference test set.
6. The consultant will prepare the final report and case studies.

On 13 May 1996, Contract Variation No 1 added the following objectives:

7. ACIL to apply a questionnaire to gather information about a number of projects identified at the Toowoomba Workshop and to report on the findings;

8. Specific plans for case studies — visits and reporting;

9. ACIL attendance and participation at the meeting of the ACLEP Working Group, scheduled for July or August, 1996 in Alice Springs.

Note that these aims go well beyond, and do not in fact *necessarily* entail, demonstrating that land resource assessment is cost effective. These aims focus on the problem of how to get value out of a set of resources which are available for land resource assessment purposes.

2. ECONOMIC FRAMEWORK FOR EVALUATION OF LAND RESOURCE ASSESSMENT

2.1 Land resource assessment as an investment

An framework for evaluation can serve a number of purposes[5]:

- to enable *ex post* assessment of actual outcomes from LRA projects;
- to assist in managing projects; and
- to guide *ex ante* decisions about future LRA investments.

The first purpose has clear attractions if it supports statements along the lines of 'This project delivered $Xm in benefits (appropriately discounted) over Y years, for a cost of only $Zm' (where X>Z). More realistically, given the diffuse and often untracked character of benefits from land resource assessment, statements along the lines of 'This project conservatively delivered $Xm in benefits (appropriately discounted) over Y years, for a cost of only $Zm' (where X>Z) would be desirable. Indeed, such evaluations may be required by State or Commonwealth Government or Parliamentary reporting requirements — or by other contributors of time money and effort to land resource assessment.

However, the practical benefits of evaluation are increased if information about the past is used to assist in managing projects and to guide better investments in the future. For example, who would not change the design of a project if this was likely to lead to higher benefits, even if the project was nonetheless attractive? The appropriate approach should therefore also facilitate *ex ante* evaluation.

5 Department of Finance (1994), *Doing Evaluations: A practical guide,* AGPS, Canberra

Furthermore, there is a need for a level of *ex ante* evaluation even in respect of land resource assessments already undertaken but where the flow of benefits has not yet ceased. The value of these assessments typically flows from the opportunities created for better land use over many years. Data generated several years back are still being used, either directly or via the use of analyses / models which drew on those data. For many land resource assessments it is likely that there will be future uses of the information. Assessment of the total block of benefits generated by such a study therefore requires that an assessment be made of these future benefits as well as the benefits already delivered.

In a real sense, there is no issue as to whether some land resource assessment is worthwhile or not. Land resource assessment was going on long before governments became involved because the value of information as an input to planning and decision making was recognised. Each of the early settlers, when choosing an area of land for farming and for a homestead, undertook an implicit, if not explicit, assessment of the competing options with an eye to existing vegetation, access to water, aspects of topography, possible flood risk etc. Farmers also adapt their practices based on the experience of preceding years and increasingly monitor soil status — and these, too, are forms of land resource assessment. These days banks may require soil tests before approving loans; Councils may require professional reports on the status of land before approving development.

Since the earliest days of agriculture, there has been the evolution of land use patterns based on trial and error — and, progressively, on more sophisticated ways of extracting value from those errors (and successes) by minimising subsequent errors without stalling progress through innovation. The key requirement if errors are to be minimised is to have a basis for extrapolating from past successes and failures to future outcomes where related practices might be brought to bear on related land. Land resource assessment is about gathering the data required for such extrapolation — and making that data available in a form which is accessible.

All of the above are examples of market (political as well as economic) driven demands for land resource assessment — and in every case a decision has been taken to the effect that a level of investment is worthwhile. In each case, also, the investment took the form of gathering and weighing up information on the basis of a recognised *pre-existing* need — the explicit existence of land use alternatives over which decisions needed to be made drove the process of gathering and analysing the relevant data.

The focus of this study is a different type of land resource assessment. This is a type of land resource assessment where pre-existing demand for much of the data has not been established. Instead, based on more modest demands or an assessment that trends are likely to (or should) lead to significant demands, data are gathered in the expectation, or at least hope, that future demands will arise sufficient to justify the data collection exercise. Typically, behind this thinking are two distinct objectives — to be able to *satisfy demands* as they arise and to *influence demands* by altering community, political and individual understanding of both opportunities and risks.

A useful analogy exists with the comparison with commercial and basic research. Commercial research is typically driven by identified applications for new knowledge. These identified applications afford ready access to the machinery needed to ensure implementation of the research, if 'successful', minimising lags between research investment and commercial 'pay off'. Commercial research is typically well focused by the anticipated applications. Commercial research will also often recognise the possibility that unanticipated outcomes will themselves prove valuable and remains on the alert for such opportunities — but views them as a by-product rather than a focus of the research.

Basic research is more about expanding the set of options available to the community. There may be some ideas as to how the research may pay off, but equally important will be a high level of 'serendipity' — where the benefits of the research will flow from valuable coincidences between the information generated and demands which may subsequently arise or be identified. The more important

this 'serendipity', the less scope there will be for a tight focus on applications — and the more attractive the idea of ranging widely and gathering data for which there is no identified use. Of course, this is not done in a vacuum. Basic research continues to receive community support because of its track record in delivering things of value (including, but not restricted to, the value of knowledge as a cultural asset) and researchers with solid track records are those most able to retain support.

The land resource assessments which are the focus of this study lie somewhat between these 'applied' and 'basic' camps. Resource limitations mean there will almost always be some pre-existing demand for land resource information before a study is commissioned. Equally, there will be a view that simply to meet these demands may be inefficient and that the prospects for future uses are strong enough to justify gathering a significantly larger data set.

As with basic research, the challenge is then to ensure that the rationale behind the information gathering exercise is not lost for want of incentives or resources to explore the data gathered and to recognise and 'bank the benefits of' the opportunities revealed. There is an important balance to be effected between investing in base information and investing in the use of that information. It is not necessarily the same individuals, organisations or interests that are attracted to these two sets of activities and this does raise the risk of imbalance and consequential resource wastage.

Furthermore, while there may be potential efficiencies in gathering a lot of data as part of a single survey, rather than undertaking a series of purpose driven surveys, this need not necessarily be the case unless the extra data gathering, analysis, collation and storage is essentially costless. Reasons for this include:

- Until the purposes have been identified, the 'optimal' scale (or scales) of data gathering — and the 'optimal' range of data types — are not necessarily clear.

- Land resource assessments typically operate at small scales[6] (1:100,000) to provide a basis for planning more detailed large scale activities later, but this may be inefficient if enough large scale work is required.

- Where there is a delay between the gathering of information and its use to deliver benefits, this delay involves real costs — in the sense that the resources could have been deployed elsewhere and swung back in to gathering this information later.
  - This 'opportunity cost' is the primary reason behind the use of discounting in cost benefit analysis and underpins a real cost in any such investments. By investing in information only when the purpose is clear and the need urgent, these costs can be minimised.

- There is a good chance that a significant proportion of the data gathered may never be used or prove of much value. This, of course, parallels the experience with basic research where researchers 'look under a lot of rocks' but only find value under a relatively small proportion.
  - In the case of basic research this can still be efficient if there is no better way of predicting which rocks hide the 'gems'. With land resource assessment, delaying the information gathering will typically yield better information on which information is needed where — there is a *trade-off* involved in gathering the information early.

6 It is accepted practice in LRA for the term 'small scale' to refer to very general mapping and 'large scale' to refer to more detailed mapping — 1/250,000 is a smaller number than 1/50,000.

It is useful, therefore, to view decisions about the type of land resource assessment activities being considered in this study as involving a range of important trade-offs. Specifically, there are trade-offs between size economies in gathering, analysing and presenting data on the one hand and diseconomies in scale and scope of data and timing on the other hand.

On the other hand, these 'bean counting' considerations may be swamped by the value of the data in revealing opportunities to avoid serious mistakes in land use decisions. If having the data available leads to better questions being addressed; prompts the generation of additional important information which might not otherwise have been sought; or changes the culture of land planning in a way which better reflects what we now know of long term risks; then the benefits delivered in the form of land usage mistakes avoided might provide the overriding justification for such activities. There are, however, important qualifiers to this observation which are developed further below.

Implicit in all of the above discussion, is a cost-benefit perspective. Investments are about incurring costs which are justifiable in the light of prospective benefits — including the 'benefits' associated with avoiding even greater costs. Trade-offs are about judgments as to whether one package of outcomes, with its associated benefits and costs, is more valuable than another such package. Risk reduction entails benefits and may justify incurring costs.

There has been no mention of dollar values and ACIL recognises that there can be sensitivities about attaching dollar values to some outcomes, particularly of an environmental or public health nature[7] — both outcomes where LRA may have a role to play. The fact remains that LRA assessment involves dollar costs and it is

[7] Even where people would be extremely reluctant to attach a dollar value to some definite outcomes, such as the loss of a particular life, they are often willing to value a change in risk such as the risk to a particular life. For example, driving a car entails risks to life which are

/cont.

these investment dollars which are most limiting on LRA activity in Australia. To say that an LRA activity is cost justifiable is to assert that the set of benefits delivered is of greater value to the community than the dollar cost involved in undertaking the LRA. It seems not unreasonable in these circumstances to assert that the dollar value of the outcomes exceeds the dollar value of the costs incurred.

This is little more than a convenient language for comparing the costs and benefits of an investment. ACIL uses this language throughout this study because it is convenient[8]. There is no intention to narrow the focus onto outcomes which can be readily valued in dollar terms.

2.2 Overview of framework

The propose of the framework is directed explicitly at the question of whether past and prospective benefits attributable to a land resource assessment are of sufficient value to the community to justify the past and prospective future costs associated with the investment. The framework is, essentially, a cost benefit framework.

In its essential form, benefit-cost analysis is simply a structured discipline for addressing the question of whether the benefits of an investment exceed, or can reasonably be expected to exceed, the costs. This means a focus on:

- recording of costs which can be directly attributed to a project;
- issues of allocating costs that might be shared across projects or data uses;
- valuation of benefits where there is a reasonable market standard;
- issues of valuing benefits when there is no clear market.

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readily accepted by society, even where the purpose and benefit in driving is strictly pecuniary.

8 Department of Finance (1991) *Handbook of Cost-Benefit Analysis*, AGPS Canberra

Assessment of net benefits requires comparability of costs and benefits, as the one must be subtracted from the other. This is conventionally achieved through valuing both costs and benefits in money terms. Some costs and benefits can fairly readily be valued, particularly where there is an associated market — for example, an improvement in agricultural production. Inevitably, some costs and benefits resist the assignment of dollar values. However, at some point a trade-off needs to be made and this entails a judgement or assessment that these intangibles are "worth" more or less than the net value of the benefits and costs quantified in dollar terms. Implicitly, if not explicitly, the intangibles are assessed in dollar terms — at least to the extent of categorising them as exceeding or falling short of the dollar value necessary to justify the investment.

However, the characteristics of land resource assessment introduce complexities which need to be accommodated carefully if credibility of the assessment is to be achieved. The particular characteristics most needing to be addressed are fourfold:

- As was noted above, an investment in information, LRA often has more the characteristics of basic research than of applied research — with the attendant much greater difficulties in identifying and weighing benefits. The value and uses of the information are often not predictable with any accuracy at the time the investment is made, but the lead times involved in generating the information militate against waiting till the uses are identified before gathering the data.
    - In these circumstances, greater weight needs to be given to track record of broadly comparable LRA activities and perhaps even to the track record of the team running the LRA. More generally, individual project assessments are likely to need to draw heavily on the collective experience of LRA activities and a structured facility for doing this is an essential element of the framework.

- LRA is an investment in information, but other activities may be needed before value can be realised from having the information. There is an issue as to how benefits might be attributed to LRA and other activities.
  - The former are treated as a sunk cost. There is a difference between past and prospective activities. The latter can be treated as an expected cost, in the same way as expected benefits. The probability of the activity taking place may, of course, depend on what information is available.
  - There may be value in having information without necessarily using it — as a form of insurance against possible developments. This is akin to the fact that few people complain about getting through a year, or even a lifetime, without needing to claim on their household insurance policy, despite the premiums paid.
- The range of uses of LRAs is so wide and has been so lacking in structure that it has been judged virtually impossible to work through these outcome possibilities to a balanced view of the overall impact of the LRA.
  - The framework needs to incorporate facilities which assist the identification, prioritisation and assessment of outcomes. Again this will sensibly draw heavily on the collective experience across LRAs but with the incorporation of considerable structure to allow a more considered and balanced weighing of the significance of different outcomes.
- In relation to at least some LRAs a significant proportion of the likely benefits appear to be associated with difficult to quantify, and even to define, impacts — such as those associated with reductions in

environmental degradation or loss of amenity or reductions in public health risk.

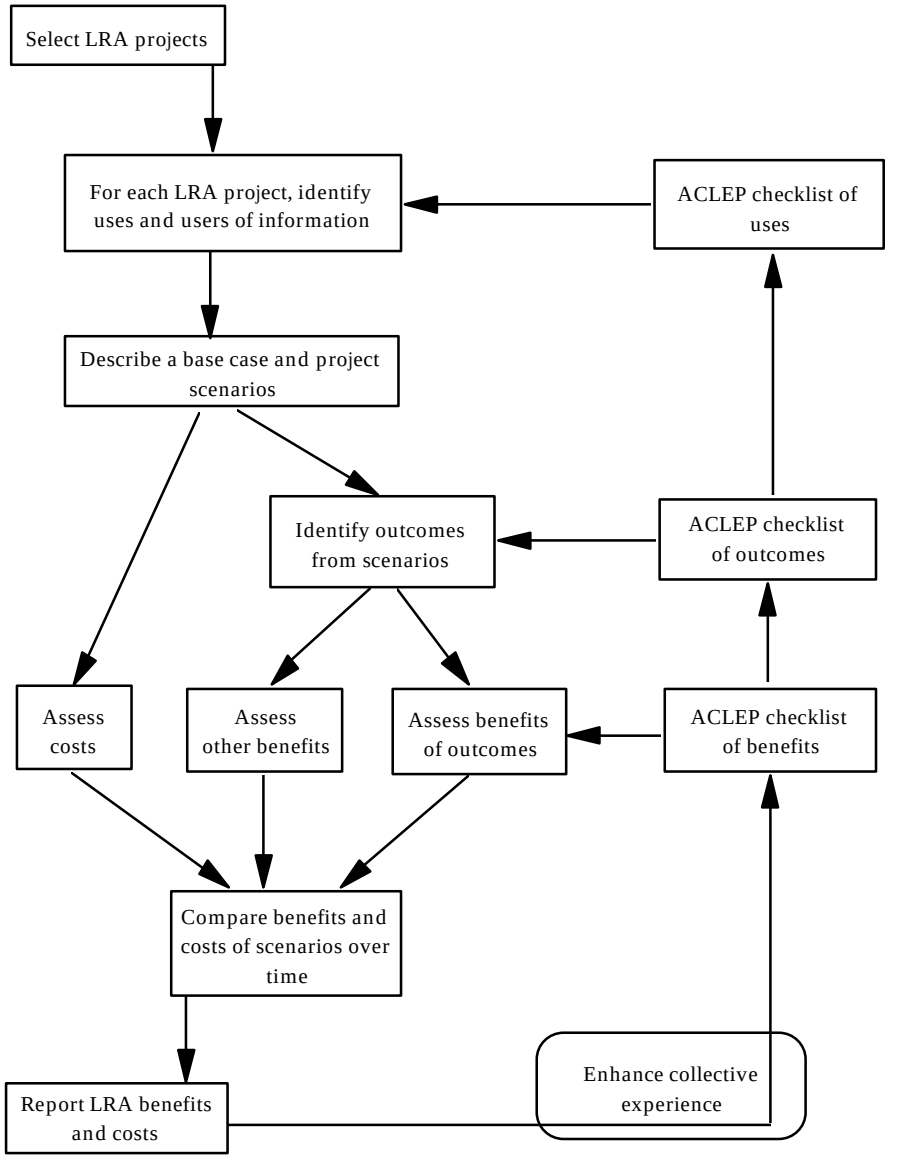
- This problem is by no means unique to LRA assessment but does impose added demands on the benefit assessment process. The benefits of these outcomes need to be capable of being viewed in terms comparable with the more concrete, and often quantified in monetary terms, benefits associated with outcomes that can be valued in the marketplace.
- An added complication is that valuation of some of these benefits is inherently controversial but is necessary if sound accountability and planning is to be undertaken.

These demands of a suitable framework are inherently complex. It would be naive to think that they could be met with a simple framework. The framework needs a richness of facilities for handling these complexities sufficient to meet the terms of reference of the study. In particular, some of the machinery of the framework is complicated — for example, there are issues in valuing benefits which are still areas of active research.

2.3 Overview of Assessment Methodology

This section presents an overview of the assessment methodology, while subsequent sections discuss technical methodological detail. The next chapter presents a set of guidelines for applying the framework.

Box 2.1 Overview of evaluation framework



2.4 Assessment of benefits

A striking feature of LRA, particularly to those who do not have a background in LRA, is the wide range of uses to which information is put, and hence the range of potential benefits. For example, from one particular survey, information uses ranged from specific site selection for an abattoir, to incorporation into guidelines for erosion mitigation for logging, to land use planning and zoning by local governments. Benefits from these included avoided costs, both direct and of environmental nature.

The diversity of potential benefits supports a view that LRA has large benefits which however may be elusive, due to the diversity of users. A benefit of having an explicit market for information, as noted in section 2.8, is that it would give more direct signals about demand and total benefits. In the absence of a market, the best that can be done is to attempt to assess the gamut of uses and benefits.

Thanks largely to collaborative efforts, such as ACLEP itself, there is now a good deal of collective experience with LRA and, in particular, its outcomes. This encompasses a high proportion of potential uses of LRA information, and perhaps a good knowledge of benefits also. Indeed, the collective experience is in one sense *too extensive*, as it appears almost impossible to work through all possible outcomes. To draw usefully on LRA collective experience therefore requires the development of considerable structure, to facilitate a balanced weighing of different benefits.

There are many ways in which benefits could be classified, just as there are presumably many ways in which soils could be classified. In choosing a classification system, there are several factors to be borne in mind:

- ease of use, but capacity to handle sufficient complexity to be useful;
- acceptance by practitioners in the discipline;
- flexibility to adapt to evolution in understanding.

ACIL's framework proposes classification of benefits as shown in Box 2.2, and described below.

Box 2.2: Benefit classifications system

Category	Examples	Description
Generic benefits	Increased use of LRA information in planning and decision making	Benefits attributable to the program of LRA activity, rather than to any particular projects
Economies of scale	As described in Section 3.1	A general LRA project may reduce the need for, or cost of, subsequent information gathering.
Risk management benefits	Study of potential radioactive waste disposal sites had value even though no site was selected, or may indeed ever be selected	LRA project can have benefits even without specific outcomes.
Benefits from project specific outcomes	Improved opportunities - - realised - potential	LRA information can clearly lead to better land use decisions. Care is needed to take account of supporting activities that may be needed in order to realise benefits.
	Avoided costs	Ready access to the LRA data for an area, at low incremental cost, may well indicate that proposed strategies would be unwise. A benefit of this type only accrues if *both* the proposed strategy would otherwise have been pursued *and* the strategy is prevented as a result of access to the LRA information. If LRA data would otherwise have been collected and used as a basis for deciding the strategy, then the benefits are more likely to be savings in information costs.
	Unexpected benefits	As with research type projects, there can be benefits which were not expected at the time of the projects.

In practice, cost benefit assessment of a recent or proposed LRA survey can and should take into account all classes of benefits and can set these against the total incremental costs. Survey specific benefits, assessed against a realistic 'do nothing' option in which the previous history of LRAs is taken as given, can be added to an assessment of the incremental generic benefits which will flow from undertaking the survey. In then weighing the benefits against the costs, it would be appropriate to reflect on whether even greater benefits might not be obtained through the direction

of some of the resources more explicitly at further changing the culture or otherwise addressing relevant market failures.

2.4.1 Assessing generic benefits

There is an important distinction which needs to be drawn between the benefits and costs associated with a specific LRA survey and those which are more generic in nature and which flow from the collective LRA activity in Australia. The distinction is particularly important because ACIL believes that it has strategic implications for future LRA activity.

The significance of the strategic role which has been played by land resource assessment information lies in the greater clarity it brings to which benefits should be counted against a specific survey and, perhaps more importantly, in the emphasis it places on the generic benefits of an established program of LRA surveys and associated systems for extracting value from the surveys.

These generic benefits are likely to be large. Certainly, as was noted earlier, it is now evident that the culture of land use planning and approval processes has changed markedly over the last couple of decades. There is now much greater awareness of the long-, and sometimes the short-term consequences of making mistakes and of the role which land resource information can play in managing these risks better. There has also been significant institutional change, with formal requirements for land resource information to be lodged as part of a development application or in response to specific queries raised by approving authorities.

Some of the people ACIL has consulted with have indicated that there is a lot of scope for further beneficial change in this culture. Examples were given of 'best practice' guidelines for planning which ignore or advise poorly on the role of land resource assessment. Examples were also given of major investments being undertaken where the information is already available which shows that there are far more cost effective ways of achieving project objectives. None of this detracts from the basic proposition that much fuller use is being made of land resource

information than previously — and that this is commonly delivering significant benefits in the form of better land use outcomes.

The main difficulty lies in assessing how different the culture would be these days without the investment which has taken place, and to what extent this shift in culture, and the associated benefits, might be attributed to the types of LRA activities which are the focus of this study. Certainly, LRA information has been commonly use in diagnosing why problems have occurred and in emphasising ways in which they might have been avoided. By helping the community to learn from its mistakes, these surveys are likely to have contributed to the culture shift.

Another source of contribution has probably been via the cost advantages and relative simplicity created for approvals authorities by the availability of high level survey data. For example, even though requiring developers to originate land resource information may be cost effective even without a small scale survey, the fact that the extra information demands are made more modest almost certainly has made such requirements more acceptable politically. Furthermore, the availability of such data will often mean that relatively simple rules can be developed along the lines of — 'if the 1:100,000 survey has the following characteristics in the area of the proposed development, then the following information must be provided as part of the development application'. Such a specification is generally easier to sell than a blanket requirement to provide data even where the chances of the extra investment having any implications for the development are small.

In other words, the availability of this sort of data may well have been of direct benefit in handling market failures associated with the community or approval agencies underrating the value of investing in and utilising land resource information. In effect, an implicit subsidy has been created, making it more attractive to start using the information and, in particular, to use such information in reviewing the mistakes of the past and in assessing alternative procedures for the future. Such processes have fed on themselves, spawning additional information with which to further strengthen requirements.

The shift in culture has not been a purely regional phenomenon — in which all lessons are drawn within a region based on a survey of the region. There is considerable scope for cross-fertilisation of key lessons and procedures, so that additional value can be extracted from the critical mass of LRA data and analysis — and can even then be applied in areas in which there is no high level LRA information available.

A related consideration is the role that government-driven LRA activity has played in developing LRA skills in Australia — skills which are finding increasing use in response to developer/approval authority demand for LRA. While ACIL would urge caution about pushing the argument too far, there may be a market failure case for some intervention in developing a supply of such skills. Again, the case would rest principally on the proposition that LRA has been undervalued in the marketplace and that in these circumstances any changes which make sourcing the skills easier or cheaper can be expected to enhance take-up and probably in a direction which is efficient. There may, of course, be more cost effective ways of developing these skills if this were the only reason, but as part of an array of arguments for making these strategic LRA investments, this 'training' argument may be of some value.

Serious assessment of the magnitude of these generic benefits would require careful evaluation of the *incremental* value of fresh survey information relative to more use of existing information. While quantification of the generic benefits is difficult, it may be possible to make some progress through the use of a range of methods. These could include 'market research' surveys in which users and prospective users of LRA data, and private generators of data LRA, are questioned about the reasons why the demand is there and possible factors behind changes in awareness of the possibilities offered by LRA activities.

The possible incorporation of a routine survey form as part of the distribution of LRA material is discussed in sections 2.9 and 3.10.2, and such questions might be usefully incorporated there — though it would be important to ensure that the form

was not made too onerous to the point of greatly reducing response rates. A better approach might be a follow-up survey — possibly a telephone survey — of a subset of respondents to this routine survey.

The work done by ACIL to date has not had sufficient breadth to allow strong conclusions to be drawn about generic benefits, that is, from the LRA program *per se*. However, ACIL does proffer the view that the sorts of generic benefits outlined here may well be a significant part of benefits so far delivered by the investment in LRA. Over time, ACLEP may develop some collective experience about generic benefits as a multiple of project benefits, varying according to project class.

2.4.2 Economies of scale

In a similar vein, costs of collecting information may be lower once a specific study has been completed than would be the case otherwise. Such benefits might be termed 'economies of scale', in two respects:

- In an LRA sense, a small scale, say 1:100,000, study may enable better focusing of subsequent larger scale studies, say 1:25,000.
- In an economic sense, it may be more efficient to do a comprehensive study once rather a number of studies over a period of time.

Such benefits can be estimated as reductions in costs that would otherwise have been incurred in gathering LRA information, had the study not gone ahead. Hence benefits may not be significant if there were many areas within the LRA region where ad hoc studies would never otherwise have been needed. However, small scale LRA is likely to have benefits of economies of scale in areas where there is larger scale LRA follow-up. For example, access to a 1:100,000 scale LRA survey may allow tighter focusing of larger scale LRA activities and may enable some tests to be eliminated on the grounds that the risks of a problem for which those tests are suited are negligible.

Box 2.3 Examples of economies of scale from Curlewis study

The Curlewis study in NSW produced savings of 2 person years field time collecting data for regional water balance modelling (approx $140,000). Result = more rapid appraisal of effectiveness of different agricultural practices in relation to saline aquifer recharges across the Liverpool Plains

Provision of base information on suitable sites lead to the location of trial sites on representative soil and land types of the Liverpool Plains. Result = savings in correct location of sites to have widest applicability

Use of map and report to stratify and minimise sampling of sites on Caroona feedlot saved extraneous and unnecessary sampling time and laboratory analysis in project ($10,000). Result = better management of feedlot effluent disposal and less accession of nutrients.

Curlewis study response in ACIL survey

2.4.3 Risk management

Sound comparisons of the benefits and costs of investments in land resource assessment need to take into account the value of the information in managing risks better. In a real sense, this could be viewed as the principal argument for LRA. By allowing land use decisions to be taken after considering LRA information which may allow better prediction of the consequences of different land uses, the risks of inadvertently choosing a poor land use pattern is reduced.

These benefits are sensibly viewed as having two quite distinct forms. The first, and probably principal, form is as a means of increasing the net benefits expected from better land use. For example, suppose irrigated land use is being considered and there is a chance that its value will be thwarted by salinity problems. Suppose in the absence of LRA the prospects of this occurring, based on typical experiences in the regions, is rated as 1 in 10, with benefits of, say, $20 million over ten years if salinity is not a problem and losses of $40 million over twenty years if it is a problem. Expected benefits are $14 million. Suppose an LRA is now undertaken, at a cost of $100,000 and indicates whether or not salinity is likely to be a problem. There is 1 chance in 10 that it will indicate a problem and the irrigation project will be cancelled; ie, 1 chance in 10 of avoiding losses of 40 million. The expected benefits

from the project, inclusive of the LRA costs, are now $17.9 million, an increase of $3.9 million for an outlay of $100,000. This would appear quite cost effective.

The second form of risk management operates in the opposite direction — it involves an investment in LRA even though expected net benefits, *as normally measured,* are likely to be reduced. This is not irrational — maximising expected net benefits is not likely to be the appropriate objective of either individuals or the community where such a strategy entails heightened risk.

By analogy, anyone seeking to maximise the net financial benefits of owning a car would not purchase non-compulsory insurance. Most drivers can safely assume that their insurance premium exceeds the average cost of claims made. However, most people do insure because the implications of a serious accident (for example, collision with a Rolls Royce) which was the responsibility of the driver would be financially devastating. The expected financial costs attach equal weight to a hundred instances of saving $1,000 and one instance (which just might be in the first year) of losing $100,000 but for most people this is not the case.

The same logic applies to land use decisions. Even where the risks of serious, largely irreversible loss of resource and financial liability are very small, most in the community would attach considerable weight to reducing such risks. This is likely to be all the more the case where public health issues arise. The reality is that, in many settings, the community has demonstrated (more through demands for regulation than through individual action) a willingness to forgo considerable expected benefit in order to reduce risks of extreme loss. The "precautionary principle", often cited in support of low risk environmental strategies, reflects this logic.

Financial markets have long built allowance for such risks into project evaluations. Effectively, where there are risks then markets tend to seek higher rates of return (they impose a "risk premium"). In effect, this means that, of two projects with the same expected benefits and costs but where one has a higher variability and hence

risk, the less risky one will be favoured. In fact, up to a, point the less risky one will be favoured even though expected benefits and costs (assessed without any risk premium) are less than for the riskier prospect. There is a trade-off between expected returns and risks.

An alternative way of looking at this is to view the community as attaching additional costs to a project to reflect its riskiness. The smaller the risk, the smaller these costs. Conversely, the larger the risks, the larger the sum the community might be willing to pay to avoid the risks. Viewed in these terms, the project offering the highest expected net benefit (net of the risk costs as well as other costs) will be preferred.

From an analytical perspective, there are two logical ways into allowing for these risk factors. One is to impose a higher discount rate on the riskier project, in line with the sorts of risk profile which have been documented in great detail by financial analysts. The other would seek more direct measurement of the value the community would attach to the risk reduction offered by an LRA investment. Both methodologies can be accommodated within the proposed framework. Some recent work examining community attitudes to risk, and especially the risks of irreversible damage to the resource base, suggests that the latter may be more soundly based, though probably more costly to implement.

2.4.4 Assessing benefits from specific project outcomes

Most discussion and analysis of the costs and benefits of LRA has, to date, focused on survey-specific costs and benefits. In effect, all the land resource assessment activity which has already taken place is treated as a sunk cost — and the focus is on the additional benefits and additional costs which flow from undertaking a fresh survey of an area. This approach, if implemented consistently, is sound and appropriate where a project-specific emphasis is taken. In practice, there has been some blurring of the lines, with a temptation to claim the benefits from sunk investments as part of the justification for a new or most recent investment.

A significant class of benefits arises from measurable changes in the world. In standard planning terminology, such changes are called "outcomes". It is also well known that outcomes are difficult to describe; it being easier to describe processes than results. Sometimes, outcomes from a LRA project can be readily identified and described. However, consultations have indicated that this is not always so — discussion usually centres around uses of information. Even so, those responsible for planning or undertaking surveys do not know how LRA information is being used, and indeed some uses were only possible by virtue of technology that was not available at the time of the survey. Such benefits should continue to form part of the justification for these surveys.

Box 2.4 Burdekin River Irrigation Area (BRIA) study

Even though the BRIA study was given a high priority at the time, in assessing its benefits it is necessary to ask what might have happened otherwise.

One alternative is that the BRIA might not have been developed at all, in which case, none of the increased agricultural production due to irrigation would have been realised. Under this scenario the value of increased production is a benefit attributable jointly to the study and subsequent development work. There is no, non-arbitrary, way to apportion benefits between LRA study and other development work. Fortunately, there is no need for such apportionment for the purposes of ACIL's framework.

Another alternative is that the BRIA might have been developed anyway, without using LRA information. Under this scenario, there could have been serious land degradation, due to salinisation and groundwater rise. Subsequently, degraded areas might have been rehabilitated, at considerable cost; or might have stayed degraded, at the cost of loss of productive capacity.

A third alternative is that, even if the study had not been funded by the Queensland Government, then information may have been collected anyway. This scenario then leads back into the two previous, in that information collected might have enabled some increase in production, or some avoidance of damage.

Practically speaking, alternatives to the BRIA would be some combination of the above, albeit with probabilities that may be hard to specify. The benefit attributable to the BRIA study is therefore some weighted combination of the benefits compared to the alternative scenarios. In other words, if there was probability p1 of alternative scenario S1 with loss of benefits b1, probability p2 of scenario S2, with loss of benefits b2, etc; then the benefit due to the BRIA study is p1b1+p2b2+p3b3.

The first step in assessing benefits is to identify them. It makes good sense, and indeed was one of the terms of reference for this study, to identify the types of uses to which LRA information could be put. However, it is worth making the point that using information does not necessarily confer benefits. Rather, benefits arise from measurable changes in the state of the world, which of course may have come about as a result of using LRA information. The approach identify outcomes.

The following subsections describe the broad elements of the approach and analytical techniques which can be used to quantify the following elements:

- identifying outcomes that would not have occurred to the same extent had the LRA study not been done;
- taking account of the uncertainty in respect of alternative outcomes;
- finding values for net benefits, especially those which can be difficult to measure.

2.4.4.1 Techniques for identifying outcomes

ACIL's survey of LRA projects and subsequent consultations have resulted in lists of over 70 uses, and somewhat fewer outcomes. We are interested in synthesising collective experience of LRA activity from these lists. What is needed is a way of structuring this list:

- to be easily useable as an aid in identifying actual, anticipated and unexpected benefits; and
- to be capable of being updated, as other outcomes arise;
- but which does not constrain any subsequent analysis of benefits

Box 2.5 shows one result of this structuring, namely summarising to a list of 18 general categories of uses of information. Detailed responses from the survey are the subject of a separate report to ACLEP, *Responses to ACIL Survey for ACLEP*.

Box 2.5: Uses of LRA data

Categories of uses
Land use assessment
Planning & development - industry, strategic level
Planning & development - regional level
Planning & development - local or urban level
Planning & development - property level
Site specific applications
Property Valuation

Preparation of Local Environment Plans
Identification of areas of land with degradation potential
Drought assessment & monitoring, modelling
Conservation areas - planning, management
Integrated Catchment Management
Detailed vegetation studies / surveys
Forestry planning, management
Reference Soil information
Community awareness activities
Spatial Information Analysis
Research, education
Training

Source: ACIL analysis of survey of LRA projects.

Surveys reported some outcomes associated with preceding uses of LRA information. ACIL has supplemented those with other possible outcomes.

Box 2.6: Outcomes of using LRA information	
Category of outcomes	Examples
Increased economic production	Targeted soils with potential for increased productivity Tasmanian Forest Soils
Development of industry	Site selection for manned spacecraft re-entry
More efficient property valuation	In the case of private buyers, result is a better idea of the resources and potential problems which they are buying (so cost avoided in case land is overpriced). Valuer Generals Office may use the maps where available to determine land value
More productive use of staff resources	Digital Atlas ensures consistent data format
Better catchment management	Improved water quality
Avoided infrastructure damage	Information is identify potential problems associated with proposed subdivisions and to place restrictions on activities in proposed subdivisions (eg enforce foundation standards to cope with soils which shrink and swell or avoidance of sites) Curlewis study Optimum route selection for optical fibre cable
Avoided environmental damage	Land suitability predictions validated and some farms not released for irrigation development Burdekin study
Remediation / rehabilitation of degraded or damaged land	Recommendations for revegetation of degraded lands with native vegetation based on original (and therefore most well suited species) vegetation types. Result = costs saved by planting appropriate species initially no need for tree trials etc Curlewis study
Preservation of biodiversity	
Source: ACIL analysis of survey of LRA projects.	

There is not a one to one relationship between uses and outcomes. In other words, the same outcomes may arise from more than one use of LRA information. For example, LRA information might be used to recognise the potential for acid sulphate soils, and hence to prevent certain types of land use. Outcomes could include avoiding damage to receiving waters, with benefits of preserving recreation and amenity values. Exactly the same outcomes may arise from using LRA information to exclude land uses for reasons of, say, erosion control. Benefits from such an outcome should not be counted twice.

The many to many relationships between uses and outcomes means that it is not possible to have a hierarchical list of uses and outcomes. Rather, Box 2.7 is intended to prompt for potential outcomes which may arise from various types of uses.

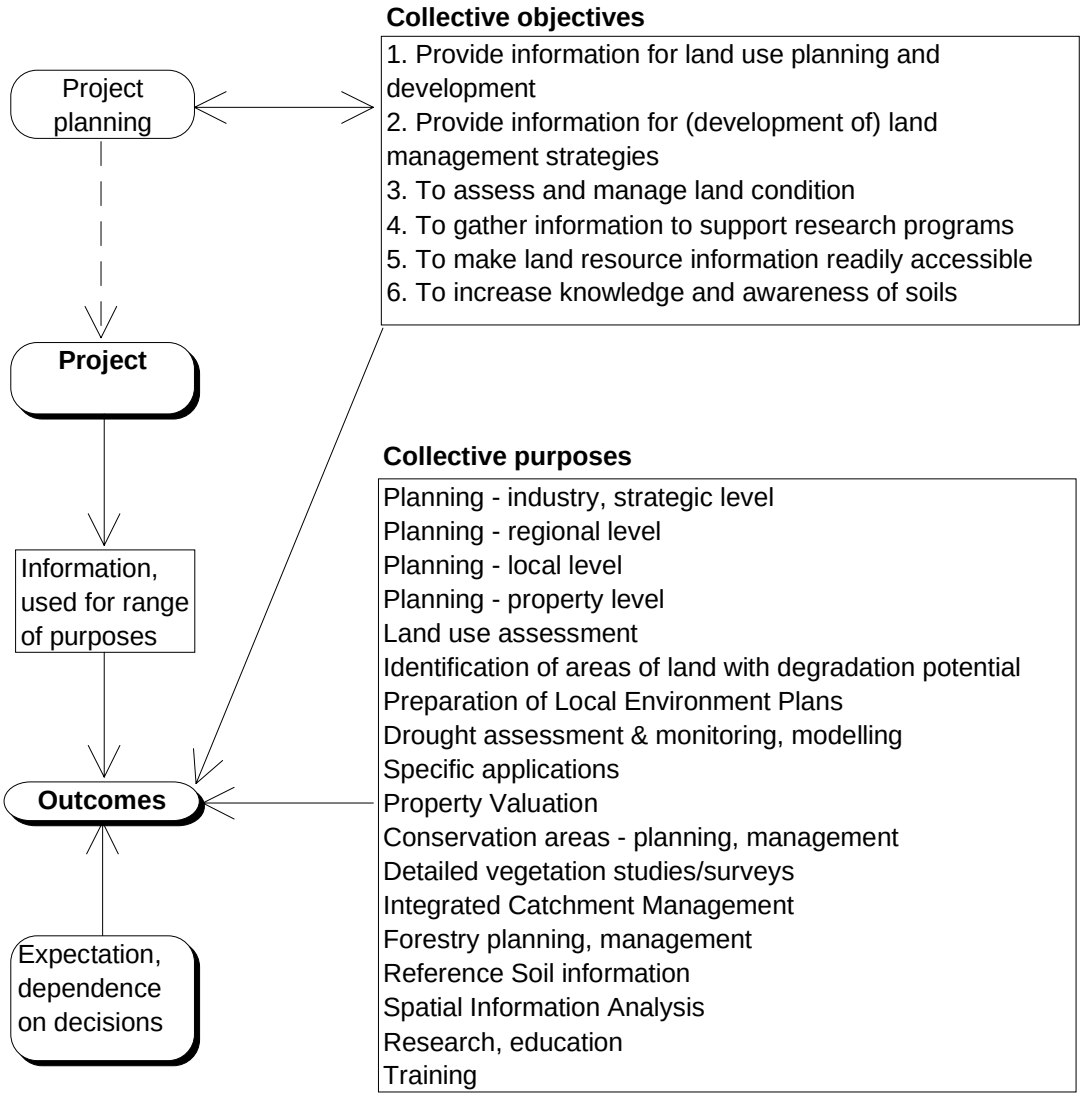
Box 2.7 Uses and outcomes

Use/Outcomes	Increased economic production	Develop-ment of industry	More efficient property valuation	More productive use of staff resources	Better catchment management	Avoided infra-structure damage	Avoided environmental damage	Remediation/ rehabilitation of degraded or damaged land	Preservation of biodiversity
Land use assessment	1	1	1		1				1
Planning - industry, strategic level	1	1							
Planning - regional level	1	1			1		1	1	1
Planning - local or urban level				1	1	1	1	1	
Planning - property level			1		1	1	1	1	
Site specific applications	1	1		1		1			1
Property Valuation			1						
Preparation of Local Environment Plans					1		1	1	1
Identification of areas of land with degradation potential	1		1	1		1	1	1	1
Drought assessment & monitoring, modelling	1	1	1				1		
Conservation areas - planning, management				1	1		1	1	1
Integrated Catchment Management				1	1				1
Detailed vegetation studies/surveys				1					1
Forestry planning, management	1			1					1
Reference Soil information	1	1		1		1			
Community awareness activities				1		1	1		1
Spatial Information Analysis	1	1		1			1		
Research, education	1			1			1		
Training	1			1		1			

Another result of ACIL's structuring of collective experience of LRA has been to close the loop between planning and evaluation. As just described, project outcomes might arise on the basis of the type of information collected, which in turn depend on objectives. However, going the other way, ex-post evaluation of a project

requires a comparison of outcomes with planned objectives. Box 2.8 shows this additional approach to identifying outcomes.

Box 2.8: Collective experience



Source: ACIL analysis of survey of LRA projects.

ACIL has designed this framework to be consistent with standard planning methodologies, which typically use *objectives* and *measurable outcomes*. There is a variety of definitions of these planning terms — for the purpose of this report:

Objectives are statements of reasons for undertaking a planned activity.

Outcomes are statements of what is (hoped to be) achieved, incorporating ways of measurement.

There is an extensive literature on planning, notably the (complex) area of setting measurable outcomes and performance indicators. There is merit in the framework linking with planning processes, without straying from the primary purpose of quantitative assessment.

It should be noted that ACIL has not included better planning or better understanding as outcomes *per se*. The reason is that planning is an enabling activity, rather than a directly measurable benefit. This is not to say that planning has no benefit, as the likelihood of improvements being achieved may well be lower in the absence of planning. Rather the calculation of benefit has to be done by taking into account uncertainty about outcomes being achieved, as described in section 2.4.4.2.

2.4.4.2 Accounting for uncertain outcomes

By their very nature, many of the outcomes are conditional on other activities or outcomes. For example, assessing avoided costs of structural damage from using information about acid sulphate soils, say, needs to compare:

- a scenario in which there is no information, and structures are built in an area with acid sulphate soil, without appropriate design;
- a scenario in which there is no prior information, but structures are appropriately designed anyway;
- scenarios in which there is information, which may or may not be taken into account.

Fortunately, there is an accepted methodology which takes account of values which are both uncertain and contingent on particular decisions being made, often called "decision analysis", which was originally designed to assist in making decisions in an uncertain environment. In brief, decision analysis[9] is about making:

> "deliberate, reasoned, and logical analysis of a problem, an analysis that can suggest a best course of experimentation and action in an uncertain environment. It is assumed that the decision maker must make a choice, or a sequence of choices, among various possible courses of action; that the consequence of any course of action depends on an unpredictable event or "state of the world"; that the decision maker already has some information at hand that bears on the uncertainties of the problem and therefore can make some judgments about these uncertainties; and that they can obtain further information, at a cost, that bears on these uncertainties. It is also assumed that the decision maker wishes to choose a strategy for experimentation and action that is logically consistent with 1) basic preferences for consequences, and 2) basic judgments about the unknown states or events".

The merit in using decision analysis is that it provides a structured way of describing and analysing probabilities of outcomes being achieved. Indeed there are software tools[10] to assist the process.

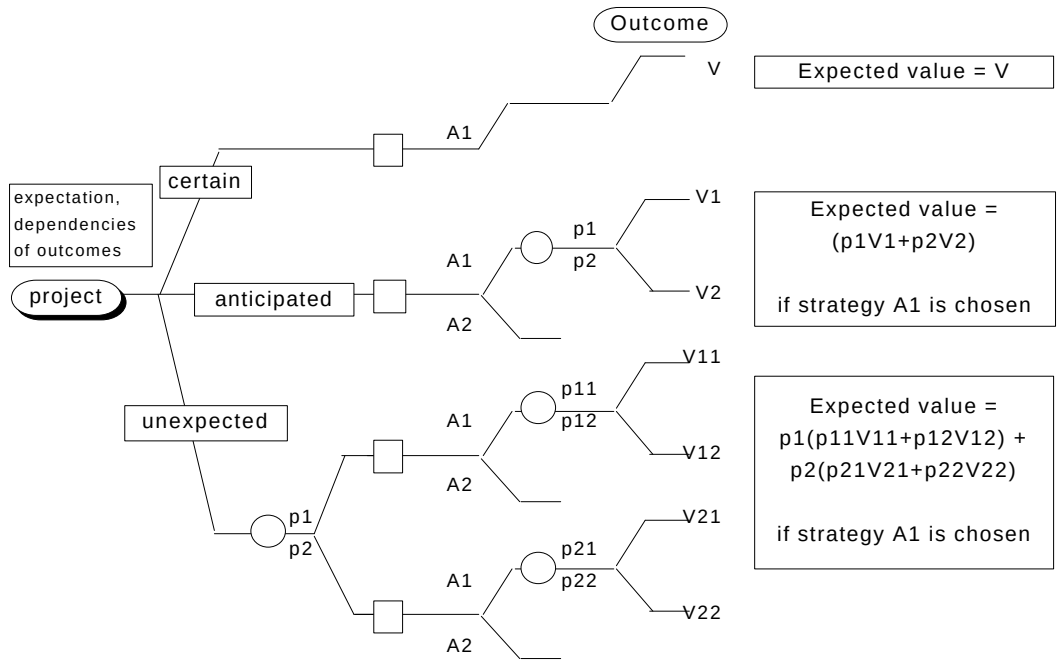
The characteristics that LRA shares with research, namely difficulties in identifying and weighing benefits, are precisely those which decision analysis can handle. In fact, decision analysis has been used extensively in evaluation of research.

9 Raiffa, H., *Decision Analysis*, Introductory Lectures on Choices under Uncertainty, Harvard University.

10 DPL (Decision Programming Language), ADA Decision Systems, California.

Box 2.9 illustrates the approach:

Box 2.9: Decision Tree



The key points from Box 2.9 are:

- Outcomes which are already realised, or certain to be realised, have some value.
- Outcomes which are anticipated, but which have probabilities p1 and p2, if a future decision is made to adopt strategy A1, have an *expected value* depending on these probabilities.
- More generally, outcomes may arise as a consequence of decisions which arise from earlier options. Decision analysis provides a way of analysing such complexities.

Box 2.10: Valuing expected benefits

Suppose that there is a probability of, say, 50% that information from a LRA study might be taken up and used to improve agricultural production in an area. Suppose also that improved production might be worth, say, $5/ha over an area of, say, 1,000ha, for 5 years. The *expected value* of benefits from improved production would be:

50% * $5/ha * 1,000ha over 5 years,

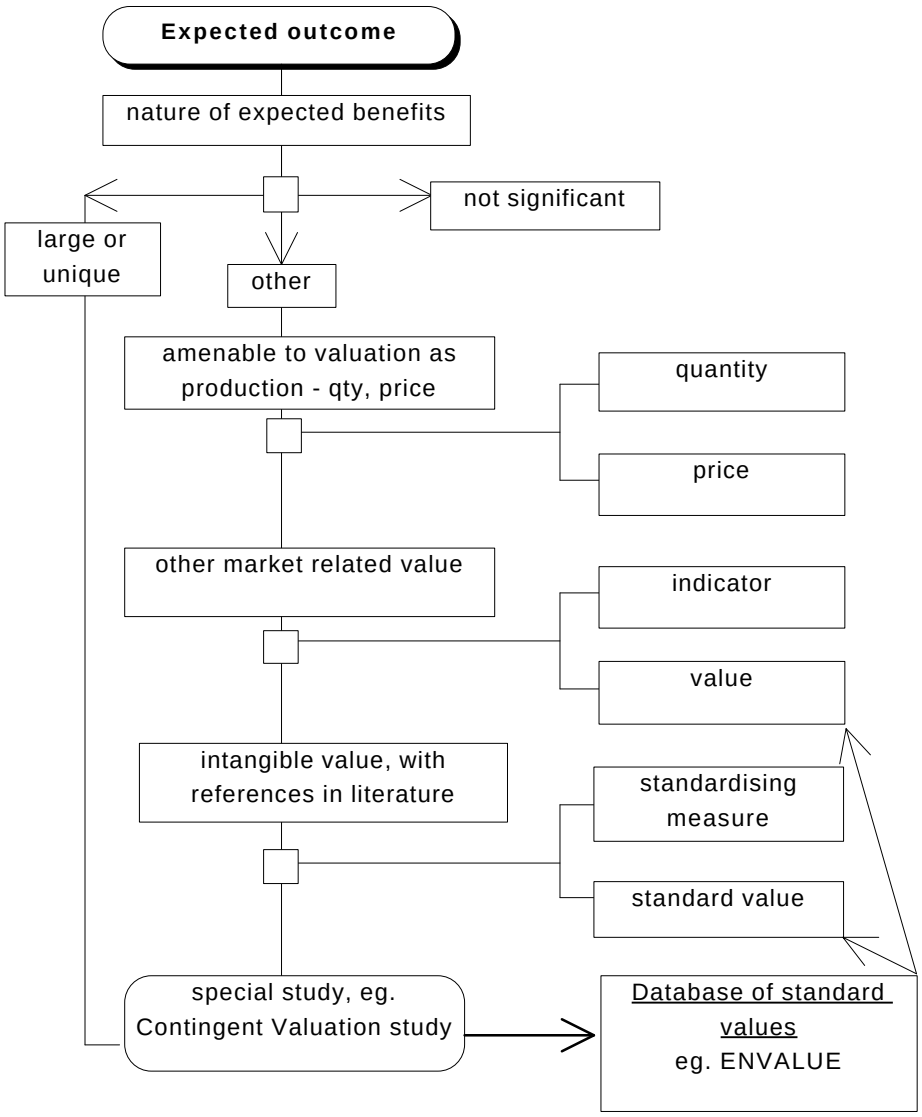
which can be appropriately discounted back to a net present value.

2.4.4.3 Techniques for assessing benefits

Last, but by no means least, is the task of actually quantifying net benefits. The challenge here is that many of the benefits do not have direct market valuations. Assessment and measurement of such benefits is an area of active debate and research, and there is an extensive literature. It is beyond the scope of this report to cover all the nuances, but section 2.4.4.4 presents widely accepted techniques and further references.

ACIL's LRA framework is designed to recognise the ease with which benefits can be quantified, as illustrated in Box 2.11. For example, benefits arising in respect of changes in production can readily be valued, as described below. At the other extreme, some benefits might be considered so unique that it is felt necessary to undertake a special study to assess what people might be willing to pay to achieve them. In broad terms, benefits at the former end of the spectrum are likely to be more widely accepted.

Box 2.11: Methodology for assessing benefits



2.4.4.3.1 Production values

Estimates of benefits made by direct valuation are likely to be the easiest to produce, but nonetheless require care if they are to be accepted.

In particular, it is necessary to take off costs incurred in reaching the benefits. This may be obvious in the case of direct increases in production, but requires more care in the case of avoided loss of value. For example, suppose that agricultural production of an area is expected to be lost in the absence of LRA information. The benefit of avoiding the loss is not equal to the gross amount of production, because the costs of that production would disappear also. In simple terms, closing down a business means loss of profits, not loss of gross turnover.

One approach is to count both avoided loss of output and avoided costs of inputs. This raises questions about:

- how to value inputs; and
- how to value production which has been lost.

ACIL's LRA framework uses an approach consistent with calculation of Gross Domestic Product (GDP) in Australian National Accounts[11], which the Australian Bureau of Statistics (ABS) estimates using income and expenditure approaches. At an industry level, the measure of contribution of an industry to the national economy is called "value added", calculated as follows[12]:

> "This approach to measuring economic production is usually applied to industries. The unduplicated value of industrial production can be measured by taking the market value of the goods and services produced by an industry (called its *gross output*) and deducting the cost of goods and services used up by the industry in the productive process (*intermediate consumption*) which leaves the value added by the industry (also called its *gross product*)."

Comprehensive estimates of value-added can be the subject of entire studies in themselves. For the purpose of this framework, however, it should usually be

11 Australian Bureau of Statistics 1990, *Australian National Accounts - Concepts, Sources and Method*s, ABS Catalogue No.5216.0, p.7-8.

12 *ibid*, p.7.

sufficient to estimate value-added using standard ratios, for example, as illustrated in Box 2.12.

Box 2.12: Value-added, eg. for agriculture

Value-added could be calculated from the market value of goods less cost of inputs. However, a recurring theme in ACIL's framework is maximising the use of existing information. In this regard, there are already published estimates of value-added for various industry sectors and states. For example, for the sheep industry in South Australia, average income per farm in 1993/94 was $14,958(1) including operator and family labour plus $4,668(2) hired labour. Value-added per farm was therefore $19,616 out of total receipts of $149,406, or 13% of gross production in 1993/94. In view of fluctuations in farm incomes, it is better to use average value-added, as has been done, for example, in Box 4.1.5.

(1) ABARE 1996, *Farm Surveys Report 96*, Table F10
(2) *ibid*, Table F9

Another trap to watch is that, if an industry were to close down in one area but start up somewhere else in Australia, then there may not be any change in national economic indicators. There will be changes between regions, and for this reason, the import is sometimes called a 'transfer'. It is appropriate to count the loss of value-added only if the industry was not replaced at all, or replaced by imports.

2.4.4.3.2 Other market related values

Other benefits may be estimated with reference to market values, such as property prices[13]. For example, erosion damage might reasonably be valued as a decrease in property price; assuming a reasonably informed market for land. This implies a value for the benefits of avoiding erosion damage (again to the extent that this might be attributed to an LRA study). Market related benefits can sometimes be derived readily for a particular project; but more often are inferred from other studies.

As a general rule, difficulties with valuations increase as benefits become less market related.

13 Methods of valuation using property pricing are called 'hedonic pricing'.

2.4.4.3.3 Intangible values

Special care is needed with those benefits which are less clearly market related, such as "better environmental management". Values which are derived from use of resources, such as recreational use of an area, are sometimes amenable to valuation using proxies such as users' costs in travelling to the area. Another class of methods, which has also been applied to so-called "existence" values, make use of surveys to elicit people's stated willingness to pay for benefits.

2.4.4.3.4 Unexpected benefits

A recurring theme throughout the study is that there have been benefits from LRA studies which could not have been anticipated at the time of the study. A striking example is the digitising of the *Atlas of Australian Soils*, which is described in Section 4.3. Digitising technology was not available at the time that the Atlas was prepared, and consequent benefits could not have been included in an evaluation in 1968 of potential benefits of the Atlas.

Unexpected benefits are a characteristic of research work, which LRA shares to a degree, as noted in Section 2.1. It is appropriate to include a loading for unexpected benefits, taking into account:

- collective experience for similar types of projects; and
- the extent to which unexpected benefits have already been anticipated in the preceding category.

That said, it would be unusual for a LRA study to be justified predominantly on the basis of unexpected benefits.

2.4.4.3.5 Unrecognised benefits

The above assessment of benefits may be perceived as a little pessimistic in character, reflecting the view which came through strongly to the consultants in the course of this study, that LRA data is often under-exploited. In other words, LRA surveys contain potentially valuable information, but much of this value is not

captured because of weaknesses in the processes which identify, assess and choose between land use options.

Accept for the moment that some of the data is going to be underutilised and that some inappropriate land use decisions are going to be made as a result. Of the better decisions that are made through the use of LRA information, how many of these will arise because of the availability of the specific survey under consideration. The question goes to the heart of the so-called 'do nothing option' which provides the benchmark for sound cost benefit analysis. It is apparent to the consultants that a lot of private sector (often local government driven) project specific land resource assessment now takes place. Similarly, government agencies involved in land use activities are making these investments. Many would claim considerable benefits from access to the LRA surveys. Many would also argue that in the absence of these surveys they would just have to pay more, but would still need access to the same information before key land use decisions were taken.

It is easy to say that there are potentially big opportunities to be had through the sound and thorough use of LRA information in land use planning, and that this potential value comes nowhere near being fully realised. ACIL's framework is designed to assist in quantifying benefits. But this is a second best approach, compared to having demand and hence benefits revealed by what people are actually willing to pay in a market for information.

2.4.4.4 Quantification of benefits

In specifying the methodology for quantifying benefits, it is useful to distinguish between measurement and valuation. The latter implies some statement about what people might be willing to pay for a result which may be difficult to define, even though the extent of the result can be objectively measured. For example, what is the community willingness to pay to reduce salinity problems in a defined area?

Section 2.4.4.4.1 describes the approach to measuring outcomes and section 2.4.4.4.2 describes the approach to valuing benefits, although the two approaches are inter-related.

2.4.4.4.1 Indicators

Ideally, (project) plans would include statements of indicators to be used for measurement of anticipated outcomes. But this is easier said than done, particularly for projects with long time horizons and public policy objectives.

A key challenge for ACIL's framework is to identify appropriate indicators. Reflecting this, survey responses did not nominate very many indicators. This seems to be due to the diverse range of indicators rather than lack of knowledge, as follow-up consultations elicited a rich variety. Fortunately indicators relating to outcomes for one project apply to similar outcomes for other projects, so it makes sense to put together structured lists of indicators. Box 2.13 contains such a list, culled from ACIL's knowledge of the literature, experience, and consultation.

Box 2.13: Outcomes and indicators

Outcome	Indicator	Type of measure
Increased economic production	yield, area	production
Development of industry	value-added	industry contribution to GDP
More efficient property valuation	turnover	improvement in productivity
More productive use of staff resources	number of staff	improvement in productivity
Better catchment management	area, number of people concerned	improvement in water quality
Avoided infrastructure damage	amount	extent
Avoided environmental damage	area, number of people concerned	loss of productive capacity cost of remediation loss of recreation values loss of amenity values
Remediation/rehabilitation of degraded or damaged land	as above	as above
Preservation of biodiversity	as above	as above

2.4.4.4.2 Standard values

Another challenge for the methodology is to find ways of valuing benefits which:

- will be generally accepted; and
- minimise the need for costly, project specific studies.

The key to the methodology is to make as much use as possible of a suitably broad collection of "standard values" — estimated in empirical studies, which have a wider currency. Such standard values have an important use in assessing benefits, provided due care is taken with their application in particular locations, as discussed in a subsequent section.

Box 2.14: Example standard values — Wetlands

One way to value benefits of avoiding damage to wetlands is in terms of what people might be willing to pay for recreational use and preservation of the wetlands. Possible indicators include willingness to pay per person or per visitor.

Stone[1] has used a contingent valuation method to estimate recreational and preservation value, for Victorians, of the Barmah wetlands along the Murray River. Personal interviews with 203 people in regional and metropolitan areas in Victoria indicated an average value of $29 per person in 1992, comprising 7.6% use value, 21.4% option value, 40.6% bequest value and 30.4% existence value.

Sappideen[2] used a contingent valuation method to estimate willingness to pay to preserve water quality (holding salinity at 500-5,000 ppm, rather than increasing it to 10,000-15,000 ppm) to maintain the recreation value of a wetland, at $3 per person per visit.

1. Stone A, 1991, Valuing Wetlands: a Contingent Valuation Approach *paper presented to the 35th Annual Conference of the Australian Agricultural Economics Society. University of New England, Armidale, 11-14 February*

2. Sappideen B, 1992, "Valuing the Recreation Benefits of Sale Wetlands using Contingent Valuation", in Lockwood, M. And DeLacy, T. (Eds). Valuing Natural Areas: Applications and Problems of the Contingent Valuation Method. *Johnstone Centre of Parks, Recreation and Heritage, Charles Sturt University, Albury*

2.4.4.4.3 Database of standard values

ACIL's methodology is based on using existing values from the literature to the maximum degree possible. If benefits were expected to be significantly larger than published values, or if there were no useful precedents, then there may be merit in commissioning special studies. However, conducting empirical studies to measure benefits tends to be very costly and perhaps site specific.

ACIL believes that there is merit in having a database of standard values. The NSW Environmental Protection Agency (NSW EPA) has published an environmental valuation database, *ENVALUE*, which is very useful. Even so, there may be merit in enhancing land evaluation databases to include relevant information.

2.4.4.4.4 Benefit transfer

Value of benefits for specific projects will typically depend on their particular local circumstances. For example, benefits from land management in a wilderness

heritage area could be expected to be different from a residential area. Likewise, values from overseas studies may not be immediately applicable to Australia, due to differences in exchange rates, salary rates, and recreational values.

The solution is to transfer an existing environmental valuation to a different context, so-called **"benefit transfer"**. The name, "benefit transfer", was coined by Desvousages, Naughton & Parsons (1992)[14] to describe the use of monetary valuations given in existing studies at sites different from the original study site. The site where an existing study was conducted is termed the "study site", while the specific location of the project is termed the "policy site". Benefits are to be estimated at the "policy site" by transferring values from the "study site".

Benefit transfer is used to avoid the substantial costs and lead time involved in conducting studies at policy sites. The *NSW EPA Environmental Database Handbook (ENVALUE Handbook*) says[15] that "in view of its advantages, the use of benefit transfer is likely to increase in line with the expected increase in demand by government agencies for environmental valuations within areas of public decision making". Benefit transfer is an important technique for using published results, but can be non trivial, given the wide diversity of land resource assessment studies. Important considerations are described in detail in the ENVALUE Report, Part 1, Chapter 3.

Applications of benefit transfer can also be found in:

- Pearce, D., Whittington, D. and Georgiou, S., (1994), Project and policy appraisals: integrating economics and environment, OECD France;

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14 Desvousages, W.H., Naughton, M.C. & Parsons, G.R. (1992) 'Benefit Transfer: Conceptual Problems In Estimating Water Quality Benefits Using Existing Studies', *Water Resources Research*, 28(3): p675-683.

15 NSW Environmental Protection Agency (1995) *NSW EPA Environmental Valuation Database Handbook*, NSW EPA, p9.

- Loomis, J., Provencher, W., and Brown, W.G., "Evaluating the Transferability of Regional Recreation Demand Equations", in Economic Valuation of Natural Resources, edited by Johnson, R.L. and Johnson, G.V., (1990) Westview Press, USA.

2.4.4.5 Caution!

Readers should be aware that there is not universal agreement on the use of cost benefit analysis, especially when benefits are of an environmental or social nature. Rather there is ongoing debate within the literature. This debate is, however, less about the broad concept of benefit-cost built into the earlier discussion than it is about specific tools which have been developed for quantifying benefits and costs. ACIL considers it perfectly appropriate to address the questions of whether the benefits of an LRA exceed the costs — in the sense of asking whether the community would be better off or worse off for having the LRA, costs as well as benefits. There are fine philosophical debating points about what is meant by community being better off, but practical government requires some basis for making such judgments and this has been assumed here.

The concerns with specifics of methodology do require greater care, especially as the types of benefits often sought through LRA investments are precisely of the kind where these concerns are greatest. For example, amenity values of natural resources, which might be better protected though LRA investments, are not readily quantified through the operation of markets. Considerable reliance is typically placed on survey-based methods for assessing how much individuals might be "willing to pay" to preserve these values or to reduce the risks of degrading these values. These methodologies are referred to as *contingent valuation methods.*

The *Journal of Economic Perspectives* recently devoted an issue[16] to the debate focussing on assessing (particularly environmental) benefits through contingent valuation surveys:

- Portney, P.R. "The Contingent Valuation Debate: Why Economists should care", p.3-17;
- Hanemann, W.M. "Valuing the Environment through Contingent Valuation", p.19-43.
- Diamond, P.A. and Hausmann, J.A. "Contingent Valuation: Is Some Number Better Than No Number?", p.45-64.

Diamond and Hanemann criticise the argument often used to justify cost-benefit analysis, namely that "some number is better than no number", on the grounds that possible inaccuracies or biases in the numbers may mislead policy decisions. These problems are seen as most acute where the values concerned relate more to the *satisfaction of knowing* that a key resource is intact than to the active use of the resource by the individuals surveyed.

While Hanemann acknowledges the risks of meaningless result from studies that are done poorly, as with any research, he points out that results from studies using contingent valuation methodology are becoming more widely used by governments in making decisions. Indeed, some Australian Government agencies have made use of contingent valuation results. In particular, this proposed application is at the leading edge.

ACIL believes that decisions about projects can be better made *with* well founded information about environmental and community benefits than without. Hence the

16 Journal of Economic Perspectives, 8(4) Fall 1994.

aim in designing this framework has been to enable the gathering and analysis of such sound information.

At the same time, a sound understanding of the weaknesses and possible misinterpretation of these methods is essential if they are to be used and presented credibly. A key point is that difficulties in measurement do not imply that certain costs or benefits should be ignored. Instead, they need to be assessed with caution and, in weighing them, the framework must recognise and accommodate the related uncertainties.

Note that for some benefits and costs, the difficulties are not just measurement ones — there can also be problems of definition where the value "society" might attach to an outcome is heavily dependent on assumptions made regarding the manner in which individual values should be aggregated to reflect "society's" values.

Contingent valuation methods incorporate one aggregation system which seeks to emulate the value an informed market might place on the outcome if it were feasible to use a market and for the "winners" to compensate the "losers".

2.5 Assessment of costs

Assessment of costs is in general much easier than assessment of benefits. Agency information systems are usually designed to capture direct costs of collecting and processing LRA information, although not always allocated to individual projects because:

- many people from a range of areas contribute to LRA studies
  - field staff;
  - mapping staff;
  - staff involved in activities;

- records may not be readily accessible; and
- actual costs may be different to planned.

However, it is necessary to take into account costs of any supporting activities needed to enable realisation of outcomes. For example, if LRA work suggests remediation work, then benefits of the LRA study include expected (in the sense of section 2.4.4.2) net benefits, that is, expected benefits of the remediation minus expected costs, of undertaking the work.

Note that before any supporting activities are undertaken, it makes sense to attribute all expected net benefits to the LRA study. Once the activities have been done, their cost is "sunk". There is rarely any sensible way ex-post of apportioning benefits between LRA and supporting activities. One way, and another benefit of having a market in information, is to set a price for using information in subsequent stages. The benefit of the LRA information is then at least as large as people were willing to pay to use it in using it to realise outcomes.

In any event, costs can reasonably be estimated with precision comparable to benefits.

2.6 Time value of benefits and costs

Another feature of cost-benefit analysis is that costs and benefits occurring at different points in time are explicitly compared. This is necessary if only because costs are usually concentrated at the beginning of the project, while benefits occur over an extended time period. The technique of converting benefits and costs that occur over time into present values is known as discounting. This involves "factoring down" costs and benefits according to the extent to which they occur in the future. This discounting is one way of taking into account the real costs of tying up funds and other resources which might otherwise have been used to generate benefits of a different kind.

The fundamental principle of discounting — in its recognition that there are opportunity costs associated with resources and with the investment capability associated with rapid exploitation of those resources — is fairly unexceptional and is certainly a principle which ACIL endorses. However, there is greater scope for arguing with the way in which it is used in standard cost-benefit analysis and with the additional assumptions implicit in this methodology.

Standard discounting assumes a constant rate of return available on the options which are forgone in choosing a particular investment (such as an investment in LRA). This rate of return is typically of the order of 7 to 8 per cent, *after adjusting for inflation* (and risk), and such rates are commonly prescribed by governments as part of their standard guidelines for project and policy evaluation. The rationale for this is fairly solid in the case of financial costs — because active equity and debt markets exist and, broadly speaking, deliver options with this characteristic.

Box 2.15 Standard financial discounting

Standard financial discounting is a method for converting a series of cash flows, typically annual, back to a single value, typically at the start of the period, by dividing by (1+discount rate) to the power of the year number, and summing. The following sample calculation shows how this is done, for a discount rate of 7% over 5 years:

Year	Annual cash flow	Discount factor	Discounted cash flow
1	$ 10.00	1.00	$ 10.00
2	$ 20.00	0.93	$ 18.69
3	$ 30.00	0.87	$ 26.20
4	$ 40.00	0.82	$ 32.65
5	$ 50.00	0.76	$ 38.14
			$ 125.69

The case for discounting is not so clear with some classes of benefits for which markets do not exist. For example, in respect of fundamental environmental degradation, it may be that the community would seek to impose standards which are rather stricter, and may even entail some absolutes. Some might argue that this generation has a responsibility, to subsequent generations, not to degrade the

environment beyond a certain point, or in an irreversible manner etc; this is sometimes used to argue for the use of a lower (sometimes zero) discount rate in relation to environmental (public health etc) benefits and costs. Some evidence cited in support of this effect is based on contingent valuation surveys which suggest that short term discounting at the normal rates fits reasonably well with community preferences, but that actual community discounting over longer time periods is much less than is implied by normal compounding of discount rates. The implied attitude is understandable, but needs to be scrutinised carefully:

- In part, this attitude may reflect an *instinctive* valuation of benefits of environmental retention etc which should, appropriately, be reflected in the benefits and costs of the analysis. In this case, the argument would logically be for the use of a lower discount rate as an approximate adjustment for the failure to fully value all benefits and costs, particularly those which lie well in the future.
  - Under some circumstances, this could provide a "rough justice" correction, but this is likely to be the case almost by coincidence. ACIL would prefer that greater explicitness be introduced into the statement of benefits and costs and even that an increasing set of ill-defined opportunity costs associated with degradation be incorporated into the analysis so that a sound debate about these impacts can be conducted.
- The attitude could be in part attributable to poor general community understanding of the mathematics of discounting.
  - Many people are still amazed to learn the total dollars that they pay off on a standard housing loan — typically many times more than the nominal sum borrowed. Similarly, long term investors can be staggered to learn of the impact of compounding on their investments. The effects are counter intuitive and much stronger than instinct suggests.

– This is likely to be even more the case when dealing with costs and benefits where investment returns, expressed as yields etc, are not normally available.

ACIL is reluctant, therefore, to suggest that a lower discount rate be used in these analyses, but notes that there is an active debate about these matters. ACIL's recommendation is that greater emphasis be given to recognising the range of non-market values associated with many aspects of land use activities.

A somewhat similar, but perhaps even more substantial, issue arises where careful attention is paid to valuing the precise options involved and their associated opportunity costs. It is normal to assume that a widget, a dollar, a day's amenity value in a national park etc has the same value to an individual whether it is being "bought" or "sold". A person who has only just been persuaded to buy a widget for the sum of $1 should probably be fairly relaxed about selling it (or having it compulsorily acquired) for $1. Certainly, if widgets are readily available in the marketplace for $1, this would seem sensibly to be the case. In fact, a number of recent studies suggest this is not the case[17]. The owner of the widget appears typically to want considerably more before selling than that owner would be willing to pay to acquire. In essence, this literature suggests that there is a psychological reluctance to trade.

Given that this effect occurs for something as readily available as a widget (lottery ticket, investment portfolio etc) it would not be surprising to find a much stronger effect in relation to assets which are not readily available in the marketplace — access to, or mere existence of, a pristine Kakadu environment, an unpolluted river system etc (even, for reasons of personal emotional ties, a person's own home). The literature suggests that people would typically require far more compensation for loss of access to these assets than they might be willing to pay to create such assets

17 An excellent example is the publicly funded compensation to owners of outlawed semi-automatic and automatic guns in Australia in 1996.

in the first place. This may flow through into any attempt at measuring how much the community would be willing to pay to preserve an asset being an understatement of the compensation they would require for its loss. There is evidence that the values attached to assets depends strongly on what people think they start with as their "rights"; there are so-called "endowment" or "embedding" effects[18].

These issues are not yet well resolved but they do suggest that relatively simplistic application of cost-benefit tools to investments — such as LRA — where the benefits may well be in the form of sounder environmental / public health / secure housing development outcomes could be biased towards underestimating the cost or benefit. ACIL believes, as a result, that significant care needs to be directed at the statement of costs and benefits, including a recognition of the range of intangible considerations, and that it is quite appropriate to incorporate into the final assessment some of these considerations.

In other words, the case for an LRA can be strengthened by showing sound empirical reasons to suspect that the simple numbers emerging are likely to be underestimating the cost effectiveness. Of course, the extent of such bias will vary significantly between LRAs. In areas where commercial development will be the norm, these factors are likely to be modest in comparison with the more straightforward financial and risk factors. As the region develops stronger environmental dimensions — with reasonable expectations that the LRA investment

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18 For further discussion of these principles and of specific empirical evidence, see, for example:
Kahnemann, D., J. Knetsch and R. Thaler (1991), 'Experimental Tests of the Endowment Effect and the Coase Theorem', in Richard Thaler (ed.), *Quasi rational economics.* New York: Russell Sage Foundation.

Loomis, J, M. Lockwood and T. DeLacy (1993), *Some Empirical Evidence on Embedding Effects in Contingent Valuation of Forest Protection*. Journal of Environmental Economics and Management, 25(1), pp 45-55.

Knetsch, J., *Environmental Policy Implications of Disparities between Willingness to Pay and Compensation Demanded Measures of Values.* Journal of Environmental Economics and Management, 18(3), pp 227-37.

will reveal *and lead to the implementation of* more environmentally friendly outcomes, then the bias could also strengthen considerably.

Furthermore, the arguments do suggest that, where contingent valuation studies are to be used, then careful consideration should be given to the options which people are asked to value.

A great deal has been written about theory and applications of cost benefit analysis. This report has previously referred to a publication[19] by the Commonwealth Department of Finance (1991) which provides guidelines for the general application of the methodology to assist in applications such as those of the current framework. These guidelines are valuable methodologically, but are increasingly being seen as limited in the way that these complex issues involving community value systems are handled. The NSW Treasury has recently commissioned a study to develop new guidelines for policy evaluation where there are significant environmental impacts. Further references are given in the list at the end of this report.

2.7 Ranking LRA prospects

Where funds are scarce and perhaps even more so where required technical skills are scarce, there is a need for sound methods to be used in choosing how best to direct those scarce resources. In practice, this requires a means of ranking, or prioritising, LRA prospects — whether they be new surveys or investments in the further analysis and / or 'marketing' of existing information.

It will always be appropriate that there be a level of subjectivity and expert discretion in such ranking. However, the tools of cost benefit analysis can help to make the exercise of such discretion more informed and can provide strong guidance.

Suppose there is a long list of prospects for LRA investment — far longer than can

be afforded within the existing constraints, but all of which appear, *prima facie*, to be sound prospects which have been well designed. Suppose also that the objective of those setting priorities is to expend the available funds in such a way as to maximise the net benefits (in cost-benefit terms, to maximise the present value) of the benefits purchased with the funds.

The theoretically sound approach would be to assemble all subsets of LRA prospects which can be undertaken within the funding constraint and to undertake a cost benefit assessment of each of these subsets *viewed as an investment package*. That is, you would estimate the flow of benefits, costs and risks associated with the package of investments and calculate the net benefits associated with each package. The preferred set of investments would, *by definition*, be that package offering the highest net benefits. In effect, what is involved here is a constrained optimisation, involving maximising net benefits subject to a funds constraint.

Note that this approach does not require that individual LRA prospects be ranked; it simply entails a determination that a prospect is inside or outside the preferred investment set. In effect, what has been ranked is the set of feasible investment packages but the purpose is purely to find the highest ranked set. No more effort need be deployed in assessing individual packages than is needed to determine if it is the highest ranked — as soon as the analysis can establish that it offers a smaller net benefit than at least one other set, the analysis of that set can cease.

There are circumstances in which this theoretically sound approach may be justifiable — especially if the funding constraint rests with an agency with a relatively small set of LRA prospects. However, if a national perspective were to be taken then the task of homing in on the best set in this way can be daunting. If, for example, there were 100 LRA prospects of equal cost, of which only 20 could be

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19 Department of Finance (1991) *Handbook of Cost-Benefit Analysis*, AGPS Canberra

afforded, then the number of feasible packages of prospects to be assessed would be of the order of 10 to the power of 20. Even with clever algorithms for sifting out the least promising packages, the evaluation task itself is likely to more than consume all available funds and a lot of time. What is needed is an approach which can reasonably reliably find a 'good' package of prospects rather than one which guarantees to find the best package.

What is recommended is that individual prospects be ranked on the basis of their own benefit cost ratios; importantly, these need to be calculated in the way recommended earlier — as the ratio benefits less costs implied after the LRA investment is made, divided by the cost of the LRA investment. If gross costs over gross benefits is used, the method would not work. The point is that we want a measure of net benefits per dollar of LRA resource expended. Prospects can again be ranked on this basis.

If you then start with the highest ranked prospect and move down the list until the point is reached where the budget would extend no further, this will create a subset of prospects which, *prima facie*, offer the highest net benefits from investing the budget in LRA activities — the objective of the exercise. The method is not perfect, however. The net benefits offered by one prospect may change depending on which other prospects will be undertaken — a difficulty which is handled naturally when the packages of options are assessed.

This suggests that consideration might be given to any particularly strong interactions between prospects. For example, if the subset includes two prospects which would have involved considerable duplication, then the scope for removing such duplication should be considered. If one prospect which is in the set would be far more valuable if another prospect were also included, then the analysis might sensibly be extended to include the combination of those two prospects etc.

Again, it will not in general be necessary to undertake highly detailed cost benefit assessments of all prospects. The key information required is whether a prospect

lies above or below the 'cut-off'. Quite crude methods will usual allow a categorisation into 'clearly above', 'clearly below' and 'doubtful' classes, with detailed evaluations only then being needed for the doubtful cases.

Furthermore, the process need not necessarily be highly mechanical. Once the guiding principle is understood, and once a familiarity with cost benefit evaluations has been built, it is often possible to use less formal and even instinctive methods to develop a reasonably accurate categorisation as above, with more detailed analyses being used in fine tuning the selections. importantly, though, it is important not to over-engineer the prioritising process. If funds and skills are scarce, and there are a lot of good prospects out there, then what is not wanted is a process which wastes a lot of resources in achieving accuracy which is likely to be spurious, given the inevitable data limitations. ACIL is more concerned that the principles underpinning the above process be accepted and use to guide those making these resource usage decisions, and that selective use be made of more formal analysis where large expenditures are involved or as part of periodic review / performance monitoring arrangements. Importantly, decision makers need to be able to learn from such review by fine tuning their own decision processes.

2.8 Public/private values

The types of LRA activity under consideration in this study are typically fairly large scale surveys which involve a significant proportion of public funding. This study is not about determining the appropriate level of public funding. However, this study exists as a consequence of public funding. It is where public funding is significant that questions typically begin being asked about cost effectiveness. If all the funding were private, then it would be reasonable to conclude that the private funders have decided that there are benefits in excess of costs.

A feature of governments becoming involved in the provision of investments in information, such as LRAs, is that judgments need to be made other than by the beneficiaries as to whether benefits exceed costs — and it is this which triggers a lot

of the complexities in describing and valuing benefits. It is useful, therefore, to reflect on the reasons why government involvement may be necessary and on what this might tell us about benefit description and quantification.

A market already exists for small scale land assessment, with some well defined benefits:

- direct benefits from increased agricultural production; or
- avoidance of potential costs arising from uses incompatible with land characteristics, such as inadequate building foundations.

Such (private) benefits are in many cases already large enough for the beneficiaries concerned to pay for relevant land assessments. This has been evident in a number of the case studies examined by ACIL, where it was clear that, in the absence of LRA data, significant private investment in analogous information would have gone ahead. There would seem to be no reason for publicly funded land resource assessment in these cases, unless the study would not go ahead otherwise or unless large size economies could only be achieved through public involvement (though even here this may not involve significant public funding as opposed to co-ordination).

It is not difficult to envisage situations in which an investment in LRA data would have delivered benefits in excess of costs but where private interests may not make such an investment. Such situations are referred to as *market failures*, though in some cases they may be better viewed as examples of failure within government policies and decision processes. Examples where such problems *may* arise include:

- A land developer wishes to undertake housing development of a particular site. It is possible that the soil is such that special footings may be necessary to ensure stability, or that acid soil problems may cause contamination to water bodies below the development site.
  - The developer assumes that the average buyer of the houses will not check the footings or that downstream pollution will

become a cost to be borne by the community and the local Council — but not by the developer. The costs of testing and possibly modifying the development strategy exceed the benefits the developer expects to be able to capture — and the testing is therefore not done.

- Over the next ten years, it is likely that a hundred developments will go ahead in a given area. For each individually, the costs of organising soil testing and analysis is too great to be justified.
  - However, the one hundred individual sets of tests could be done collectively, taking advantage of size economies in both negotiating and managing the testing contract and in undertaking the sampling and tests themselves at half the cost of one hundred individual contracts.
  - At half the original price, the tests would be justifiable for the developers.

It is still necessary to be cautious about jumping in and assuming that a government driven and funded LRA program is the appropriate response to these sorts of circumstances. Markets may well be capable of addressing even these problems, particularly with legal and institutional support from government. For example, the *risk* of legal action by those affected, including by the Council, may be enough to make it worthwhile for a developer to undertake the testing in the first examples. A somewhat stronger intervention would be for Councils to require that the tests be undertake, possibly by a registered testing body, and that the report be lodged with the development application. These represent ways of increasing the benefits to the developer from undertaking such testing.

A variant on this would involve financiers beginning to require such testing before they will approve loans — a requirement which could well be expected if the risks to financiers are judged to be substantially affected by such testing.

With the second example, the facts suggest that there are potential benefits if developers co-operate in issuing a contract for soil testing, or a commercial opportunity for a soil testing entity to undertake the tests and sell the results. It would be appropriate to ask is assumed this would not happen (and whether something might not be better done to address the cause of any such reluctance) before committing government resources to an LRA program.

However, ACIL accepts that there are likely to be situations of real market failure where government involvement in LRA is justifiable, at least until such times as far more sophisticated methods have been developed for handling risks to third parties. Examples include situations where:

- Bankruptcy laws place an effective limit in legal redress and may leave it still attractive for developers to take risks on behalf of third parties because they cannot be confronted with the full consequences of their actions.
- The risks are underestimated by the market and it is judged more cost effective to 'subsidise' the cost of risk reduction by providing the necessary information at low cost than to make market assessments of the risks more realistic.
  - Making the information available at low cost may be one way of actually improving the market assessment of the risks if it is part of a program directed at revealing the extent of such risks.
- The risks will largely be borne at a relatively low level by a large number of people, rather than being concentrated on the few natural parties to any development contracts.
  - For example, land usage patterns which contribute to diffuse source pollution of waterways, with attendant downstream algal problems may be quite rationale for the individual landowners and the costs of co-ordinating all those involved to

fund appropriate testing could prove prohibitive — other than through government using its taxing powers.

All these examples are characterised by what are described as *unpriced spillovers*, in which some of the costs are not borne by the direct parties to any of the decisions involved, either because these parties have no rights to a 'place at the negotiating table' or because the costs involved would be too great.

An added dimension, referred to earlier, is that of unanticipated benefits. Many commercial activities deliver unanticipated benefits. It is even possible to anticipate, based on experience, that there will be unanticipated benefits (what remains unanticipated is the form and level of those benefits). Commercial markets are quite capable of investing in part because of the likelihood of unanticipated benefits. However, where significant risks are involved, these commercial interests will typical look for a fairly high rate of return on such investments. It is possible that there are failures in the markets for pooling and managing such risks, such that there will be underinvestment in information of this type. That is, society would be better off for such investment taking place, but the transactions costs involved in acceptably pooling the risks limits the amount of such investment.

Assumptions, and some empirical support, along these lines have been used to justify government involvement in supporting a lot of research activity and LRA could well be viewed in the same terms. Certainly, those working in the area of LRA have expressed to ACIL the view that the risks of not investing in LRA are widely underestimated. Viewed from the perspective of a financier, the typical LRA would look poorly focused in terms of clients and marketing through to users, would be heavily justified in terms of rhetoric about unanticipated uses and benefits, would clearly be seen to entail poor control over intellectual property and would be judged high risk. Some of these characteristics are the direct result of government involvement in the provision of the information as a public good. Others perhaps say more about weaknesses in the links between gathering the data and ensuring that maximum value is derived from the data.

A real problem with the subsidised provision of LRA data is that it is not possible to conclude from the fact that it is widely used that there are therefore large benefits. If the government were prepared to subsidise the provision of purple cars with pink spots to a high enough level, it could probably dominate the market in cars but ACIL would rather not conclude that we would be better off driving around in such cars. The point is that subsidies can rob us of valuable information regarding the value of an activity and, while this may be justified, it is appropriate to look at containing the extent to which such information is lost. Without such information, it is almost certain that government sponsored LRA investments will also fall short of being cost effective — because they result in overinvestment in LRA (not likely if the views of current practitioners are to be believed); in underinvestment in LRAs (perhaps more likely); or in poorly balanced investment which does not deliver maximum value for the resources committed (most likely — rather akin to ending up with too many purple cars with pink spots not having feedback to say we all think it reflects very poor taste because demand has been 'bought off' by the subsidies).

These considerations are behind ACIL's view that, over time, there will be clear advantages in moving from a supply driven approach to one that is more demand driven. If coupled with appropriate institutional incentives, this should yield clearer signals regarding where best areas in which to direct effort and scarce resources and is likely to result in more rapid and effective use of the information generated — further increasing benefits. It is likely also to open up opportunities for greater direct private sector involvement in funding the generation of the data or in covering the costs through user pays arrangements. These considerations fall outside the scope of this study but are an important element in the context which led to the commissioning of this study and are likely to figure prominently in the application of the assessments of the value of LRA investment.

2.9 Enhancing collective experience

ACIL has developed an LRA framework by making use of the collective experience of members of ACLEP. This collective experience can be enhanced by adding results from application of the framework, which can in turn improve the framework.

ACIL proposes that ACLEP hold, as a planning and assessment resource, an "information base" of collective experience. This has to be structured:

- to take account of evolving uses and knowledge of uses;
- to associate outcomes with uses and objectives;
- to be capable of being updated, if required;
- to be readily accessible by anyone wishing to use such information about benefits.

ACIL's LRA framework has already incorporated hardcopy checklists of objectives, uses, outcomes, and benefits, grouped under a number of headings. A key challenge for ACLEP is to continue building this collective experience in ways that add useful value.

ACIL has identified a number of ways to build and enhance collective experience:

- The (proposed) ACLEP home page on the Web could be an ideal location for collective experience to be stored electronically -
  - information would be stored in one place, with CSIRO as facilitator of ACLEP responsible for maintaining and updating;
  - as uses, outcome and values are identified, they could be mailed to CSIRO for inclusion; and
  - uses of information could be monitored by counting the 'hits' on Web pages.

- Brief survey forms could be included with LRA publications, such as maps and reports, perhaps with some incentive for their return, such as inclusion on a mailing list.
- Special projects could be commissioned to collect information on demand for LRA information.
- The development of markets for LRA services would enable demand to be revealed by prices paid.

3. GUIDELINES FOR APPLYING ACIL'S LRA FRAMEWORK

3.1 Introduction

This paper presents an economic framework for assessing benefits and costs of land resource assessment (LRA) in Australia. It was developed by ACIL Economics & Policy Pty Ltd (ACIL) in 1996, for the Australian Collaborative Land Evaluation Program (ACLEP). ACLEP also holds a comprehensive report, prepared by ACIL, containing:

- a more detailed discussion of ACIL's LRA framework;
- references to the literature; and
- application of the framework to three case studies.

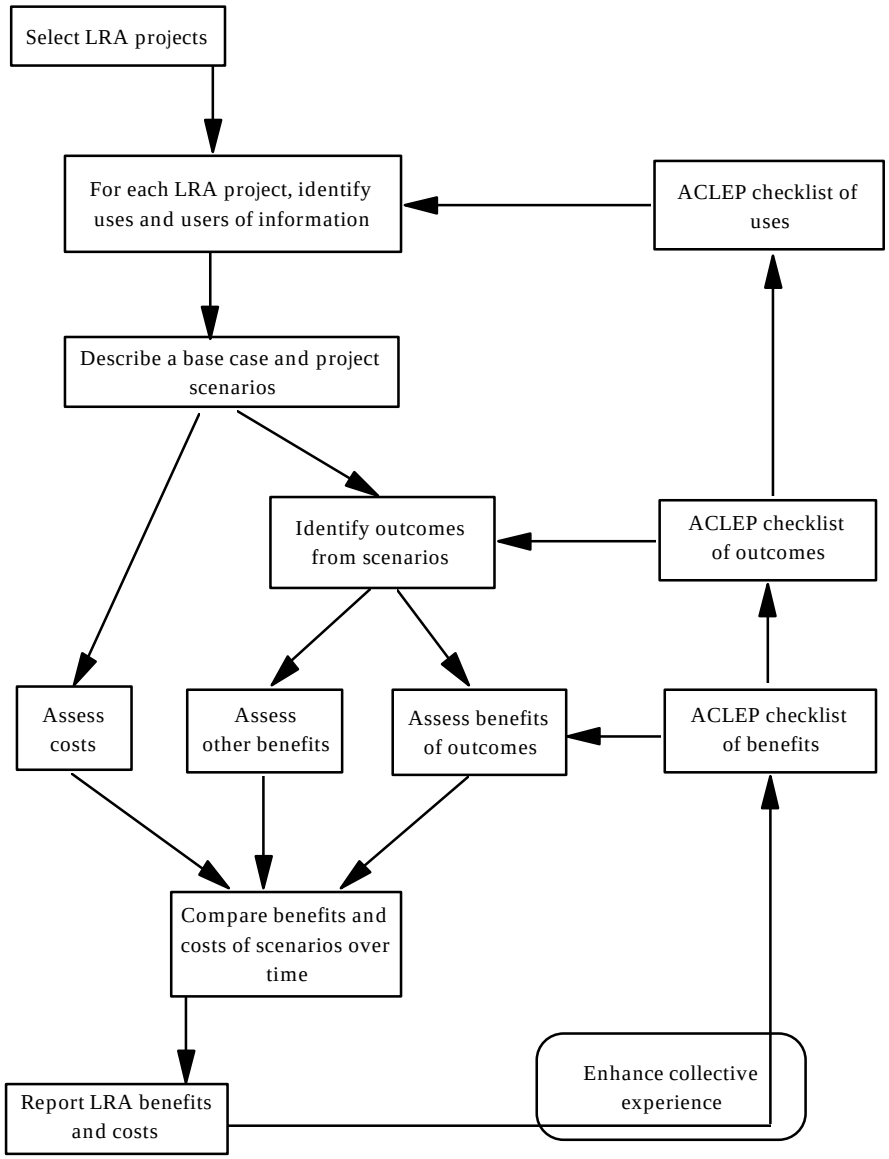
A copy of the report can be obtained from ACLEP at the following address:

ACLEP
CSIRO Division of Soils
GPO Box 639
Canberra ACT 2601
Fax: (06) 246 5965
Email: aclep@cbr.soils.csiro.au

In applying the framework described in this paper, judgments will have to be made, for example, about sizes and likelihoods of various benefits being realised. In practice, such judgments are made all the time, albeit implicitly. The strength of the framework lies in making such judgments explicit. However, due care is needed to ensure that findings are taken seriously, and this may require reference to the more comprehensive report or even the literature.

ACIL's LRA framework is illustrated in Box 3.1, and the components are described below. References are to sections in the above mentioned report.

Box 3.1 ACIL's LRA framework



Box 2.1

3.2 Select the project(s) which are to be assessed.

Often, the framework will be used to assist in designing or justifying specific projects. However, for evaluating a number of projects, or even a program of LRA, it is important to select projects which will provide a basis for drawing inferences

about all the projects or the program. This is, in theory at least, a standard statistical issue.

The simplest method is to select a random sample; though significant efficiencies might be gained through stratification of the sample in terms of project size or type. It is difficult to be highly prescriptive about the size of the sample. For a program consisting of only two projects, a sample size of two would involve no sampling errors. For a large and diverse program, inferences based on a sample of two would be highly courageous. As a general guideline, a sample of at least ten[20], or 50 per cent of total funds expended, might be taken as providing a lower bound to reasonable coverage. Note that this figure of ten applies equally to any subgroups about which inferences are to be drawn, so may entail a larger overall sample size. In any case, samples this small may have large sampling errors, but a sample of at least ten provides some scope for estimating this error rate and for estimating how much more sample may be required to achieve a certain level of reliability.

On no account should confident inferences about sets of projects be drawn if sample projects have been selected merely on the basis of being 'typical' or 'feasible to evaluate' or, worst still, by being proposed by individual agencies. Both conscious and unconscious biases are likely to be considerable; any evaluation of these investments should allow for studies which fell short of expectations as well as those which met expectations — both entail costs which must be acquitted.

3.3 For each project, identify users and uses of LRA information

LRA studies can produce a range of information, with a very wide range of uses and users — not all of which may be evident during an evaluation. ACIL's LRA

20 Standard error is proportional to sqrt ((n-1)/n), for sample size of n.

framework includes a checklist of categories of previously identified uses of LRA information — see Box 3.2 (more detail in section 2.4.4.1)

Box 3.2 Checklist of uses of LRA information

Categories of uses
Land use assessment
Planning & development - industry, strategic level
Planning & development - regional level
Planning & development - local or urban level
Planning & development - property level
State specific applications
Property Valuation
Preparation of Local Environment Plans
Identification of areas of land with degradation potential
Drought assessment & monitoring, modelling
Conservation areas - planning, management
Integrated Catchment Management
Detailed vegetation studies / surveys
Forestry planning, management
Reference Soil information
Community awareness activities
Spatial Information Analysis
Research, education
Training

Source: ACIL analysis of survey of LRA projects.

Box 3.2 comprises uses from a range of projects analysed by ACIL, and should indicate most potential uses. However, a project may have uses not covered in this list, or uses which are significant enough to warrant a separate category. Such enhancements to the checklist of uses should be notified to ACLEP, as described in 3.10.2 below.

3.4 Describe a base case and project scenarios

Benefit cost assessments should count only *incremental* expected benefits — that is, those benefits which would not have been realised if the project had not been done — and, equally, in counting only incremental costs. The challenge in assessing incremental benefits and costs often lies in defining this 'base' or 'otherwise' case.

Another challenge arises in handling uncertain benefits, in that benefits may not have been realised at the time of evaluation, and in particular, may depend on enabling activities.

For example, one may wish to claim benefits of avoided loss of agricultural production due to an LRA study. However it is necessary to show that:

(a) in the absence of the LRA study, production would have been lost; and

(b) given that the study was done, at least some resulting recommended measures for addressing loss would have been taken up.

In principle, it is possible to produce a probability distribution of possible scenarios, and hence calculate expected benefits and risk profile. As described in section 2.4.4.2, Decision Analysis is a useful technique for keeping track of probabilities.

In practice, however, robust estimates of probabilities are hard to make. Hence it may be more sensible to define a number of scenarios without actually quantifying their respective probabilities. This approach still allows evaluation of benefits contingent on take-up rates. Often this is sufficient for comparing scenarios. However, in comparing these scenarios it is still necessary to be realistic about the chances of significant change flowing from the investment in information; in some cases, particularly where large outlays are being considered, this may be best done by being explicit about probabilities, working these through and possibly exploring additional measures which might increase the 'probabilities of implementation' of the study. Relatively simple spreadsheets can be used to simplify these calculations and can be used to impose a level of consistency in the approach used.

3.5 Identify outcomes from scenarios

Benefits are anticipated due to changes in the study area as a result of the project having been done. Such changes could be called outcomes of the LRA project, at least to the extent that they would not have happened if the project had not been

done. There is a strong link with project planning provided that outcomes are *measurable* statements of the way that the world is different. Identifying measurable outcomes can be easier said than done in practice, so this component of ACIL's LRA framework has been designed to assist in identifying outcomes, for measurement and valuation of benefits in the next component. The distinction is for clarity of presentation; in practice, an iterative process is required — statements of outcomes may need to be modified to enable more robust measurement or valuation.

The LRA framework includes a checklist of categories of *outcomes*, in Box 3.3 (section 2.4.4.1). Analogous to the checklist of uses of information, this list should cover most outcomes. Outcomes not covered in the list, or significant enough to warrant a separate category, should be notified to ACLEP.

Box 3.3 Checklist of outcomes

Category of outcomes	Examples
Increased economic production	Targeted soils with potential for increased productivity Tasmanian Forest Soils
Development of industry	Site selection for manned spacecraft re-entry
More efficient property valuation	In the case of private buyers, result is a better idea of the resources and potential problems which they are buying (so cost avoided in case land is overpriced). Valuer Generals Office may use the maps where available to determine land value
More productive use of staff resources	Common data formats
Better catchment management	Improved water quality
Avoided infrastructure damage	Information is identify potential problems associated with proposed subdivisions and to place restrictions on activities in proposed subdivisions (eg enforce foundation standards to cope with soils which shrink and swell or avoidance of sites) Curlewis study Optimum route selection for optical fibre cable
Avoided environmental damage	Land suitability predictions validated and some farms not released for irrigation development Burdekin study
Remediation or rehabilitation of degraded or damaged land	Recommendations for revegetation of degraded lands with native vegetation based on original (and therefore most well suited species) vegetation types. Result = costs saved by planting appropriate species initially no need for tree trials etc Curlewis study
Preservation of biodiversity	

Box 2.6

Scenarios described in the previous component may have different outcomes, so it is necessary to keep track of respective likelihoods of outcomes, and anticipated extent of changes. Of course, different scenarios could well have similar outcomes.

3.6 Assess benefits of outcomes

This component seeks to produce quantitative estimates of extent of outcomes and value of associated benefits. Some debate is to be expected here; the aim is to enable constructive debate by making the process of valuation explicit and based as soundly as possible in already published literature.

Hence ACIL's LRA framework comprises two parts:

- find indicators for measuring outcomes, where possible from the literature; and
- find standard values associated with the above indicators, where possible from the literature.

In both parts, there is a spectrum of acceptability of quantification. At one end of the spectrum are readily quantifiable benefits of market related outcomes, typically avoided loss of production due to environmental remediation undertaken as a result of the LRA study. Along the spectrum, it may nonetheless be possible to quantify some benefits, such as continuing recreational use of natural areas as a result of the LRA study, notwithstanding the lack of established markets. However, the further along the spectrum from directly measurable market values, the more likely that values may be debated, and hence the more care needed in claiming benefits.

ACIL's LRA framework has a checklist of outcomes and indicators, shown in Box 3.4.

Box 3.4 Outcomes and indicators

Outcome	Indicator	Type of measure
Increased economic production	hectares, yield	production
Development of industry	size	value of industry
More efficient property valuation	turnover	improvement in productivity
More productive use of staff resources	number of staff	improvement in productivity
Better catchment management	area, number of people concerned	improvement in water quality
Avoided infrastructure damage	amount	extent
Avoided environmental damage	area, number of people concerned	loss of productive capacity cost of remediation loss of recreation values loss of amenity values
Remediation/rehabilitation of degraded or damaged land	as above	as above
Preservation of biodiversity	as above	as above

Box 2.2

Measures not covered in the list, or significant enough to warrant separate categories, should be notified to ACLEP.

3.7 Assess other benefits

ACIL's LRA framework recognises benefits in addition to those arising from changes in the world as a result of the LRA project. Currently three categories are distinguished:

- benefits due to economies of scale
- risk management benefits
- generic benefits

Additional categories, or types of benefits within these categories, should be notified to ACLEP where appropriate.

3.7.1 Benefits due to economies of scale

Doing a particular LRA project may reduce the need for subsequent work in collating LRA information. The avoided cost of work that would otherwise have been done is a benefit of the original LRA project. (section 2.4.2)

3.7.2 Risk management benefits

People are demonstrably willing to pay to insure against future risks, such as the risk of damage to property. LRA projects offer similar benefits to the extent to which information so gathered enables better management of risks of environmental damage; what might be called a 'precautionary' benefit. A direct survey of such willingness to pay may be the most robust method of valuing such benefits, although rarely likely to be warranted. Another indicator of concern is the amount of work undertaken to gather information about an area at risk.

In some cases, quantification of risk reduction benefits may not be necessary, especially if other benefits are sufficient to cover costs. Simple recognition of this risk reduction as a 'bonus' may be all that is needed. In other cases, more detailed economic analysis may be necessary. (section 2.4.3)

3.7.3 Generic benefits

The most difficult to quantify, but nonetheless significant, category of benefits are 'generic' in the sense that they arise more from some LRA studies having been done, rather than from any specific LRA study. The creation, use and availability of a body of existing LRA studies has altered the culture of land resource planning and has identified opportunities which would not have emerged from single studies viewed in isolation. For example, some modern planning requirements have been introduced as a result of lessons learnt from past studies, such as the potential for acid sulphate soils identified from LRA programs rather than any particular study.

ACIL suggests that survey methods may be useful in estimating generic benefits, as described in sections 2.4.1 and 3.10.1.

3.8 Assess costs

Assessing LRA costs is relatively easier than assessing benefits, as costs generally are the direct costs of undertaking LRA studies. Some care may be needed where accounting systems do not attribute all costs, e.g. publications, to specific projects. However, estimated attribution will almost always suffice.

Some benefits, particularly those due to project outcomes, depend on enabling activities which have some cost. Such costs need to be taken into account; either under this heading or by reporting only net benefits under previous headings. ACIL recommends the latter approach. Note that, typically, these enabling costs are subject to the same uncertainties as are the benefits — where there is a risk that the benefits will not arise because the LRA information is not well used, then the same risks apply to these enabling costs so that both the costs and the benefits are scaled back in any estimates of expected outcomes.

3.9 Compare benefits and costs of various project scenarios over time

This part of the framework brings together values from preceding stages, and presents them in a way which enables comparison of net benefits, over time, for various scenarios.

Findings from application of the framework will be more widely accepted if readers can follow the logic and check sources for valuations, if required. Hence there is merit in showing detail of timing of benefits and costs, perhaps in separate tables for each scenario.

If it has been possible to estimate probabilities for various scenarios, then these can be used to estimate a Net Present Value for each scenario, enabling a 'bottom-line'

comparison. It is generally more useful to test sensitivities, such as comparing benefits under different assumptions about adoption rates.

Note that it does not matter, for purposes of calculating net present values, whether costs attributable to enabling activities are treated as additional costs or are netted off benefits. However, the different approaches can imply very different benefit/cost ratios. For consistency, ACIL recommends that benefit/cost ratios be determined as the ratio of benefits, net of all non-LRA costs, to the LRA costs. This measure is most useful in prioritising competing LRA opportunities, being a direct measure of the 'leverage' available to scarce LRA resources.

3.10 Report LRA benefits and costs

This component of the framework has two aims:

- reporting results at the program level, if required; and
- feeding back information into the collective experience of ACLEP.

3.10.1 LRA program reporting

This part may be required to complement the first component of the framework if, as noted in 3.2, projects were selected to enable valid inferences about a broad program.

3.10.2 Feedback to ACLEP

ACIL has developed an LRA framework by making use of the collective experience of members of ACLEP. This collective experience can be enhanced by adding results from application of the framework, which can in turn improve the framework. Throughout the framework, it has been suggested that enhancements, e.g. to checklists, be notified to ACLEP for inclusion in the framework.

The ACLEP web site would be an ideal way to publish the framework and prompt for enhancements. However, as described in section 2.9, other methods may be

needed to reach beneficiaries who are unaware or do not use ACLEP's web site, including:

- brief survey forms included with LRA publications, such as maps and reports;
- special projects to collect information on demand for LRA information; and
- development of markets for LRA services in which demand is revealed by prices paid.

4. WORKED EXAMPLES

This chapter illustrates application of the framework, by working through three examples:

- Upper South East South Australia Salinity Study;
- Gosford - Lake Macquarie study; and
- digital *Atlas of Australian Soils.*

These studies were not selected at random, and hence, as noted in section 3.2, cannot be used as the basis for inferring benefits of LRA programs as a whole. The framework will be applied to each separately. Heading numbers in this chapter correspond to the parts of the framework described in chapter 3.

In applying the framework, ACIL has relied on information about uses and outcomes provided by members of the Working Group and, particularly in the case of Gosford, some users. In particular, the case studies do not purport to be comprehensive studies of all benefits and costs. The nature of collective experience is such that readers may be aware of other uses, outcomes or benefits not described below. As any such items are identified, they should be notified to ACLEP for incorporation into the framework for use in future evaluations.

4.1 Upper SE Salinity Study, SA

4.1.1 Background and objectives of the study

Box 4.1.1 Upper SE study

The Upper South East region of South Australia covers an area of approximately 6,900 Sq km, roughly rectangular in shape, with a line between Woods Well and Tintinara in the north and a line from Kingston to Naracoorte in the south. About 90 per cent of the area is farms, with the remainder comprising (part of) the Coorong National Park and six designated conservation parks containing a number of wetlands. Surface flooding, together with rising saline groundwater, is degrading the value of land.

The *KEITH* 1:100,000 scale map was originally soil mapped in 1988. In 1992, the South Australian Government commissioned the Land Resources Unit of Primary Industries, South Australia (PISA), to undertake another land survey, enabling an assessment of the changes in land categories over that four year period. Information about transfers between land categories, or 'slippage', has provided base data for analysing trends in land degradation.

4.1.2 Select study

This study has been selected as an example because:

- it is an example of a study commissioned for a specific purpose, which should be reflected in higher likelihood of benefits being reached;
- it illustrates the use of decision analysis;
- information about potential outcomes and benefits has been collated and published[21], [22]; and
- ACIL has some familiarity with the study, following a visit to Adelaide in May 1996.

4.1.3 Identify users and uses of LRA information

Information was collected on landscapes and land degradation in the area, at a scale of 1:100,000. This has been made available for people working on the development

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21 Barber A, 1993, *Benefit :Cost analyses of on-farm pasture renovation strategies and catchment drainage options* Environmental Impact Statement Background Report, Primary Industries SA

22 Walsh C., Thomson N., Buckby M., 1993, *The Upper South East Dryland Salinity and Flood Management Plan —A strategic economic overview*, a report for the Steering Committee for the Upper South East Dryland Salinity and Flood Management Plan.

of a management plan to alleviate salinity and flooding for the area, but has not yet been officially published. However, the Upper *South East Dryland Salinity and Flood Management Plan,* has been published, as has supporting material including the benefit cost analysis of proposed remediation work[23]. In addition, the area is currently the subject of a survey of community attitudes to proposed remediation methods[24].

Collective experience from other LRA activity suggests that uses of information will be broader than remediation of salinity. The list of types of uses in Box 2.5 serves as a checklist:

23 ibid

24 Bennet J Blamey R and Morrison M, 1996 *Development of approaches for assessing non-market values related to salinity,* address given to Australian Agricultural and Resource Economics Society, 17 June 1996.

Box 4.1.2: Checklist of uses of information from Upper SE study

Categories of uses	Anticipated?
Planning - industry, strategic level	Not anticipated
Planning - regional level	Yes, as salinity remediation is focussed at regional level
Planning - local level	Possibly, eg. location of drainage trenches
Planning - property level	Yes, eg. as Primary Industries extension activities
Land use assessment	Anticipated
Identification of areas of land with degradation potential	Yes, original objective of study
Preparation of Local Environment Plans	Probably, eg. wetland preservation
Drought assessment & monitoring, modelling	Not anticipated
Specific applications	Not anticipated
Property Valuation	Probably, if financial institutions realise that property values depend on salinity
Conservation areas - planning, management	Yes, eg. Coorong
Detailed vegetation studies / surveys	Possibly, eg. surveys of wetlands vegetation
Integrated Catchment Management	Anticipated
Forestry planning, management	No
Reference Soil information	No
Spatial Information Analysis	No
Research, education	Yes, eg. developing methods of valuing environmental remediation
Training	Anticipated

Source: discussions with PISA, ACIL survey of projects

4.1.4 Describe base case and project scenarios

Much of the benefit from this study is anticipated to come from actions which reduce or rehabilitate damage to agricultural production. Hence it is important to

be realistic about the base case, namely what would have happened if the study had not been done, or perhaps had been done differently.

LRA benefits are uncertain, in broad terms being benefits from drainage work less the costs of any such work, compared to remediation had the study not gone ahead. The timing and probabilities of benefits will depend on timing and probabilities of:

- remedial actions being implemented; and
- remediation being effective,

which will depend on factors such as:

- when/if and how the study was done; and
- local conditions and politics.

The decision tree methodology described in section 2.4.4.2 provides a structured way of working through dependence on choices, enabling activities and uncertain benefits. Most of the benefits to be attributed to the LRA depend on the South Australian Government choosing from options such as:

- drainage schemes, as described in Box 4.1.3;
- over the longer term, plantings to further reduce water levels.

Conceivably, one could build a decision tree taking account of both alternative scenarios and uncertainty in respect of outcomes. In principle, one could build a single 'otherwise' scenario as a weighted combination of all other alternative scenarios. This level of sophistication would be required for calculating a single benefit cost ratio, but is not necessary for the purposes of showing whether the Upper SE salinity study was cost effective. In any event, cost effectiveness should not be sensitive to the study cost of $20,000.

Box 4.1.3: Upper South East Dryland Salinity and Flood Management Plan Groundwater and Surface Water Drainage Schemes

Barber[25] has analysed 28 separate drainage options and calculated benefits and costs of undertaking various options, as functions of:

- costs of undertaking schemes;
- different adoption rates; and
- benefits in terms of agricultural production which would be possible if land degradation was avoided as a result of drainage schemes going ahead.

ACIL has drawn on this analysis. However, benefit / cost analysis of LRA studies is different to benefit / cost analysis of drainage options *per se*:

- The benefits of LRA are estimated as the net benefits of drainage options, after taking off ex-ante costs of any enabling activities. As noted in section 2.5, there is rarely any sensible way apportioning benefits amongst "sunk" inputs, if the inputs have not been priced.
- As advised by PISA, the base case is continuing degradation of the agricultural land, and benefits arise as avoiding this degradation. With this base case, it is wrong to double count costs of land degradation if LRA information is not used.
- The probability of benefits being realised depends on both probability of major drainage schemes being built as well as the adoption of on-farm drainage. It is unrealistic to assume that LRA information will be used just because someone has collected it.

As ACIL understands the situation, decisions on drainage works have been deferred pending assessment of environmental impacts and values arising from the proposed Northern scheme draining into the hypersaline environment of the Coorong. One

25 ibid

scenario, depending on such values, is that all drainage schemes will be built, perhaps by 1998. An alternative might have been to build the Central and Southern schemes earlier, say 1993, soon after the LRA study was done. A third alternative, to build the Southern scheme only, might not even have needed the LRA study.

ACIL does not know the respective probabilities of these scenarios. However, we can still work through the analysis, carrying conditional probabilities associated with the following branches of the decision tree:

*ALL. given that study was done -

- likelihood of all proposed drainage works starting in, say, 1998

*C&S. given that study was done -

- likelihood of Central & Southern drainage schemes starting in, say, 1998;

*S. assuming no study was done -

- likelihood of Southern drainage scheme being done in, say, 1993.

The importance of using LRA information can then be expressed as a function of these probabilities. Other outcomes are expected to be generally similar for the alternative scenarios, *ALL, *C&S, *S, although of course the probability, timing and extent of the outcomes will vary.

4.1.5 Identify outcomes from scenarios

To date, the only outcomes realised are the development and publication of the management plan.

However, the uses in Box 4.1.2 may prompt other outcomes, and as above, collective experience in Box 2.6 and Box 2.7 serves as a checklist.

Box 4.1.4: Checklist of outcomes from Upper SE study

Category of outcomes	Likelihood & net change
Increased economic production	Yes, depends on adoption rates
Development of industry	Not expected
More efficient property valuation	Possible
More productive use of staff resources	Possible
Better catchment management	No
Avoided infrastructure damage	No
Avoided environmental damage	Significant outcome
Remediation / rehabilitation of degraded or damaged land	Significant outcome
Preservation of biodiversity	Expected

Source: discussions with PISA, ACIL survey of project

4.1.6 Benefits arising from project outcomes

The task now is to assess benefits from the above outcomes. As described in Chapter 3, the approach is to find indicators which can be used to measure the extent of the outcome, and use standard values to assign dollar values.

Box 4.1.5: Benefits from outcomes from scenarios

Benefit	Indicator	Standard value	Discounted value (7% over 30 yrs)
Increased production / rehabilitation of damaged land	-390,200 DSE (dry sheep equivalent) (Barber)	See Box 4.1.6. Average (1981-92) gross margin 1992$14.36 per DSE (Barber)	See Box 4.1.6
Avoided environmental damage to conservation areas, parks and wetlands /biodiversity	perhaps 5,000 tourists fewer (Walsh et al p34) numbers of people concerned	SA tourist expenditure averages $40 per day(Walsh et al p34) willingness to pay for environmental amenity being estimated in CV study	$2.5m not yet available
Staff productivity	Staff	small	

Barber A, 1993, Benefit :Cost analyses of on-farm pasture renovation strategies and catchment drainage options *Environmental Impact Statement Background Report, Primary Industries SA*

ACIL analysis

Benefits of outcomes of increased production and remediation of degraded land can both be measured in terms of changes in production from the land involved. For this study, benefits are significant and hence warrant careful scrutiny in Box 4.1.6. The calculation of discounted net benefits requires a number of linked spreadsheets, and so has not been reproduced here.

Box 4.1.6 Benefits of increased production

Benefits of changes in production arising from remediation work can be compared to a baseline trend of continuing degradation from rising groundwater. Estimates have previously been prepared by Barber[1] and quoted in Walsh et al[2]. In this report, ACIL has used these estimates. Barber developed a series of spreadsheets, modelling agricultural production, land degradation / pasture revegetation, costs and prices:

gross margin calculators for five livestock enterprises (merino ewes, wethers, prime lamb flock, beef herd, and grass fed steers);
pasture redevelopment and landscape revegetation costs calculators;
pasture strategies planner, incorporating land area, socking rates and land category degradation;
benefit cost analysis reckoner, incorporating capital budget and discounted cash flow data.

Barber's base case or "DO NOTHING" option was for no catchment infrastructure or integrated drainage schemes. This implied the following losses[3], over 30 years, in DSE carrying capacity at an average (1981-92) gross margin 1992$14.36 per DSE:

Northern	-129,800
Central	-150,000

Capital costs for the three drainage schemes were calculated by an engineering team to be:

Northern	$9.9m ($10.6m at end of year 1)
Central	$16.6m ($17.8m at end of year 1)
Southern	$4.6m ($5.0m at end of year 1)

Benefits of pasture renovation at assumed adoption rates of 80% following major drainage works were estimated, in present value terms discounted at 7%, to be:

Northern	$14.4m
Central	$15.5m
Southern	$9.7m (Walsh et al p27-28 reconciles these figures with Barber Table 18)

Barber also calculates various sensitivities, such as change in net present value of benefits due to five year deferral of schemes:

Northern	-$2.1m
Central	-$3.3m
Southern	-$2.1m

1. *Barber A, 1993,* Benefit :Cost analyses of on-farm pasture renovation strategies and catchment drainage options *Environmental Impact Statement Background Report, Primary Industries SA*

2. *Walsh C* et al, *1993,* The Upper South East Dryland Salinity, Flood Management Plan - A Strategic Economic Overview, *p.23.*

3. ibid

Walsh *et al* also noted impacts on:

- employment, other than on affected farms;
- public sector; and
- international sector.

In ACIL's view, these latter impacts are changes in distribution of value, rather than any net changes in value. While distributional effects are important for equity considerations, they should not be included in the framework.

4.1.7 Assess other benefits

4.1.7.1 Economies of scale

The study was specially commissioned to gather information for assessing the extent of damage at the broad level. However, more detailed information may well be required, particularly for locating deep drains and pipes. This would be more expensive to collect in the absence of the 1:100,000 map, and so any time saving from having the maps when collecting more detailed information, perhaps one week of staff time for any of the above scenarios, is appropriately counted as a benefit of the 1:100,00 study.

4.1.7.2 Risk management

There is some value in understanding the scope of the problem, in excess of any remedial work. For example, the area has been the subject of a number of studies since 1992, which ACIL estimates may have cost in excess of $1m. Assuming that such expenditure meets SA targets for rates of return, then the benefits of better understanding from LRA would be at least 7% of $1m, which in itself is greater than the cost of the study.

4.1.7.3 Generic benefits

The Upper SE Salinity study has been used as a case study in contingent valuation, and also in developing ACIL's LRA framework. One way to value generic benefits would be for members of the LRA working group to report the value they attach to this use of the LRA study.

4.1.8 Assess costs

The cost of the project itself was estimated at $20,000. Note that costs of previous, smaller scale, LRA projects are treated as sunk.

The costs of drainage works needed to enable benefits to be realised is shown in Box 4.1.6. However, such costs have been netted out of benefits of drainage options, as described in section 3.9.

4.1.9 Compare benefits and costs over time

Boxes 4.1.7 to 4.1.9 compare benefits and costs for respective scenarios.

Box 4.1.7: Net benefits over time for *ALL drainage options

Benefit (cost)	Maximum present value (1993$m, 7% discount over 30 yrs)	Probability	Expected Present Value (1993$m, 7% discount over 30 yrs)
Change in production	$1m	p_ALL	p_ALL * $1m
Tourism Environmental amenity	$1.25m to be obtained from Contingent Valuation study	p_ prob. of loss of amenity in absence of LRA	p_ * $1.25m not yet available
Economies of scale	$0.001m	100%	$0.001m
risk mgt value	$0.07m	100%	$0.07m
cost	($0.02m)	100%	($0.02m)
Net benefits			$0.051 + p_ALL*$2.25m
Benefit Cost ratio			3.38+p_ALL*112.5
ACIL Analysis			

Box 4.1.8: Net benefits over time for *C&S drainage options			
Benefit (cost)	Maximum present value (1993$m, 7% discount over 30 yrs)	Probability	Expected Present Value (1993$m, 7% discount over 30 yrs)
Change in production	$4m if 1993 ($1.4m) if 1998	p_C&S	p_C&S * $4m or p_C&S * - $1.4m
Tourism Environmental amenity	$1.25m to be obtained from Contingent Valuation study	p_C&S prob. of loss of amenity in absence of LRA	p_C&S * $1.25m not yet available
Economies of scale	$0.001m	100%	$0.001m
risk mgt value	$0.07m	100%	$0.07m
cost	($0.02m)	100%	($0.02m)
Net benefits	1993 1998		$0.051 + p_C&S*$5.25m $0.051 - p_C&S*$0.15m
Benefit Cost ratio	1993 1998		3.38+p_C&S*262.5 3.38 - p_C&S*7.5
ACIL Analysis			

Box 4.1.9: Net benefits over time for *S drainage options			
Benefit (cost)	Maximum present value (1993$m, 7% discount over 30 yrs)	Probability	Expected Present Value (1993$m, 7% discount over 30 yrs)
Change in production	$5.1m	p_S	p_S * $5.1m
Tourism Environmental amenity	no benefits in the absence of Central & Northern drainage options		
Net benefits			p_S*$5.1m
Benefit Cost ratio			not defined as no LRA costs
ACIL Analysis			

In summary, on the basis of information above, the insurance value alone suggests that the LRA study had positive net value, irrespective of whether any remedial action is taken. However, net benefits might have been higher if LRA activity had been directed to achieving a greater than 50% chance of just the Southern scheme being built in 1993. However, if the probability of building just the Southern scheme is less than half the probability of building all drainage schemes, then LRA activity was cost effective.

Further information, especially in respect of environmental values, may however make drainage options look less attractive. However, if LRA information has meant avoiding loss in amenity, then the value of the LRA study could increase.

4.1.10 Report LRA benefits and costs

Information from the Upper SE study has already been incorporated in ACIL's LRA framework. However, information from the Contingent Valuation study should be added when available.

4.2 Gosford-Lake Macquarie 1:100,000 study

4.2.1 Background and objectives of the study

Box 4.2.1: Gosford — Lake Macquarie

The Gosford-Lake Macquarie 1:100 000 sheet includes most of the central coast of New South Wales and its hinterland. Situated between the cities of Sydney and Newcastle, it is an area undergoing rapid changes in land use. Traditionally the central coast has been both an important rural area as well as a popular retirement and holiday area largely because of its beaches, lakes and attractive scenery. The combination of high prices of Sydney real estate and the opening of the F3 Freeway from Wahroonga to Freemans Waterhole has opened up the central coast for urban development. The central coast is fast becoming a northern extension of Sydney, with extensive urban development occurring between Gosford and Wyong. Growth of these urban areas has been accompanied by industrial expansion, with increasing pressure on surrounding land for both rural residential and urban fringe uses. There has been a corresponding decrease in the agricultural enterprises of dairying and citrus production. Associated with many of the developments in the area have been soil related problems including landslips; flooding; urban, rural and coastal erosion; and sedimentation of drainage systems including lakes and rivers.

Source: Murphy, C.L., 1993, Soil Landscapes of the Gosford — Lake Macquarie.

In the late 1980's, the NSW Soil Conservation Service (now NSW Department of Land and Water Conservation) undertook a land survey at a scale of 1:100,000. The objective was to gather information about soil types and land use capability. Information has been published in the form of report and map.

4.2.2 Study selection

This study was selected as an example at the suggestion of ACLEP coordinators and NSW Department of Land and Water Conservation. ACIL was greatly assisted in the study by conducting a workshop at Gosford attended by users of LRA information. Box 4.2.2 lists the participants, some of whom had previously worked in the NSW Soil Conservation Service. Participants also had experience with land uses outside the Gosford area — this has also been included in the collective experience of LRA.

Only a small sample of users of the Gosford-Lake Macquarie work were asked to attend the meeting. As a result, the benefits identified may be only a relatively small proportion of total benefits generated by the project. It was beyond the scope of this project to estimate such total benefits.

Box 4.2.2: Participants at Gosford Workshop

Name	Organisation
Brian McCourt	Gosford City Council
Rick Morse	Morse McVey & Associates
Robbie Economos-Shaw (by letter)	Lake Macquarie Council
Phil Conacher	Integrated Site Planning
Christine Wittemore	Public Works
Robert Payne	Ecological Survey & Management
Liz Shelly	ERM Mitchell McCotter
Bob Scammel	Dept. of Land & Water Conservation
John Patten	Dept of Land & Water Conservation
Bruce Pirie	Dept. of Land & Water Conservation
Rowena Morris	NSW NP&WS
Norm Hawkes	State Forests
Casey Murphy	Dept. of Land & Water Conservation
Linda Henderson	Dept. of Land & Water Conservation
Sally McInnes	Dept. of Land & Water Conservation
Chris Malouf	ACLEP, CSIRO Division of Soils

Additional information has also been provided in follow up discussions, and through ACIL's questionnaire completed by the Soil Conservation Service.

4.2.3 Identify users and uses of information

The study collected information on soil and landscapes in the area, and identified major soil and landscape limitations to both urban and rural development.

Identified users included:

- Government authorities, particularly Local Government, considering applications for changes in land use.
- Urban developers, as required by regulation.
- Consultants.
- Environmental groups.
- Hawkesbury Nepean Management Trust.

The workshop provided an opportunity to test the checklist of uses from Box 2.5.

Box 4.2.3: Checklist of uses of information from Gosford study

Categories of uses	Anticipated?
Planning - industry, strategic level	Not anticipated
Planning - regional level	Not anticipated
Planning - local level	Yes, eg. rezoning applications
Planning - property level	Yes, site preparation and building design for both urban and industrial development
	Also for rural
Land use assessment	Yes, eg rural, urban
Identification of areas of land with degradation potential	Yes, eg. acid sulphate soils
Preparation of Local Environment Plans	Yes, eg. wetland preservation
Drought assessment & monitoring, modelling	Not anticipated
Specific applications	Yes
Property Valuation	Probably, if financial institutions realise that property values depend on site characteristics
Conservation areas - planning, management	Yes, eg. national parks
Detailed vegetation studies / surveys	Yes, eg state forests
Integrated Catchment Management	Yes, eg for Hawkesbury Nepean
Forestry planning, management	Yes
Reference Soil information	No
Spatial Information Analysis	No
Research, education	Yes, eg schools
Training	Yes

Source: discussions at Gosford workshop, ACIL survey of projects

Workshop participants noted that many potential users are not aware of the range of information available, or the advantages of using information.

4.2.4 Describe base case and project scenarios

This study was undertaken as part of the program of mapping soil landscapes of NSW.

One alternative to consider is that the survey would not have been done as a comprehensive 1:100,00 study, but might have been targeted more directly to need, taking into account:

- when information was needed; and
- what information was needed.

Alternatively, given that the study was done, perhaps more benefits could have been realised from:

- higher rate of use of information; or
- other uses.

4.2.5 Identify outcomes from scenarios

Workshop participants nominated few specific outcomes, but ACIL's checklist assists in identifying others.

Box 4.2.4: Checklist of outcomes from Gosford study

Category of outcomes	Likelihood & net change
Increased economic production	Better use of LRA information might avoid loss of, say, 25% of fish production
Development of industry	Possible
More efficient property valuation	Yes
More productive use of staff resources	Yes
Better catchment management	Better soil erosion control measures may reduce sediment entering Hawkesbury Nepean by 25%.. This might reduce recreational values by 50%
Avoided infrastructure damage	Increase in capital maintenance costs for bridges, water pipes in acid sulphate soils
Avoided environmental damage	Reducing leaching from acid sulphate soils into water receiving environments
Remediation / rehabilitation of degraded or damaged land	Perhaps 50% reduction in cost of remediation after Tuggerah Lakes dredging, although some additional assessment would have been needed
Preservation of biodiversity	Yes, eg better management of hazard reduction in state forests and national park

Source: discussions at Gosford workshop, ACIL survey of project

4.2.6 Benefits arising from project outcomes

It now remains to assess benefits from the above outcomes. The approach is to find indicators which can be used to measure the extent of the outcome, and use standard values to assign dollar values.

Box 4.2.5: Benefits from outcomes

Benefit	Indicators	Standard values	Discounted value (7% over 30 yrs)
Increased production	change in production	see Box 4.2.6	Box 4.2.6 estimates $7m.
Avoided cost of infrastructure damage from acid sulphate soils	capital value of infrastructure affected	increase in 10% of capital cost needed for maintenance over life, compared to 1% increase in capital cost to make resistant to acid sulphate attack	perhaps $1m
Avoided environmental damage	estimated tonnes of silt transported to water receiving environment	$1m per 10,000 tonnes dredged	perhaps $0.5m
Avoided environmental damage	willingness to pay to reduce loss of water quality numbers of people concerned	see Box 4.2.7 below	Box 4.2.7 estimates $6.3m
Remediation / rehabilitation of degraded or damaged land		part of cost of remediation work on Tuggerah foreshores, less avoided cost of collecting information to guide remediation	one-off, say $0.25m

ACIL analysis

Box 4.2.6 estimates benefits from avoiding damage to commercial fishing industry.

Box 4.2.6 Benefits from avoiding damage to commercial fishing

The Hawkesbury Nepean Catchment Management Trust has estimated that, without further action, commercial fishing in the Hawkesbury could be affected significantly. New South Wales Commercial Fisheries Statistics[26] indicate that commercial fishing in the Hawkesbury River estuary (including Pittwater and Broken Bay) had a catch of 441 tonnes worth $1.6m in 1993/94. Oyster production was $2.6m. This is of course gross production; of which some 20% might be value-added.

The impact of slowing or perhaps even reversing loss of fishing has not been modelled comprehensively. However, indicatively the benefit of maintaining 20% of current production compared to complete loss of all commercial fishing would be worth some $0.17m per year. This analysis has not taken into account any costs of preserving commercial fishing, eg. for increased erosion control.

In present value terms, over 30 years discounted at 7%, the benefit of avoiding the loss of the entire commercial fishing industry is worth some $7m.

26 *NSW Fisheries Research Institute 1994, New South Wales Commercial Fisheries Statistics, 1984/85 to 1993/94*

Non-market values of avoided damage to the local water environment appear to be significant, and warrant careful consideration in Box 4.2.7, illustrating an approach which was described in Section 2.4.4.3.2.

Box 4.2.7 Benefits of maintaining recreational water use in Gosford - Lake Macquarie area

The benefits of preserved recreational values are challenging to quantify, as there are no readily available statistics on numbers on values[0]. However, there are some published studies which have sought to estimate recreational use values of river and marine environments, reporting the following values:

(1) Ovens River $8–$30 / person day
(2) NSW North Coast $143 / visitor
(3) Rocky Mountains, Colorado, USA — US$41-$44 per visitor day

These environments are different from those in the Gosford area so care is needed in 'transferring' benefit values. The Hawkesbury Nepean may not warrant such high values as above; perhaps $5 per person day would be reasonable.

For 100,000 annual person days [check with Hawkesbury Nepean Trust], the recreational value would be $0.5m pa, or $6.3m in present value terms.

0 *Industry Commission, 1992,* Cost Recovery from Managing Fisheries, *Report No.17, Appendix F.*

1 Walpole, S.C., 1991, The Recreational & Environmental Benefits of the Ovens-King River Systems, Australian Parks and Recreation, *33-37.*

2 Pitt MW, 1992, The value of coastal land : an Application of Travel Cost Methodology, NSW North Coast, *Paper presented to the 36th Annual Conference of the Australian Agricultural Economics Society, Canberra, 10-12 February*

3 Sanders, L.D., Walsh, R.G., McKean, J.R., 1991, Comparable estimates of the recreational value of rivers in Water Resources Research *27(7) 1387-1394*

Participants felt that there were potentially many more significant benefits from LRA information, for example, if people had a better understanding of what information was available and how it could be used. However, it is very difficult for ACIL to estimate what these might be.

4.2.7 Assess other benefits

4.2.7.1 Economies of scale

Participants were adamant that if information had not been available from the Gosford study, then some of it would have had to be collected anyway.

Examples of specific savings in costs of collecting information include:

- The time required for fire hazard reduction studies is reduced by perhaps one day per study when information from a soil landscape map is used, saving staff costs of $100/day for perhaps 14 days per year.
- The cost of preparing an erosion and sediment control plan for a residential development site of, say, 50–100 blocks was estimated by Gosford workshop participants at $2,000 if there is useable LRA information, and $3,000 without such information. The difference is presumably due to additional costs of collating soil information in order to prepare a comprehensive plan. Repeated cost of collection for more than 10 developments per year over 10 years would warrant a comprehensive study.

4.2.7.2 Risk management

Community concern with water quality in the Hawkesbury Nepean is high, but it is difficult to estimate the insurance value of having LRA. It is not clear which came first, but recognition of the problems of acid sulphate soils did seem to increase at the same time as acid sulphate soil risk maps were published.

4.2.7.3 Generic benefits

The existence of the LRA study has improved the quality of land use decision making in the Gosford - Lake Macquarie area, which should be captured as project-specific benefits. A consequent increase in demand for LRA information could be counted as a generic benefit, but there is no information about changes in demand on which to base an estimate.

4.2.8 Assess costs

The cost of the LRA study has been estimated by the Soil Conservation Service to be $155,000.

Costs of taking action to avoid environmental damage when indicated by LRA are expected to be not large.

4.2.9 Compare benefits and costs over time

Box 4.2.8 compares project costs and benefits over time, given that the survey was done. Box 4.2.9 compares data collected as needed.

Box 4.2.8: Net benefits over time, given survey

Benefit (Cost)	Maximum present value (1993$m, 7% discount over 30 yrs)	Probability	Expected Present Value (1993$m, 7% discount over 30 yrs)
Avoided cost of infrastructure damage from acid sulphate soils			perhaps $1m
Avoided loss of commercial fishing	$7m	25%	$1.75m
Avoided loss of recreational values	$6.3m	50%	$3.15m
Avoided cost of dredging			perhaps $0.5m
Remediation / rehabilitation of degraded or damaged land			$0.25m
Avoided cost of repeated surveys for erosion control			$0.13m
Avoided cost of studies for hazard reduction			$0.18m
Survey cost			($0.16m)
Net benefits			$6.8m

Benefit Cost ratio			44

Box 4.2.9: Net benefits over time, if data collected as needed			
Benefit (Cost)	Maximum present value (1993$m, 7% discount over 30 yrs)	Probability	Expected Present Value (1993$m, 7% discount over 30 yrs)
Avoided cost of infrastructure damage from acid sulphate soils			perhaps $1m
Avoided loss of commercial fishing	$7m	25%	$1.75m
Avoided loss of recreational values	$6.3m	50%	$3.15m
Avoided cost of dredging			perhaps $0.5m
Remediation / rehabilitation of degraded or damaged land			$0.25m
Cost of ad-hoc, erosion & hazard surveys	say $0.08m for ad-hoc		($0.39m)
Net benefits			$6.26m
Benefit Cost ratio			17

Improvements in water quality, to the extent that these are due to LRA studies, are likely to constitute the most significant benefits. Many of these benefits could have been obtained from more focussed, specific purpose surveys. However, the actual survey had additional benefits in terms of economies of scale in gathering information used elsewhere.

4.2.10 Report LRA benefits and costs

Information from this study has been incorporated into ACIL's LRA framework. Additional information should be added as it becomes available.

4.3 Digital Atlas of Australian Soils

4.3.1 Background and objectives of the study

Box 4.3.1: Atlas of Australian Soils — hardcopy

In 1958, the CSIRO Division of Soils commenced a project, led by Dr K. Northcote, to map soil landscapes across the whole continent of Australia, at a scale of 1:250,000. The project was finished in 1968, in time to exhibit the resulting maps at the 1968 International Soils Congress, held in Adelaide.

The products of the study, comprising maps and printed reference material, including a descriptive key to soil types, became known as the *Atlas of Australian Soils.*

In printed form, the Atlas had a wide range of uses, including:

- enabling more detailed studies of soil landscapes;
- as reference material to facilitate other research;
- for training.

Northcote K, oral communication

In 1990, the National Resource Information Centre (NRIC) within the Bureau of Resource Sciences (BRS) transferred the Atlas to digital format — the maps in GIS format and the technical information as a database cross-referenced to the GIS.

4.3.2 Select study

This study was selected because:

- it is frequently cited as a case in which benefits have been made possible by technological developments which were not envisaged at the time of a field study; and
- it illustrates the merit of enabling uses of, increasing demand for, LRA information, in contrast to gathering more LRA information.

4.3.3 Identify users and uses of information

Experience to date is that standard digital information has enabled uses that would not have happened with printed or state specific GIS. Not surprisingly, these are across a wide spectrum.

Box 4.3.2: Checklist of uses of information from digital Atlas

Categories of uses	Anticipated?
Planning - industry, strategic level	Significant, due to scale of maps
Planning - regional level	Significant
Planning - local level	Some
Planning - property level	No
Land use assessment	Yes, eg as part of agricultural suitability assessment
Identification of areas of land with degradation potential	Yes, eg. potential salinity maps
Preparation of Local Environment Plans	No
Drought assessment & monitoring, modelling	Yes
Specific applications	Yes, eg. site selection
Property Valuation	No
Conservation areas - planning, management	Some
Detailed vegetation studies/surveys	No
Integrated Catchment Management	No
Forestry planning, management	Some
Reference Soil information	No
Spatial Information Analysis	Yes
Research, education	Yes, eg schools
Training	Yes

Source: discussions at NRIC, ACIL survey of projects

Digitised information is publicly available to potential users at a cost of $200, presumably the incremental costs of making the information available. Some access is also available through Internet.

4.3.4 Describe base case and project scenarios

In view of the trend towards digitising data, it is not so much a question of 'if' as of 'when'. In other words, the most likely alternatives to the Atlas being digitised in 1990 are:

- the work would have been done in a later year; and
- in the meantime, other agencies, particularly states, may have done some digitising, although not in such a standardised form.

In respect of uses which depended on having the digitised Atlas, the relevant questions are:

- would alternative access to the information, eg. hardcopy, have been used;
- would uses have been deferred till the digitised Atlas was available; and
- might some uses not have taken place at all?

4.3.5 Identify outcomes

Box 4.3.3: Checklist of outcomes from digital Atlas

Category of outcomes	Likelihood & net change
Increased economic production	Yes, eg. data available in digital form can readily be used to product on request maps with land use capability inferred from a variety of characteristics stored in geographically referenced databases. For example, suitability for particular types of mapping might be inferred from characteristics such as: • existing land use; • soil fertility data; • rainfall data. A number of such maps have been produced. Maps of suitable areas at a national or state level are feasibly only with the use of GIS and digital data.
Development of industry	Yes, as above
More efficient property valuation	No, as atlas too small scale
More productive use of staff resources	Significant
Better catchment management	No
Avoided infrastructure damage	Yes, eg. specific application to optic fibre cable routing, as described in Box 4.3.4 below.
Avoided environmental damage	Some
Remediation / rehabilitation of degraded or damaged land	Some
Preservation of biodiversity	Some

Source: discussions with NRIC, ACIL survey of project

In general, the contribution of the digital Atlas to many of the outcomes above is likely to be significant, in that they may not have been realised without it. However, the costs of achieving outcomes may be high, in which case the net benefit as a result of the digital Atlas could be small.

4.3.6 Benefits arising from project outcomes

Recall that this category counts benefits which would not have occurred if the Commonwealth had not sponsored the digitising of the Atlas. For the purpose of this analysis, the costs of producing the original information are "sunk", and we are not trying to allocate benefits between the original Atlas and the digitising.

Box 4.3.4 describes one specific application which however has large, identifiable benefits.

Box 4.3.4: Optic fibre cables

The (digitised) Atlas was used to prepare a field manual for selection of optical fibre cables of a standard appropriate for the soil types in which the cable was to be laid. Prior to the field manual, cables were failing due to strain from movement in the surrounding soil.

Locating the precise point of failure, particularly in rural locations, can be time consuming. Telecommunications companies have a great incentive to minimise cable outage, as the telecommunications revenue foregone during outages is very high - over $50,000 per hour. However, lost revenue is not necessarily economic cost. As explained in Box 2.12, economic costs comprise:

- loss of value added for businesses; and
- loss of consumer surplus;

in not being able to make telephone calls for the time that the cable is out. However, one would expect that many telephone calls could be deferred without significant loss of value. Also, since there are multiple service providers and a network of cables, there may well be alternative paths for connecting calls. Hence the economic cost of interrupted service may be much less than the value of revenue foregone / deferred. Alternatively it may be much more, eg., if a critical, very valuable, event is unable to be completed. However, the probability of this coinciding with cable outage must be very low. It is difficult to imagine actual costs due to outage being significant. However, businesses do value reliability of telecommunications.

The cost of cable suitable for laying in soils with the potential to cause damage is of the order of 10 to 12 times that of standard cable, so it is important to match cable type to soil type.

Benefits arise as:

- avoided cost of cable outage due to misjudging soil type;
- value of risk management; and
- lower cost as a result of not using high standard cable everywhere.

The cost of producing the optic fibre cable manuals was less than $1m.

A commercial price was paid for development of the manuals, so net benefits are expected to exceed 10% of the cost of producing manuals, say $0.1m.

Source: Fitzpatrick R, 1996 "Pedotechnology Examples from Australia", paper presented to Soil Science - Raising the Profile, Australian and New Zealand Soils Conference 1-4 July 1996.

Box 4.3.5: Benefits from outcomes from scenarios

Benefit	Indicator	Standard value	Discounted value (7% over 30 yrs)
Increased economic production	industries	actual production	
Avoided infrastructure damage	cases	$ per case	at least $0.1m
More productive use of staff resources	Staff	PW report internal efficiency gains of 22% over 5 years in using land and geographic data infrastructure	

Price Waterhouse 1995, *Australian Land and Geographic Data Infrastructure - Benefits Study*, Report to Australian and New Zealand Land Information Council

ACIL analysis

Box 4.3.4 also illustrates an example of an outcome that could not have been foreseen at the time of digitising the Atlas. Clearly, one such application can have benefits far in excess of the costs of the supporting LRA activity.

4.3.7 Assess other benefits

4.3.7.1 Economies of scale

For a single use, printed information is often sufficient. However, when more than one application is expected, for example, for land use decisions over time, there can be time savings in having information stored in electronic form. Multiple uses are almost always expected for LRA information, so there is a general tendency to want LRA in electronic form. By digitising **once**, the Commonwealth has avoided the task being done by a number of States; and from experience with other GIS, in ways that may not have been consistent. In view of economies of scale for digitising, that the cost of digitising at the national level was probably no more than the cost for two states, although at least four states would probably have digitised their LRA maps.

Also, the cost of the alternative of having inconsistent digital information would be at least as great as the cost of digitising, namely $50,000.

4.3.7.2 Risk management

This category seeks to identify values of reductions in risk of environmental or other damage, compared to what might have been the case in the absence of the study. Such values are very sensitive to assumptions, because probabilities tend to be small but values large. Box 4.3.6 illustrates an example the difficulties of making robust estimates.

Box 4.3.6 Benefits from site selection for radioactive waste

The digital Atlas has been used to assess potential sites for radioactive waste storage. This falls into the category of risk reduction because no waste has actually been stored anywhere (yet).
It is to be expected that the probability of radioactive waste being stored anywhere in Australia is extremely small. Nonetheless, there is a community benefit in having a better understanding of potential storage sites, be it to conclude that there are no sites, or many sites.
One way of assessing value which, however, does not capture the full public benefit, is to value the risk in an actuarial sense of expected cost, namely:

- cost of potential damage, multiplied by
- probability of site being selected, multiplied by
- probability of storage of waste.

Further, some of these conditional probabilities are almost impossible to estimate.
Another way might be by analogy with other waste storage sites, such as toxic waste. For example, Smith & Desvouges estimate a willingness to pay of US$561-748 to live more than 1.6km from a hazardous waste site in the USA.[1]
A third way might be community willingness to pay for better knowledge — this could be the subject of a contingent valuation survey, although it is possible that people will answer by saying that no storage should even be contemplated. If widely held, the latter view would reduce the perceived benefit in a better understanding of risks of various storage sites.
Benefit expected be at least $0.05m

1. Smith V.K. and Desvousages W.H., 1986, "*The value of avoiding a LULU : Hazardous Waste Disposal Sites*" Review of Economics and Statistics 68 : 293-299.

4.3.7.3 Generic benefits

The Digital Atlas is cited as an example of increased benefits from LRA as a result of developments, in this case technological. In 1968, when the Atlas of Australian Soils project was finished, no one could have imagined that the information would one

day be available in electronic form. Analogously, it is impossible to foresee what uses might arise from the digitised atlas in 28 years time, namely 2024.

It would be unduly optimistic to anticipate continuing rate of growth of benefits from this study. However, it might be arguable to apply a loading of perhaps 100% to the value of specific benefits above. (NRIC estimate that there has been a 90% increase in use of the Atlas since it was digitised.)

4.3.8 Assess costs

Digitising the *Atlas of Australian Soils* cost approximately $50,000.

Other costs of achieving outcomes are likely to be small.

4.3.9 Compare benefits and costs over time

Box 4.3.7 reports (some) net benefits, given that Atlas was digitised in 1990.

Box 4.3.7: Net benefits over time for digitising Atlas in 1990

Benefit (cost)	Maximum present value (1993$m, 7% discount over 30 yrs)	Probability	Expected Present Value (1993$m, 7% discount over 30 yrs)
Increased economic production			
Avoided infrastructure damage			at least $0.1m
More productive use of staff resources	22% of staff resources over 5 years		
Economies of scale	$0.1m		$0.1m
Risk management	insurance value of radioactive waste disposal site at least $0.05m		at least $0.05m
Generic benefits	loading of 100% on above benefits		at least $0.25m
Cost	($0.05m)		($0.05m)
Net benefits			at least $0.5m
Benefit Cost ratio			at least 10

ACIL Analysis

4.3.10 Report LRA benefits and costs

A more comprehensive survey of users of the digitised Atlas would without doubt reveal significant specific and generic benefits. Such a survey would supplement that done by Price Waterhouse[27], in seeking to estimate benefits from use of information rather than just efficiency gains from digital rather than hard copy access. An actual estimate of generic benefits would be a useful addition to collective experience of benefits.

4.4 Comments

The evolution of the preceding case studies during the development of ACIL's LRA framework nicely illustrates application of the framework. Information about uses, outcomes and consequent benefits is hard to gather, but once collected, should be available for use in subsequent evaluations. The value of the framework lies in showing how to do this, if not yet in its applications.

[27] Price Waterhouse 1995, *Australian Land and Geographic Data Infrastructure - Benefits Study*, Report to Australian and New Zealand Land Information Council

5. LESSONS FROM LRA EXPERIENCE

5.1 Lessons from specific projects surveyed

ACIL's methodology is intended to assist in evaluating projects. Ex-ante, this can assist in finding ways to improve information collection. Ex-post, evaluation can identify lessons to guide future projects.

In this latter regard, ACIL's survey of LRA projects asked respondents to suggest what might have been done differently, to increase benefits from projects. About half the respondents suggested improvements, including:

- technological improvements, for example:
  - using remote sensing for data collection
  - desktop and electronic publications.
- technical improvements of maps, for example, incorporating electronic data;
- more interaction during project with other LRA project teams and clients.

It is also important that mechanisms be in place to enable beneficiaries to make use of information which has been collected. Information of a high technical quality may nonetheless not lead to a high value of benefits if it is inaccessible, not readily capable of being applied in areas of interest, or if the cultures among respective beneficiaries work against implementation. This balance between deciding which data to gather, and then how to enable utilisation, is another key issue for the framework.

5.2 LRA production vs LRA promotion/use

Chapter 2 included a discussion of the strategic role that high level LRA investments are likely to have played in increasing demand for and application of LRA data in land use planning and approvals. Examples of this effect are evident in the subsequent sections of the report. As was suggested in Chapter 2, an important issue for future LRA planning and investment relates to the balance of effort between new high level survey activity and other activities directed at using the existing investment, in both data/analysis and skills) as a platform for building a more demand driven LRA activity in Australia.

It is likely that a reasonable body of experience in the application of the framework to a range of reasonably representative surveys will be needed before a strong position can be developed on this issue. ACIL has expressed that view that the generic benefits coming out of the role of these LRAs in altering the culture of land planning and the associated demands for LRA information may well be the dominant benefits.

The question still remains as to whether there are any particular design lessons to emerge from the application of the cost-benefit framework. The following possibilities occur to ACIL:

- LRA investments which are directed at making existing information more accessible and better used have considerable attraction, particularly now that there is growing demand and significant industry capability to build on that information.
- The earlier discussion of the digital *Atlas of Australian Soils* is a case in point. In effect, this investment has been able to "leverage off" all the preceding investments to create what is essentially a new product because of the integration and low access cost.
- There may well be a case for considering strategies for facilitating private sector involvement in "value adding" the existing data —

possibly through some strategic contracts with the intellectual property remaining with the successful tenderer for a specified period where the most competitive tenderer is likely to have factored in assumptions about future commercial value from owning that property.

  - Such investments are just as much LRA investments as are the basis surveys, with the added advantage of further stimulating demand and encouraging private agents to take on a marketing role.

- The most "valuable" new surveys are likely to be of areas characterised by significant growth or other commercial or environmental pressures which are encouraging significant change in land use patterns; by high levels of heterogeneity of soil characteristics across the area, limiting the scope for efficient learning from past mistakes; and by the likelihood that valuable new generic lessons could be inferred from such a survey.

  - This last point might, for example, favour the selection of areas where there is evidence of a degradation problem which may be linked to soil characteristics and where a survey could enable valuable scoping of preferable land use planning strategies which would have contained the problems at modest cost.

  - On the other hand, these are also the very considerations which most strongly favour private investment in LRA. This does suggest that there may be increasing scope for "joint ventures" with private sector suppliers of LRA services or for stronger cost recovery mechanisms through user pays arrangements or through licensing of access to data by consultants.

- Potential major strength of investments in the promotion of better land use planning through the generic benefits of LRA are:

- The scope which often arises for rapid implementation — implying a short time period between incurring the costs and appropriating the benefits. This reduces the detrimental impact of discounting which can work against surveys with long lead times followed by delays in achieving appropriate levels of use.

  The availability of a large "user base" for the results of the investment — potentially much larger than that offered by the coverage of a new survey.

- Both these effects can dramatically improve the cost effectiveness of an investment — and have done so in many analogous cases studied by ACIL. These considerations, coupled with the benefits of leveraging off a large block of sunk costs and strengthened by the awareness, expressed during the consultations, of weaknesses in the current "marketing" of the information, suggests that there is significant scope for sound investments of this type.

• One of the more attractive instruments for building sound demand, and one where there is evidence of significant gaps in the present marketplace, relates to land use planning guidelines which fully recognise the availability of LRA information, and the scope for originating it, and which develop sound risk management principles for land use planning which are both environmentally sensitive and commercially attractive.

  - This may well be the sort of research which is well suited to joint venture arrangements with the private sector suppliers of LRA services or to straight commercial contracts with these providers. ACIL suspects that *ex ante* evaluation of soundly structured projects along these lines, especially tied in with consultations with local councils etc regarding their approvals

requirements, could prove highly cost effective. Equally, it may well be an activity where groups such as Shires Association may want to take a lead role because of its direct application to meeting their needs.

– The availability of such guidelines could well spawn a stronger market push for strategic LRAs to allow cost effective application of these guidelines.

6. GLOSSARY

ABARE: Australian Bureau of Agricultural and Resource Economics.

ABS: Australian Bureau of Statistics.

Additive: environmental costs (or benefits) are said to be additive when the total cost of a number of impacts is equal to the sum of the costs (or benefits) of the individual impacts.

Amenity: desirable features, services or quality

Benefit transfer: the transferring of environmental values originally generated for a "study" site for use at a second site, known as the "policy" site (q.v.).

Bequest value: the value associated with bequeathing environmental goods to future generations from the perspective of the person making the bequest.

Biodiversity: the variety of all life forms, comprising genetic diversity (within species), species diversity and ecosystem diversity.

Citizen's response: in a contingent valuation survey, a response that does not reveal private willingness to pay (WTP) but rather WTP based on the public interest (see Blamey & Common (1993) for discussion of this issue).

Consumer surplus: the difference (individually or collectively) between people's maximum willingness to pay and what they are actually required to pay for an (environmental) good.

Contingent valuation method: a survey-based technique used mainly for valuing non-market resources in which use and non-use values can be estimated. It is based on the use of elicitation questions to determine people's maximum WTP for improvements in environmental quality or willingness to accept (WTA) compensation for falls in environmental quality.

Cost-benefit analysis: A widely used technique in investment and policy analysis designed to assess the relative social desirability of a project. This is achieved through the systematic evaluation of all the expected costs and benefits associated with a project, from the perspective of the community. Major non-financial cost sand benefits are included — such as environmental costs and benefits — and more than one policy option is usually considered.

Delphi technique: environmental valuation through the opinions of a panel of experts.

Direct valuation methods: valuation methods in which the benefits from environmental improvements are measured directly through revealed preferences eg contingent valuation, travel cost and hedonic price methods.

Disamenity: loss of desirable features, services or quality.

Discount rate: measures the rate at which one wishes to forego future consumption for present consumption.

Dose-response approach: a valuation method in which the marginal damages from changes in environmental quality are assessed.

Embedding effect: the effect on a survey response of the respondent's lack of awareness of (or indifference to) the scope of an environmental good. For example, if respondents show the same WTP for water quality improvements in one river in a given area as they do for improvements in 10 rivers, each of a similar size, character and recreational use, this may indicate an embedding effect.

ENVALUE: Environmental database published by the NSW EPA.

Environmental goods: naturally occurring components of the environment, such as clean air and water, natural areas, relatively noise-free environments.

EPA: Environmental Protection Agency.

Existence value: the value placed on environmental attributes (eg natural wilderness areas, water quality) from knowing that they will continue to exist.

Exogenous: an effect on a system that has an external stimulus, or a variable in a model which is defined externally.

Externalities: external, unpriced side effects of economic activity; may be beneficial or harmful.

GDP: Gross Domestic Product.

GIS: Geographical Information System.

Gross domestic product (GDP): the total value of final goods and services produced within the economy of a state or nation.

Hedonic price method: a valuation method in which it is assumed that externalities are capitalised into housing prices (or wages). Differentials in property prices or wages are then examined to find the marginal value of environmental quality or other amenities.

Indicators: measures of a project result or outcome (q.v.). For example, an indicator for a project with a tree planting outcome is number of trees planted.

Indirect valuation method: a valuation method based on examining the change in expenditure or damages related to the impact from a reduction or improvement in environmental quality, rather than attempting to value the reduction/improvement itself. Examples are dose-response, preventive expenditure and replacement/repair cost approaches.

LWRRDC: Land & Water Resources Research and Development Corporation.

Meta analysis: the combining of a large number of previously estimated demand equations into a single predictive equation.

Net present value: the present value (q.v.) of net benefits, that is, benefit costs.

Non-market valuation method: a valuation method that does not rely directly on market prices to estimate the value of environmental goods, eg the contingent valuation method.

Non-use value: the value of a good that is not related to use (eg existence or bequests value).

Offsite cost: the cost of environmental damage that occurs in an area different from the cause of the damage (often on a different property).

Onsite cost: costs of environmental damage that are experienced in the same area (or property) where the damage was caused.

Opportunity cost: the value of the alternatives foregone by choosing a particular course of action, eg the use of a resource for a selected project.

Option value: the value placed on having the opportunity to make use of the environment at some future stage. Option value has various aspects, such as bequest value and vicarious value. A related concept is quasi-option value (qv).

Outcome: change in the world which is measurable.

Payment vehicle (bias): the means of payment used in a contingent valuation survey (eg a levy or increased taxes). A payment vehicle bias occurs when the payment vehicle is inappropriate for valuing an environmental good, or if there is rejection of the payment vehicle (eg people may reject the idea of paying to enter a park if they think they are already paying sufficient through taxes).

Policy site: the site to which a primary estimate is to be transferred from a "study site" (qv).

Present value: the value in "today's dollar" of a future stream of amounts, obtained by a discounting using an appropriate discount rate (q.v.).

Preservation value: the combination of option, quasi-option, existence and vicarious values.

Production function: a theoretical or empirical equation that represents how a given set of inputs is combined to produce a range of possible outputs. It specifies the maximum output that can be produced given a limited set of inputs.

Property rights: the rights to the ownership, use and transferability of a good.

Proxy: is used to represent any variable (such as environmental degradation) which is difficult or not possible to measure.

Purchasing power parity: an index for standardising different currencies based on the amount of each currency required to purchase a given basket of goods and services in its respective country.

Quasi-option value: the value attached to learning more about the behaviour of the environment in the presence of uncertainty. It is the price people are prepared to pay for the opportunity to obtain improved information.

Recreation value: the value derived from people's use for recreational purposes of an environmental good.

Starting point: in a contingent valuation study, the initial amount of money that respondents are asked whether they are willing to pay for an environmental good. Starting point bias occurs when the starting point affects respondents" stated WTP.

Study site: the initial site or area for which an estimate of environmental value is generated.

Travel cost method: a valuation method in which travel costs are used to impute a demand curve for recreational benefits. It is based on the assumptions that people spend more on travel to sites with high environmental or other values.

Use value: value of a good related to its use.

Utility: the enjoyment or benefit derived from the use of a good.

Value-added: The contribution of an activity to GDP, comprising gross operating surplus plus wages and salaries.

Vicarious value: an element of option value in which the value is derived from the knowledge that other people may make use of an environmental good.

Willingness to accept (WTA): an expression of the compensation consumers are willing to accept for a reduction in environmental quality.

Willingness to pay (WTP): an expression of what consumers are willing to pay for an improvement in environmental quality.

Many of the definitions in this glossary have been taken from the glossary in *ENVALUE — NSW EPA Environmental Valuation Database.*

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