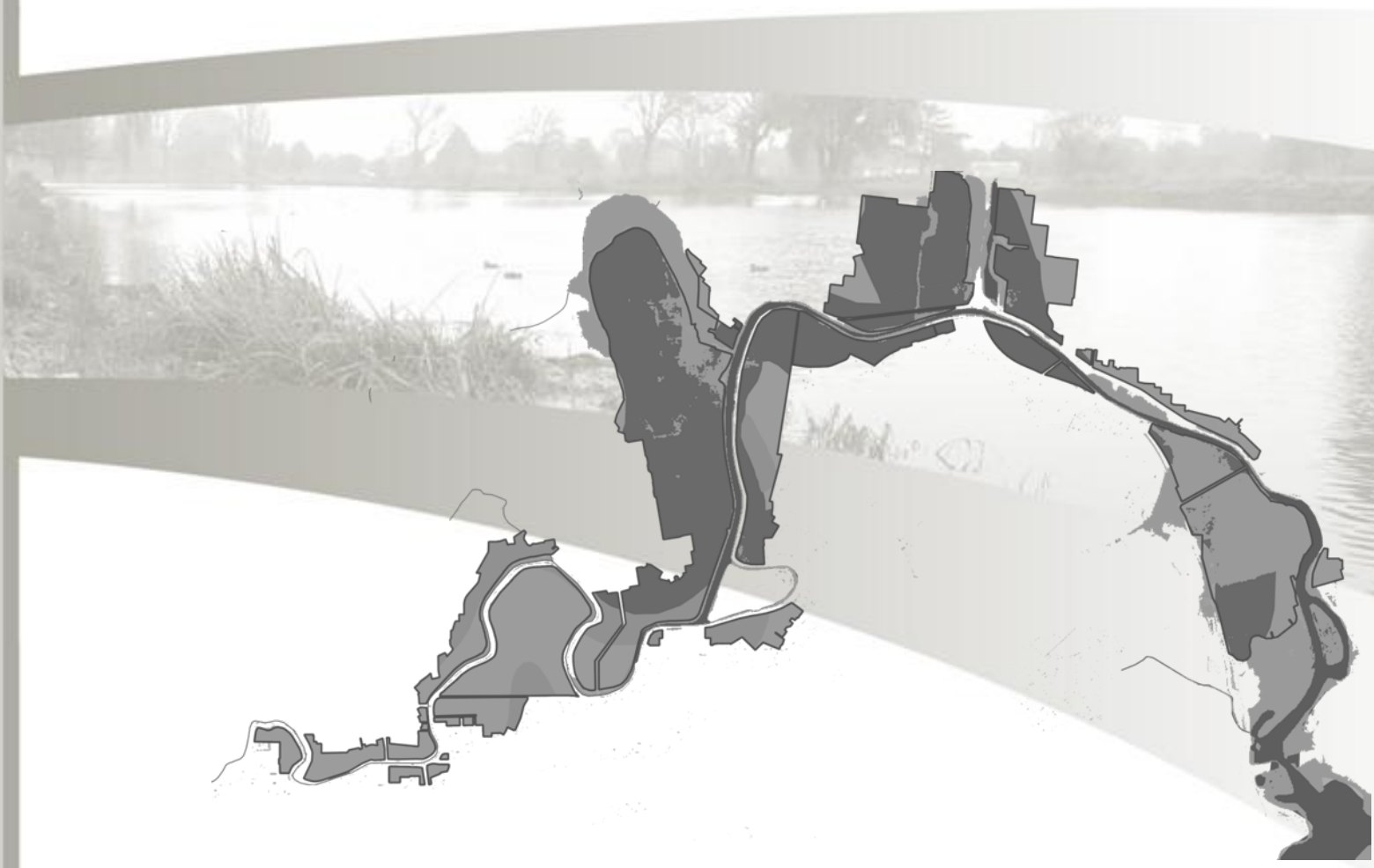
Avon-Otakaro Network
Manaaki Whenua, Manaaki Tangata, Haere whakamua
Care for the land, Care for the people, Go forward.



AVON ŌTĀKARO NETWORK

Integrated assessment frameworks for evaluating large scale river restoration

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ERO Report 1
Floodplain restoration principles for the Avon-Ōtākaro Red Zone. Case studies and recommendations.

ERO Report 2
Restoration opportunities assessment for the Avon-Ōtākaro Red Zone using a local knowledge approach.

ERO Report 3
Integrated assessment frameworks for evaluating large scale river corridor restoration.

Copies of the reports are publicly available on the Avon Ōtākaro Network website.

Front cover: A reach of the lower Ōtākaro / Avon River within the 602 ha area of river corridor that is currently the subject of future land use planning. Much of the land was purchased under a government acquisition programme to address subsidence and other land damage resulting from the 2010-2011 Canterbury earthquakes.

Photo: Shane Orchard

Integrated assessment frameworks for evaluating large scale river corridor restoration

Prepared by: Shane Orchard
Avon Ōtākaro Network

A project funded by the Tindall Foundation

in collaboration with
Avon Ōtākaro Forest Park and Greening the Red Zone

LIST OF ABBREVIATIONS

AOFP	Avon Ōtākaro Forest Park
AORZ	Avon-Ōtākaro Red Zone
AvON	Avon Ōtākaro Network
CBA	Cost Benefit Assessment
CERA	Canterbury Earthquake Recovery Authority
EIA	Environmental Impacts Assessment
ERO	Ecological Regeneration Options
DOC	Department of Conservation
GIS	Geographic Information System
GtRZ	Greening the Red Zone
LURP	Land Use Recovery Plan
LVD	Lyttelton Vertical Datum 1937
MCA	Multiple-Criteria Analysis
MCDA	Multiple-Criteria Decision Analysis
NZVD	New Zealand Vertical Datum 2016
WDC	Waimakariri District Council
WTP	Willingness To Pay
WWF	World Wide Fund for Nature

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EXECUTIVE SUMMARY

This report is the third and final report in the Ecological Regeneration Options (ERO) project series. Its purpose is to assist in developing integrated assessment methodologies for evaluating ecological regeneration options in the Avon-Ōtākaro Red Zone (AORZ). This is an important topic to ensure that their potential benefits are recognised alongside those of alternative land uses. This report complements the previous two reports in the ERO series. These provide information on floodplain restoration principles (Orchard, 2017) and an assessment of restoration opportunities in the AORZ using a local knowledge approach (Orchard et al., 2017).

The focus of this report is on facilitating robust assessments of the ecological regeneration options presented by the AORZ. A specific objective was to develop an integrated assessment framework to support comparison of those options against each other and against alternative land uses. First, the topics of river corridor evaluation and integrated assessment are briefly introduced and examples of integrated assessment in relevant planning contexts identified. A framework for the integrated assessment of ecological regeneration options is then presented.

Key findings:

- Integrated assessment is a suitable approach for the evaluation of land use options to support planning
- There is no single or standard integrated assessment methodology. Rather, the term refers to a range of techniques that may involve different forms of extended Cost-Benefit Analyses (CBA) and Multiple-Criteria Analysis (MCA) and can incorporate approaches such as ecosystem services frameworks and participatory forms of assessment.
- The benchmarking forms of MCA are an appropriate output format for informing policy and plan development processes especially when used in an iterative cycle of assessments.
- Participatory aspects are the foundation of integrated assessments using MCA approaches wherever expert judgement is used as the scoring method. Community engagement exercises to support policy and plan development processes are a much wider set of considerations and do not substitute for involvement in assessment process. Effective methods are needed to incorporate stakeholder input directly in the design of the assessment. There are a range of contexts for this to occur including in the sourcing of baseline and other technical (and non-technical) material used to inform the assessment, in the specification of scenarios for assessment, in the rating methodology (e.g. workshops or surveys) used to conduct the assessment, and potentially in the design of the process itself. This may include attention to appropriate times and formats to ensure inclusivity, such as by accommodating tīkanga based components.
- There are considerable differences between the application of integrated assessment to the appraisal of existing documents (such as draft policies and plans) versus the evaluation of options such as land use comparisons (Figure 6-1). The use of integrated assessment to support options evaluations provides an opportunity to improve plan drafting processes.

- In options evaluation, the process of developing the options is critical. In complex planning processes such as those involving a high diversity of environments or anthropogenic interests, the specification of the options for assessment is likely to be the single most important step in delivering the best outcomes. Good ideas missed at that stage may be disabled or otherwise never revisited. For this reason the development of scenarios is a key exercise and should be inclusive of multiple perspectives and forms of knowledge. Input from, or the direct involvement of stakeholders can assist this. Complex scenario development is supported by iterative stepwise processes to identify the components that are most important for achieving the overall objectives. A sequence of integrated assessment activities can support the scenario development process and help improve the level of understanding and buy-in for major decision points (such as the elimination of options) along the way. These approaches can overcome common problems around the lack of stakeholder engagement early in plan drafting processes.
- Developing approaches that support the integration of assessment investments in both space and time presents an opportunity at this early stage in the regeneration of the AORZ. This will ensure consistency and help add value over time, as well as being essential for the implementation of adaptive approaches to management. International examples are available to illustrate some of the key benefits and appropriate strategies.
- An appropriate spatial framework can assist in the development of scenarios and improve the ability to identify the impacts, including both trade-offs and synergies between overlapping land use options. This will support exploring and quantifying potential synergies between compatible co-uses as well as the opportunity costs of different competing uses at varying scales. A clear spatial basis in coarse scale assessments will also facilitate finer scale planning over time and ensure the compatibility of results to support an adaptive approach.
- Resilience to future change is an important component of long term planning. It can be addressed in the construction of scenarios and the design of assessment processes and their outputs. Resilience has been identified as one of the top-level considerations for regeneration planning of the Avon-Ōtākaro Red Zone (AORZ) as is appropriate. Exposure to sea level rise is a particular consideration for planning in the AORZ. Key implications include effects on ecological succession and consideration for the resilience of infrastructure to expected levels of change over the planning horizon, as required under the NZCPS.
- Ecological regeneration activities include blue and green infrastructure proposals that may potentially occupy a large proportion of the AORZ. In combination these land use options are likely to make a major contribution to the future value of a regenerated river corridor. The assessment framework applied to support planning must be fit for purpose to account for the potential benefits and enable meaningful comparisons to be made. The framework presented here will help in developing assessment processes to provide for these needs.

1. Introduction

The restoration of modified floodplain and river systems is an urgent priority worldwide and often involves areas that have been defended from river dynamics to allow the expansion of human activities (Arthington et al., 2010; Dynesius & Nilsson, 1994; Ward & Wiens, 2001). Attempts to integrate system dynamics and natural self-maintenance properties have led to a focus on ecological integrity as a common objective for floodplain restoration. This is generally promoted by the re-establishment of natural processes and connectivity (Petts et al., 2006). Strategies such as managed hydrogeomorphic change may be employed in staged or adaptive projects and typically lead to a myriad of results in target habitats with various consequences for associated natural values and human uses.

Particularly in larger scale projects, assessing outcomes requires attention to many parameters simultaneously. This has driven the need for comprehensive monitoring and evaluation methods to support ongoing decision making (Anderson et al., 2005; Habersack et al., 2015). Successful examples such as the Kissimmee River Restoration Project in Florida have made use of extensive baseline assessment frameworks and conceptual models to guide planning (Dahm et al., 1995; Bousquin et al., 2005; Toth et al., 1995). Others have made use of integrated assessments to undertake comparisons between options as part of developing ecological restoration strategies and the wider task of solving river management issues (Table 1-1). This has been especially prevalent in Europe where the contemporary legislation under the EU Water Framework Directive has encouraged integrative river basin management beyond the active channel and widened the scope of flood management activities (Jungwirth, 2002). The experience of projects that have been successfully implemented offer useful insights for the design of new initiatives elsewhere (Habersack et al., 2014).

Following the Canterbury earthquakes many thousands of homes were acquired by the government for demolition on the basis that the land was too badly damaged to be economically remediated for immediate residential redevelopment. A large and contiguous tract of this land lies adjacent to the Ōtākaro / Avon River in Christchurch City (Figure 1-1). This land is known as the Avon-Ōtākaro Red Zone (AORZ) and is now the subject of an extensive planning exercise (Figure 1-2).

Table 1-1. Examples of integrated assessment studies reported in the floodplain restoration literature.

Study area	Assessment framework	Key objectives for assessment	References
Kissimmee River, Florida	targeted monitoring programme supported by spatial framework & habitat classification	assess impact of restoration initiatives across multiple values	Anderson & Dugger (1998)
Rhine & Meuse Rivers, Netherlands	integrated impact assessment, extended CBA, basic MCA.	assess effects of alternative floodplain policies and associated land use change	Brouwer & van Ek (2004)
East Lents floodplain, Willamette River basin, Oregon	normalised MCA and GIS overlay techniques	assess spatial distribution of the key benefits from a floodplain restoration project	Hoang et al. (2016)
265 flood risk areas across Canada	direct rating MCA using expert panel approach	(non-monetised) benefits and costs of alternative floodplain management programme	De Loe & Wojtanowski (2001).
Kamp River, Danube River basin, Austria	Scenario modelling, direct rating MCA using expert panel approach	Outcomes evaluation for alternative floodplain management scenarios	Habersack et al. (2015)
Lobau floodplain, Danube River basin, Austria	scenario modelling, value function MCA, MCDA using outranking techniques	Outcomes evaluation for alternative floodplain management scenarios	Hein et al. (2006)

Figure 1-1. Location of the Avon-Ōtākaro Red Zone in the city of Christchurch, New Zealand.

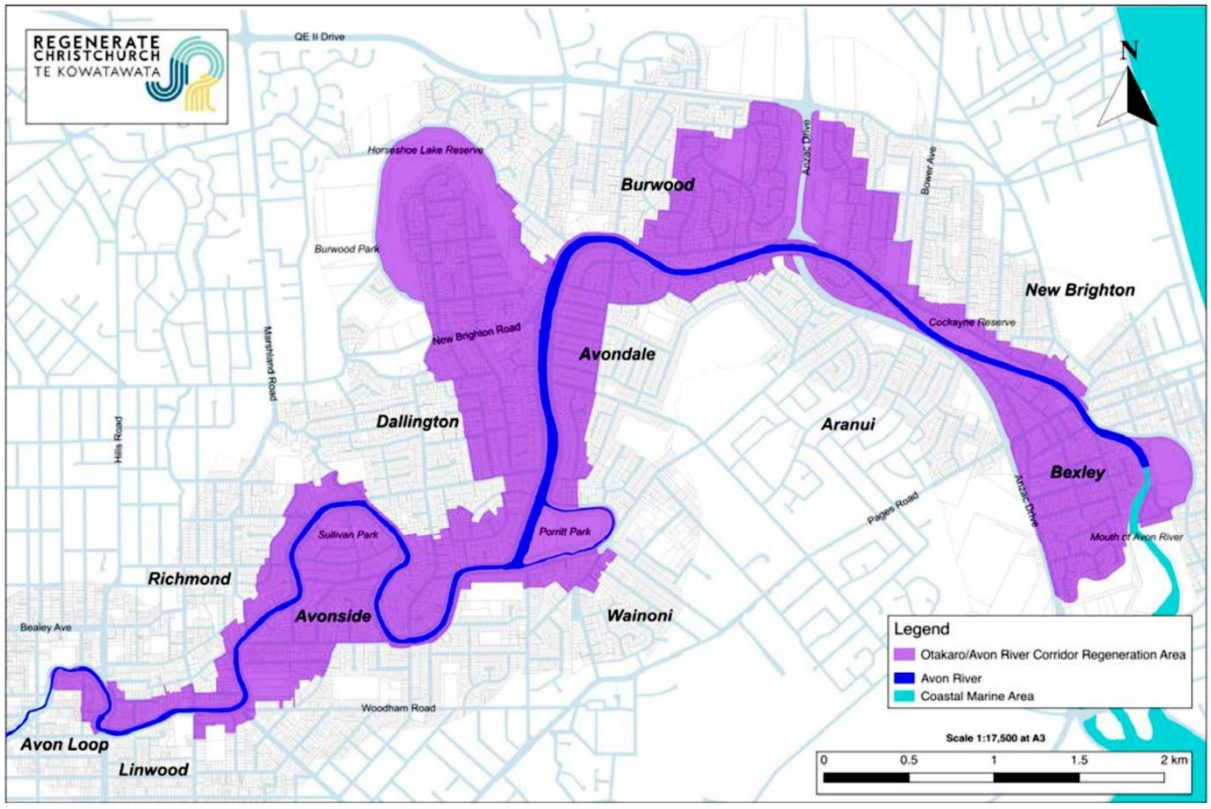

Figure 1-2. The planning area coved in the Ōtākaro / Avon River Corridor Regeneration Plan. (Regenerate Christchurch, 2017a).

Historically, much of the AORZ was part of an extensive network of riparian floodplain wetlands supporting a rich mosaic of indigenous ecosystems with high cultural values (Tau et al., 1990). However, as is common in many urbanised river systems, land use patterns associated with settlement, drainage, and river engineering have progressively modified the former floodplain and riparian environment. Consequently there is a major opportunity for ecological restoration activities to improve natural environment values in this 'red zoned' area. However, the potential benefits must be considered alongside other land use proposals and synergies explored to promote integration wherever possible.

The purpose of this report is to assist in developing integrated assessment methodologies for evaluating ecological regeneration opportunities in the AORZ. This is an important topic to ensure that their benefits are recognised alongside those of alternative land uses. First, the topics of river corridor evaluation and integrated assessment are briefly introduced and examples of integrated assessment in relevant planning contexts identified. A framework for the integrated assessment of ecological regeneration activities is then presented.

2. Ecological Regeneration Options (ERO) project

To assist the recognition and further development of key opportunities in the AORZ, the Ecological Regeneration Options (ERO) project was developed by Avon Ōtākaro Network in collaboration with two other community groups, Avon Ōtākaro Forest Park and Greening the Red Zone. The purpose of the project is to inform Regenerate Christchurch and other groups involved in planning for the future uses of the AORZ. A key aspect is to encourage and facilitate comparisons between ecological regeneration opportunities and other land-use proposals, and to support the integration of ecological design principles into more intensive land uses.

This report is the third and final report in the Ecological Regeneration Options (ERO) project series. Its purpose is to complement the previous two reports (Orchard, 2017; Orchard et al., 2017) by providing a review of appropriate frameworks for the development of assessment methodologies to address the previous findings. These findings, and a brief introduction to the ERO project, are summarised in the following sections.

The purpose of the first ERO study was to provide an overview of the floodplain characteristics of the AORZ, and review international experience in large scale floodplain restoration projects to identify key principles that may be applied in the AORZ (Orchard, 2017). Historically, the AORZ was part of an extensive network of riparian floodplain wetlands supporting a rich mosaic of indigenous ecosystems. The majority of the land was progressively developed following drainage and river regulation activities together with the raising of ground heights using fill. However, earthquake induced subsidence predominates across all of the major areas within the AORZ with the average drop in ground levels being around 0.5 m. Over the majority of the area this has resulted in greater exposure to flooding including coastal inundation and heightened connectivity to the sea. Sea level rise simulations show that much of the AORZ is also exposed to coastal inundation within a 100 year planning horizon based on current expectations. For these reasons, resilience to sea level rise as well as other environmental dynamics is an important consideration in planning for future uses of this land.

An extensive review of international experience in the implementation of large scale river floodplain restoration projects was conducted as a component of this study. A case study approach was then used to identify transferable principles for large scale floodplain restoration, and a set of recommendations developed for the application of these concepts to the AORZ (see Appendix A-1). The purpose of the second ERO study was to identify potential benefits of ecological restoration activities across both land and water systems and characterise the key options for their

implementation. The study used a local knowledge approach to generate information specific to the site based on local experience. The findings represent the most comprehensive set of concepts available to date to inform and quantify the potential benefits of ecological regeneration within and beyond the AORZ. This is core topic for planning to avoid missed opportunities and opportunity costs.

Results from the study demonstrate that there are a wide range of activities that may be applied to generate benefits for Christchurch and beyond, all involving aspects of a potential new ecology within the AORZ. A total of 165 categories of benefit and 180 components of implementation strategies were identified (Orchard et al., 2017). The latter may be applied in various ways to achieve different restoration objectives and a large number of combinations are possible. The same information may be used to develop restoration proposals and specify scenarios for assessment of the major opportunities to support the planning process.

The focus of this final report in the ERO series is identification of appropriate assessment methodologies. Their design is crucial to enable the many facets of natural environment values and restoration processes to be pulled together in quantitative comparisons to support decisions on alternative land uses.

3. Assessment context

Evaluation roles in floodplain and river restoration

The purpose of evaluation in a restoration context is to measure the effectiveness of actions taken in achieving the objectives, or to support the design and choice between options representing alternative restoration scenarios. These may include different targeted objectives, restoration strategies, or both. The measurement of a baseline is essential for both forms of evaluation. In the case of outcomes evaluation using the results of monitoring, the baseline provides the point of comparison for interpretation (Henry & Amoros, 1995).

In the evaluation of future scenarios, the difference between the proposed future state and the baseline or current state may include the inputs needed to create the alternatives as well as assessment of the results (Jungwirth et al., 2002). The status quo may also represent a preferred scenario for continuance. This is often reflected in a scenario based assessment approach by evaluating the status quo as a scenario or by reflecting it in the output as differences between the status quo and alternatives (Amer et al., 2013). The latter forms the basis for impact assessment.

Methodologies for integrated assessment

The field of integrated assessment has grown in response to the need for decision making across disciplines (Chapman & Meyer, 2014) and has been defined as a ‘‘structured process of dealing with complex issues, using knowledge from various scientific disciplines and/or stakeholders, such that integrated insights are made available to decision makers’’ (Kok, 2006).Typical contexts include sustainability assessments where integration is a clear focus. However, the need for cross-disciplinary thinking arises in many planning and decision contexts wherever choices are required with varying effects on different resources and beneficiary groups (Carmichael et al., 2004; Salter et al., 2010). Integrated assessment has been described as an approach that attempts to understand an issue from multiple perspectives based on boundaries defined by the problem itself, in contrast to any set of predefining disciplines (Rotman et al., 1996). In policy contexts the general purpose is to explore and identify as many consequences as possible in relation to different courses of action, so that their implications can be fully considered in the final decision (De Vries, 1999).

In practice there are many forms of integrated assessment, and no standard approach. Typically, integrated assessments include a range of techniques delivered in a process that facilitates communication between the evaluators and the decision-makers in need of information. This process is often iterative, and can include a range of participatory steps to elicit input from key stakeholders (Salter et al., 2010). Participatory forms of integrated assessment are common in the literature, and are typically used to help reach consensus or improve buy-in for a decision, or conversely identify divergence and diversity (Kok et al., 2007). Two main entry points for participation can be identified; the co-creation of scenarios for assessment, and the participatory assessment of them. Some studies have included extensive visioning exercises to encourage awareness of issues and co-create potential solutions as a group exercise (e.g. Vanwynsbergh et al., 2007). The assessment step typically proceeds via some form of multi-criteria analysis (MCA), and the selection of these criteria is critical to the process.

Criticisms of integrated assessment approaches include the use of a high level of aggregation (Easterling, 1997) and potential subjectivity arising from reliance on small 'expert group' processes. The design of the assessment model can reduce this in at least two ways (Gault et al., 1987). First, the choice of criteria that are assessed to create the output is open to interpretation as well as different forms of knowledge. The form of the output is also important and needs to be chosen to match the intended end use. Some studies simply report the performance matrix of all results rather than further processing these into aggregated scores as used in multi-criteria decision analysis (MCDA). The many methods for such aggregation present a range of options and can be designed to best suit the decision context. Second, participatory processes may assist in the selection of these choices. Participation can also help confirm the validity of the approach chosen as well as offering opportunities for awareness-raising and social learning among participant groups (Rowe & Frewer, 2000).

An additional technique available is to ensure that the assessment process is well informed. This often involves prior investigations to better characterise issues that are relevant to the decision, together with potential options. Numerous methodologies exist that include group exercises, technical investigations, policy analyses and computer modelling, all of which may be built into the integrated assessment process at different points (de Kraker et al., 2011; Kok et al., 2007; Tansey et al., 2002). In relation to the assessment output, this information is important to support both the development of scenarios to be assessed, and the selection of assessment criteria.

Scenarios for assessment

Scenarios provide an attractive approach to developing models for assessment and decision contexts. They are particularly useful options assessments where the direction of the planning or development proposal has yet to be established. Scenario modelling focuses on conceptualising plausible futures which may lie outside of the realm of past experience and yet are distinctly possible (Carpenter, 2002; Coreau et al., 2009; Yohe et al., 1999). Potential impacts in each scenario may then be considered to compare alternatives (Amer et al., 2013). Scenarios can be used to improve the understanding of uncertainties by comparing the sensitivity of different options potential change (Peterson et al. 2003).

Strengths of scenarios include their amenability to the inclusion of stakeholder perspectives and ability to bring together different forms of knowledge (Kok et al., 2007). This may be used to improve their relevance to decision contexts by attempting to integrate aspects of the linked socio-ecological system in the specification of scenarios, rather than rely on predictive modelling of the environmental, social, cultural and economics elements in isolation. Often this is accomplished using a variety of information sources to uncover the interdependencies between these facets at the time a scenario is

being developed. Qualitative social data and quantitative biophysical and modelled predictions may all be combined to inform the scenario specification process (Bohensky et al., 2006).

There are many methods which may be used, as their selection depends often on the subject material and context. Ecological scenarios are often selected on the basis of empirical data, though qualitative or semi-quantitative approaches based on expert knowledge are becoming common in the fields of conservation biology and climate change biological predictions (Martin et al., 2012; O'Neill et al., 2008). Scenarios can also be framed against a variety of comparison points. Examples include against each other as alternatives, against the status quo (the 'business-as-usual' scenario), or against an aspirational set of objectives or policy goals. The latter include sustainability frameworks such as the Natural Step's 'four system conditions', and policy-based evaluations to compare the performance of alternative methods for implementation.

4. Previous experience with integrated assessment

Efforts to re-naturalise river corridors in urban settings have been prominent in Europe in connection with new policies on water management. This has led to a variety of studies including those that have reported on restoration success, and others that have evaluated potential. The following example from the Netherlands typifies some of the many efforts underway to explore alternatives to historical land use patterns on the floodplains of major rivers. To a greater extent than any country, maintaining protection against flooding has always been the primary concern for water resource management in the Netherlands. Interventions have including raising land and the extensive use of dikes to hold back water. However, more recent studies have shown that construction of hard defences may exacerbate flood risk by promoting greater levels of land use intensity in areas that may remain exposed to hazards (de Kok & Grossmann 2010). This situation manifested in a series of devastating floods in 1993 and 1995 forcing the evacuation of more than 100,000 people from the floodplains of the Rhine and Meuse (Brouer & van Ek, 2004) followed by a series of major floods across Europe in the early 2000s (Barredo, 2007). Together with similar experiences elsewhere in Europe, this set the scene for a concerted investigation into new flood management approaches and new attitudes to river corridor lands (Dworak & Görlach, 2005; WWF, 2000; 2002).

Although benefits such as habitat and water quality gains and improved recreational and amenity values may result from floodplain restoration, natural hazard management remains a primary objective (Schober et al., 2015). This creates both constraints and opportunities for the re-establishment of more natural river environments. Useful concepts may include risk reduction and avoided costs aspects that may be provided by green infrastructure as a 'natural solution' to river management. However, any restoration proposals must present an effective land use alternative from the status quo across a range of ecological, social, cultural, and economic considerations. Assessments that integrate these aspects can provide the necessary decision support. Similar assessment contexts can be found wherever river engineering has led to floodplain degradation and the establishment of human settlements or intensive land uses.

A study by Brouwer & van Ek (2004) provides an example of integrated assessment applied to the evaluation of alternative floodplain management in an urbanised setting. The focus of the assessment was a set of scenarios that represent plausible management interventions for implementation (Table 4-1). An integrated assessment process was designed to evaluate the impacts of the alternative scenarios on the socio-ecological system (Figure 4-1).

Table 4-1. Alternative scenarios for the management floodplains in the Netherlands. Adapted from Brouwer & van Ek (2004).

Scenario	Description	Timeframe to implement
1	Modifications to widen and deepen selected floodplains.	15 years
2	Planning measures to claim extra space for water in and around the Biesbosch, an important national wetland nature reserve.	15 years
3	Creation of additional new watercourses (canals and rivers) around existing watercourses. These reflect a longer term planning vision for the area and would require existing infrastructure and dike enclosures to be broken down.	50 years +

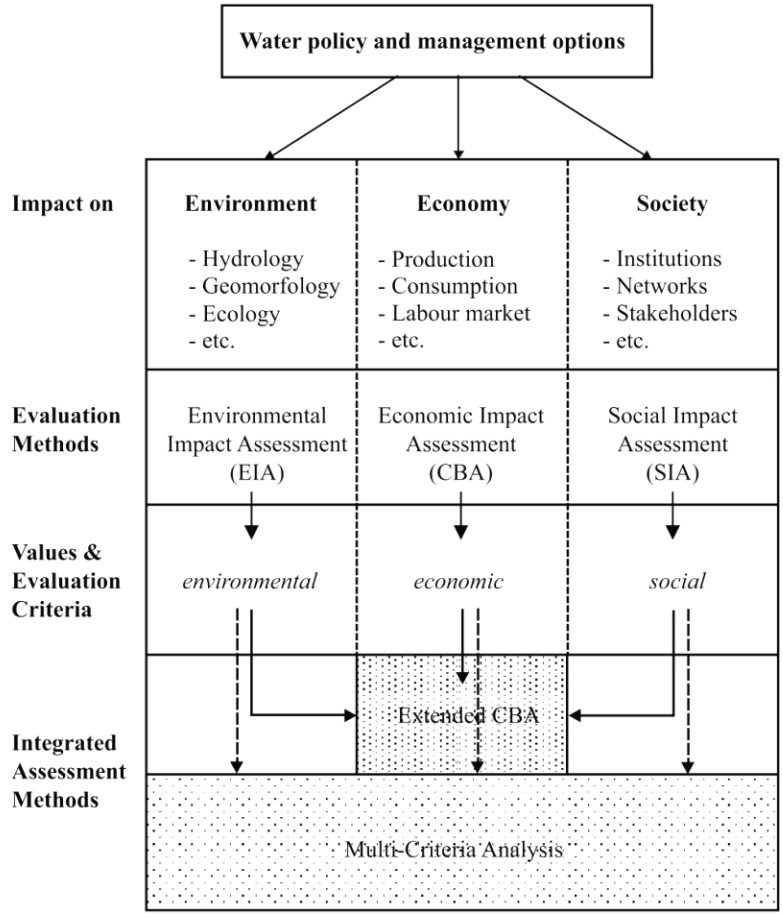

Figure 4-1. Components of an integrated assessment of floodplain management scenarios (Brouwer & van Ek, 2004)

Many of the impacts were quantified in appropriate metrics in a preliminary step that included information from sources such as technical investigations, models and surveys. To facilitate the integrated assessment step further techniques are then needed to translate those quantities into a common framework to facilitate comparisons. This study included an exploration of two different approaches to achieve the integrated assessment step. These were an extended Cost-Benefit Analysis (CBA), and a Multiple Criteria Analysis (Table 4-2).

Table 4-2. Description of the assessment steps used for an integrated assessment of floodplain management alternatives (Brouwer & van Ek, 2004).

Description
Environmental impact assessment - descriptive indicators of the state or condition of the environment were converted to criteria for quantitative assessment. - the assessment first evaluated hydrology and then ecology. The hydrological effects associated with the alternative scenarios for land use change were assessed by modelling, followed by use of hydro-ecological dose–effect model to predict effects of these hydrological changes on the ecology. This ecological modelling step was performed at a coarse level using vegetation types as a proxy for the overall ecological impact. - in combination, these steps resulted in the construction of scenario models for ecological effects following the terminology used elsewhere in this report. - for each scenario the impacts were quantified and compared to an assessment baseline reflecting the targets for the same ecological entities (i.e. vegetation types) in conservation policy. An alternative assessment baseline would be 'no change'.
Economic impacts (using traditional CBA) - the same hydrological modelling as above was used to define effects of structural changes (e.g. in flood defences) - the hydrological changes and other consideration were used to identify expected future land use scenarios - economic impacts were calculated for the land use change. - the cost assessment included opportunity costs associated with foregone value (in that case related to the expropriation of existing uses as a consequence of river activities). - The benefits assessment monetised economic impacts wherever possible and included recreational benefits and avoided costs associated with predicted damage from natural disaster events (based on an existing disaster risk model for flooding)
Social impact assessment - key stakeholders were identified in an initial step (in this case by literature review) - effects of the scenarios on the interests of the stakeholders were scored on a three point scale (positive, negative neutral) using an expert panel approach.
Extended CBA - willingness to pay (WTP) figures for 30 international studies were reviewed and use to derive economic value estimates for four ecological functions relevant to floodplains (flood water retention, surface water and groundwater recharge, nutrient retention and export, wildlife habitat and landscape diversity). - The four values were then further aggregate to yield single value for restored floodplains (which in this case was the focus the assessment) expressed as the value per house household per year - the economic value of restoration was calculated by multiplying the WTP figure (€80/household/year) by the number of households expected to benefit in each scenario. This figure was then added to the original CBA results.
MCA - the environmental,, economic, and social impacts were assessed as above. - the impact assessment results were related to a standardised scale and converted to a score. - the scores were aggregated without weighting and various combinations of differential weighting explored in interpreting the results

The results obtained highlight the importance of quantifying the impacts of the proposals to be tested prior to performing the combined analysis in the integrated assessment step (Brouwer & van Ek, 2004). This starting point for this study was the traditional use of CBA as a methodology to calculate the net benefits of the scenarios, and the MCA was presented as an alternative method. The CBA method involved extension of traditional CBA to include the non-market values of restored floodplains through use of willingness to pay (WTP) figures extracted from the literature. Although values for four environmental components were estimated these were not followed through in the assessment. Instead a single figure was used for the calculation. This simplified the assessment greatly by eliminating the need to characterise each scenario in terms of those components as would be required to quantify their value. However, this resulted in a major information loss. In addition, the WTP figures used were essentially generic to floodplains in a variety of ecological contexts. The process of arriving at the value adopted paid little attention to characterising the difference between the study site and the sites at which these figures were derived, not even going as far as utilising the four aspects that had been isolated and monetised from the literature review.

The MCA approach used produced aggregated scores following a weighted sums approach to quantify the differences between the scenarios in terms of an overall result (Brouwer & van Ek, 2004). However, the researchers reported difficulty in drawing conclusions from the integrated assessment result since the choice of weighting affected the outcome markedly essentially obscuring the original data. This is symptomatic of a more general issue across all forms of MCA regarding the choice of methods for combining the multiple criteria to best inform decision making (Convertino et al., 2013). Alternative approaches to summed score methods include establishing the comparison points individually for each of the value categories of interest (being environmental, economic, and social in the above example) following a benchmarking approach. This version of MCA has been successfully applied to integrated assessment contexts in New Zealand especially in connection with sustainability appraisal (Jenkins et al., 2014; Sadler et al., 2008). The application of this form of MCA for the integrated assessment of ecological regeneration options is explored further in the following sections.

5. Framework for integrated assessment of ecological regeneration options

Planning context

Formal planning for the regeneration of the AORZ area is being led by Regenerate Christchurch, an entity established under the Greater Christchurch Regeneration Act 2016. In addition, many community groups have developed projects or proposals for land uses in the AORZ[1]. These initiatives have mobilised a high level of interest in the future of the area and also made significant contributions to the development of ideas and researching into aspects of their feasibility and implementation. The collective efforts of these initiatives represent a major head-start for regeneration planning in the AORZ. Results from the ERO project adds to this extensive body of community-led work all of which provides useful information for the planning process.

Formal planning steps completed to date include preparation of an ‘Outline for the Ōtākaro / Avon River Corridor Regeneration Plan’ (Regeneration Christchurch, 2017a), and completion of initial community engagement activities including public visioning workshops to establish community needs and values. A single Regeneration Plan will be developed for the whole of the AORZ and some adjacent lands. This includes areas occupied by waterways and their margins and represents a total planning area of 602 ha (Figure 1-2). The next step of the planning process will develop a vision for the planning area (Regenerate Christchurch, 2017b). Following this step the first round of integrated assessment activities are scheduled in July, and these will be followed by a further assessment of the draft plan later in the planning process (Figure 5-1).

[1] see http://www.avonotakaronetwork.co.nz/projects/projects-home.html

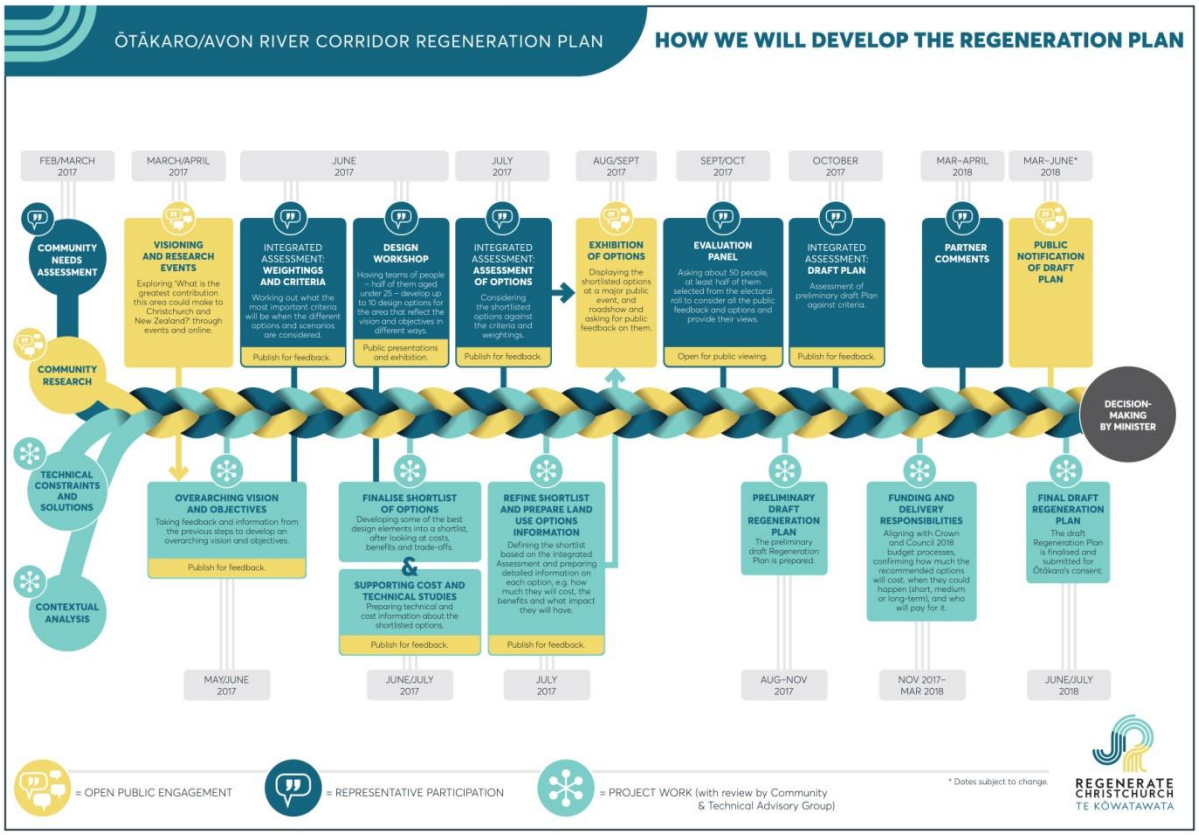

Figure 5-1. Proposed process for development of the Regeneration Plan showing the context for integrated assessment (Regenerate Christchurch, 2017b).

The purpose and therefore form of these two integrated assessment steps is quite different and this is a critical aspect. In the second and final step the purpose is akin to a policy appraisal. The starting ingredients are a draft document (e.g. a draft plan) and a set of criteria representing the policy objectives the document is designed to address. Similar integrated assessment processes have been run in Canterbury in support of plan preparation and include the CERA Land Use Recovery Plan and the Waimakariri Residential Red Zone Plan (Box 1). Used in this context, integrated assessment is a tool for policy appraisal. The results are useful to demonstrate the ability of a proposal to meet multiple objectives, and perhaps facilitate final adjustments to improve performance before adoption.

Box 1

Case Study- Integrated assessment in action

Application of integrated assessment to the Waimakariri Residential Red Zone Recovery Plan

Background

Using powers established under the Canterbury Earthquake Recovery Act 2011, Waimakariri District Council (WDC) was required to produce a statutory plan to guide the recovery of the 'red zoned' areas in the district (Figure 5-2). The Minister's direction stated that the Plan must include "an impact assessment, including an analysis of recommendations using an appropriate impact assessment methodology and explanation of how that informed the preparation of the draft Recovery Plan" (Brownlee, 2015). In providing this impact assessment, WDC used criteria to capture and balance the key considerations and to compare alternative land use scenarios (Figure 5-3).

Different land use scenarios were considered and evaluated for the regeneration planning area and whole, using these criteria (Greater Christchurch Group, 2016). The methodology used for this evaluation was integrated assessment.

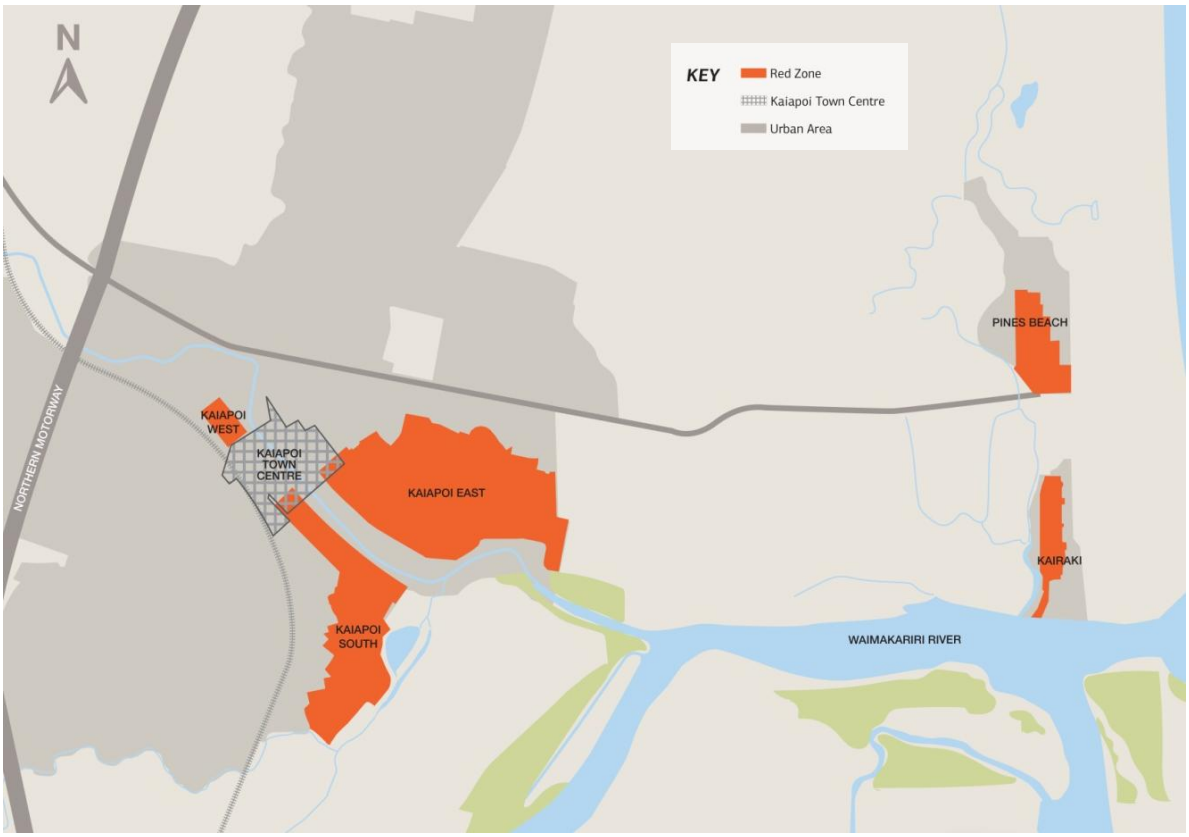

Figure 5-2. Areas identified for regeneration planning in Waimakariri District (Waimakariri District Council, 2016).

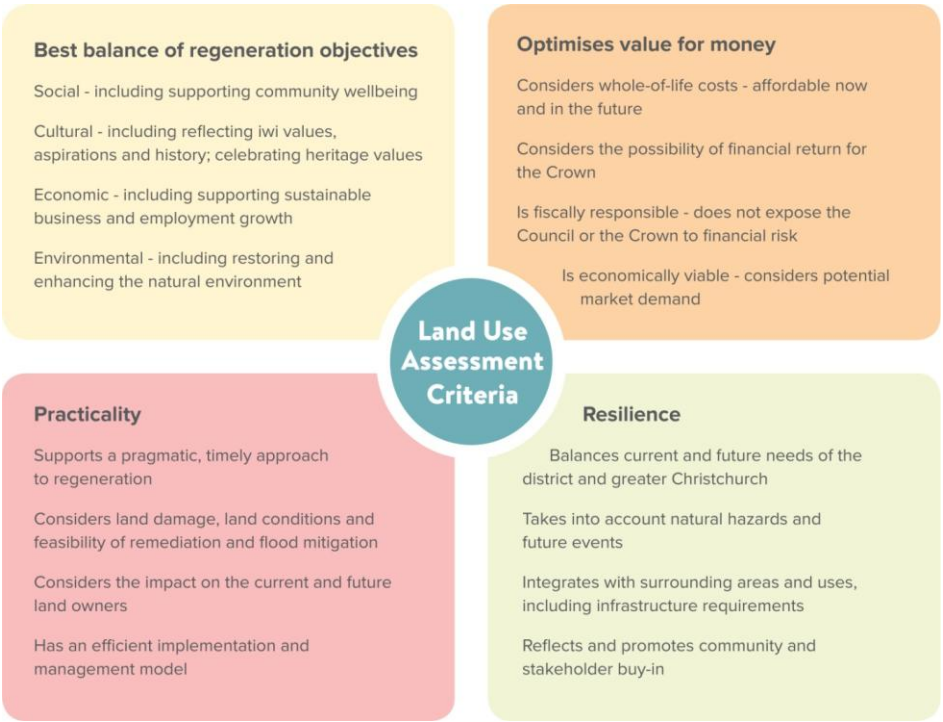

Figure 5-3. Land use assessment criteria used for developing the Waimakariri Residential Red Zone Recovery Plan. (Greater Christchurch Group, 2016).

Evaluation of the Waimakariri integrated assessment process

An evaluation of the integrated assessment process was conducted by one of the participant organisations with regards to their involvement (Community and Public Health, 2017). Conclusions from the evaluation highlighted challenges around early engagement with local government planning staff, presumably referring to staff involved in plan drafting activities. Managing the time commitments required of participants in the integrated assessment process was also identified as a key issue for effective engagement (Community and Public Health, 2017). Other recommendations from the evaluation are shown in Table 5-1.

Table 5-1. Recommendations for the design of integrated assessment processes as identified in Community and Public Health (2017).

Recommendations for integrated assessment processes
- Consider seconding staff from other organisations to work on integrated assessments, to promote integrated assessment through "learning by doing"
- Consider ways to better demonstrate the value of integrated assessment to planning staff, rather than just explaining the process.
- Consider ways to better demonstrate the purpose of each workshop, rather than just how it will be run
- Always develop a formal project plan at the beginning of an integrated assessment project. The plan should assign tasks to individuals, and should take account of planned leave.
- Local iwi or hapū should always be consulted early in the planning of any integrated assessment.
- Always assign at least one person with prior experience of integrated assessment to the tasks of developing draft criteria and creating an invitee list.
- Consider different assessment methodologies during the scoping of an assessment project.
- When providing supporting material to workshop invitees, consider supplying only the best value-for-time material.
- Always include at least one senior representative from each organisation in the integrated assessment team.
- Consider creating an integrated assessment run sheet
- Consider creating an integrated assessment rapid deployment kit.
- Consider how to deliver feedback to workshop participants, including how their input influenced the Plan, in a brief and easily accessible format.
- Consider using only a single model of health to classify the workshop criteria

Key aspects of the Waimakariri integrated assessment

In this example, the purpose for the integrated assessment was to involve a cross section of the community and provide recommendations to plan writers to improve the plan (McClung et al., 2016). A series of three workshops were used, the first focussing on establishing the assessment criteria, the second on assessing the plan, and the third a follow up workshop to assess whether recommendations from the first assessment had been incorporated in to the document and identify further improvements (McClung et al., 2016). It is evident that the starting point for the assessment was a draft recovery plan (Waimakariri District Council, 2016). For these reasons the assessment context is best characterised as a policy appraisal. The context is therefore quite different from the proposed role of integrated assessment in AORZ planning process where the assessment has been identified as a step to inform development of the draft plan. The step required is an integrated assessment of options. There are no direct examples of this available in a comparable New Zealand planning context.

Other aspects to note include the process steps envisaged for the AORZ process also involve a series of three workshops despite the above differences. Because the planning timeline is also similar, yet the size of planning area, complexity of environments, and number of interested parties is arguably more. This creates challenges that must be resolved in further design of the assessment process. Addressing some of the points made in the Community and Public Health evaluation are further considerations for design. Many of these again suggest challenges around tight planning timeframes for achieving improvements in practice.

Application to options assessment

As illustrated in the Netherlands and Waimakariri examples, integrated assessment may be applied in different ways to different contexts. Application to the options assessment stage is markedly different from appraisal of a draft planning document that has already identified particular combinations of options reflecting decisions on alternative land uses. In this context, integrated assessment is designed to support the drafting process. The building of scenarios for assessment is therefore a key activity. It is potentially more important than the assessment output itself since overlooking good ideas at this stage may lead to a situation where they are never revisited. Good ideas could be disabled by decisions made at this stage of the assessment, and this must be addressed as priority in assessment design. Obviously the assessment process also has its own constraints including the available timeline. It is therefore important to make full use of all available time in preparing and refining the conceptual framework that will guide the options assessment process, including the basis for participation, and alongside this take steps to address the major information gaps. Because of the large number of possibilities for ecological regeneration within the AORZ (Orchard et al., 2017), these are key activities to ensure that the options assessment process is robust. However, these aspects can be also managed by the degree of commitment to follow-up assessment processes and more detailed planning exercises. This can be foreshadowed and enabled within the Regeneration Plan, the most appropriate place to communicate this to stakeholders. In other words, the role of the assessment processes themselves should also be seen as a method in the plan.

This strategy offers a practical compromise between the limitations of coarse scale assessments with their inherent inaccuracies, and the advantages of more detailed but time consuming assessments at finer scales. Due to the complexity of the environment in the AORZ the latter will inevitably be needed to properly characterise the opportunities that will deliver the greatest possible benefits and therefore a strategic decision at this stage involves how to get the most value from various assessment investments. Achieving an appropriate balance may be supported by situating all such assessments within an adaptive management framework and establishing a platform for this is a subject that may be addressed within the Regeneration Plan. Its key aspects include the need for a common spatial framework linking the various assessment outputs through time, and criteria sets that also readily scale to greater or lesser degrees of detail and adequately encompass different values across the full spectrum of socio-ecological interests.

Spatial framework for assessment

In the Waimakariri example, five areas for regeneration planning were considered despite that the integrated assessment results were considered for all areas as a whole. In the AORZ there is considerably more need for an underlying framework to assist the identification of appropriate scenarios as well as their assessment. The reasons for this include the large size of the area, its contiguous river corridor setting, the complexity of the waterways, landforms, and natural ecosystems of the area, and the presence of many ecological regeneration proposals and opportunities that require assessment. Arguably, the ecological regeneration potential of the AORZ is in greater focus in this planning process than was the case in the Waimakariri.

Addressing this in a coarse scale assessment early in overall process of the regeneration does not necessarily require a complex spatial framework. However, for the reasons discussed above, the spatial basis for initial assessments should be commensurate with more detailed assessments in the future to support a sequential and adaptive approach to identifying the activities offering the greatest possible benefits. The spatial basis must be explicit enough to support the quantitative analysis of ecological regeneration options which in practical terms means identifying, with reasonable confidence, what could go where and how of it will be in the scenario.

To assist these needs a classification of 12 ecosystem types specific to the AORZ was prepared by Orchard et al. (2017). These offer a potential framework for mapping the site and may be useful in assembling different combinations of ecological regeneration options to suit the conditions that are present (Table 5-2). Although further sub-divisions are possible and will need to be developed to support finer scale planning, this set of classes describes the entire AORZ and can readily be mapped onto the existing landscape. Features of this spatial framework in relation to other pre-existing ecosystem classification mainly relate to the need to transcend land-water boundaries, account for hydrology as a major forcing factor, and address modification of the substrates present that has been a result of urban land use.

The main features are:

- hydrology is identified as the primary structural driver, followed by substrate.
- hydrosystem classes similar to the Johnson & Gerbeaux (2004) wetland classification were identified and extended to account for non-wetland parts of the AORZ.
- Historical ecosystem types as described in the Christchurch Ōtautahi Indigenous Ecosystems (Lucas et al., 1997) were re-interpreted for the AORZ. This resulted in some being combined (e.g. areas suggested to be swamp versus forest ecosystems on the floodplain) whilst other new categories were added to describe important and distinct ecosystem types that are found in the AORZ. These include aquatic systems and transition zones either not covered or subsumed with the Lucas et al. (1997) ecosystem classes.
- the ecosystem classification of Singers & Rogers (2014) was considered to be delineated at a scale that is too fine for planning support at this stage of the regeneration process. However, it could be useful in developing more detailed classifications for the AORZ, for purposes such as to support environmental monitoring.

Table 5-2. A classification of 12 major ecosystem types either currently present or suitable for future restoration in the AORZ.

AORZ Ecosystem types	Dominant AORZ hydrosystem†
Estuarine mudflats	Wet & salty
Lower saltmarsh	Wet & salty
Upper saltmarsh	Wet & salty
Estuarine margins	Wet & salty
Riparian (riverine) margins	Floodplain swamp & forest
Lake & swamp margins	Floodplain swamp & forest
Floodplain swamp & small trees	Floodplain swamp & forest
Floodplain tall forest	Floodplain swamp & forest
Inland dune forest	Higher & drier
Low terrace & landfill forest	Higher & drier
Dry forest	Higher & drier
Gravel (e.g. stopbank) communities	Higher & drier

† as used in ERO workshop materials

Other spatial frameworks that may be useful for coarse scale assessments include the four hydrosystem classes identified to support the ERO project (see Appendix A-2), or collapsing these into three as was used to support the ERO workshop (Orchard et al., 2017).

Construction of scenarios

International experience suggests that interdisciplinary teams are crucial at all stages of planning and evaluation for alternative river corridor land uses and are especially vital in coarse scale assessments (Jungwirth, 2002). Within this process it is essential to fully specify the potential benefits of restored environments. Therefore, the key steps for specifying ecological regeneration scenarios involve

identifying the activities to be applied in a given area. These specifications underpin the use of comparative assessments to inform decisions on alternative land uses.

Results from the ERO opportunities assessment demonstrate that some opportunities are site-dependent whilst others could be applied to various locations and at a range of scales (Orchard et al., 2017). An additional aspect is that competing land use requirements may be present even within the general objective of ecological regeneration. These aspects must be resolved in the scenario development process. The practical steps involve combining components of ecological regeneration into scenarios for assessment. A local knowledge based approach using expert panels or a wider participative process is likely to offer advantages for this critical step in the overall options assessment process. In a spatial sense implications for the AORZ include the need to account for connections between river corridor lands and active waterway channels, whereas most of the previous planning and waterway management assessments for the area have generally restricted attention to one or the other. This expanded scope requires a focus on integrated resource management and an evaluation process that is well supported by a comprehensive range of skill-sets. It is important these scenarios have input from local stakeholder and knowledge-holders in the specification process to ensure that they can fairly reflect the potential benefits even at a coarse scale.

Implementation strategies identified in the ERO opportunities assessment may be a useful starting point for identifying scenarios. These results can be analysed in different ways to identify specific opportunities that suit particular sites, as well as major themes that are more generic. Various combinations of these applied to different spatial footprints create a practical approach to specifying scenarios for assessment. The potential to re-engineer flood defences in the planning area creates an additional complication. However it may be readily accommodated in scenario building using the approach in Table 5-3. This simply adjusts the spatial footprints of the land uses to reflect the impacts of an alternative hydrological situation. Using the example of either four hydrosystems or 12 ecosystem types as a spatial framework to guide scenario building, the impacts of re-engineering are considered only for those areas affected. This creates additional scenarios to consider in those areas but not elsewhere in the AORZ.

Table 5-3. Example of incorporating hydrological manipulations into the development of alternative land use scenarios.

Spatial framework guiding assessment	Number of scenarios	Effect of two stopbank re-engineering scenarios	Total scenarios to consider
Four areas based on classification by hydrosystems (Appendix A-2)	4	2 areas affected 2 largely unaffected	6
12 ecosystem types (Table 5-2)	12	8 areas affected 4 largely unaffected	20

Results presented in Orchard et al. (2017) also illustrate that there may be more than one implementation strategy for a given opportunity. For large parts of the AORZ there are considerable opportunities to apply passive ‘work with nature’ style approaches over longer periods of time although this may not suit all sites or objectives. The analysis also indicated that decisions on these choices may be influenced by agency and opportunism. Therefore, in specifying a restoration strategy there may not be an ‘optimum’ version, only alternatives each offering different benefits. This is especially the case where social benefits of participation or availability of labour sources may influence the desirability of different options. To assist with these choices, Table 5-4 shows a classification of the 13 major strategies for implementing ecological regeneration organised under three topics. The first two of these relate to choices on levels of human agency and participation in design of the restoration strategy. The third consideration involves components needed at start-up. These are generic needs common to most restoration strategies and can be budgeted accordingly in the development of restoration scenarios.

Table 5-4. A classification of major themes for the implementation of ecological regeneration in the AORZ.

Supporting processes	**Planning approaches**	Planning frameworks Spatial planning Resilience planning Plan for maintenance requirements
	Funding & governance	Funding models Governance models
	Baseline assessment	Baseline assessments Mapping Values mapping & assessment Assessment of wider catchment
	Knowledge gaps and technical investigations	Address knowledge gaps Extract learning from relevant examples Technical investigations Investigate carbon potential Investigate ecological engineering technologies Investigate health benefits of forests and greenspace Techniques to intercept surface water run-off Research value
	Modelling & options assessments	Development of conceptual models to inform regeneration Modelling Scenario modelling and impact assessment Investigate low impact designs for intensive & built land uses Identify low cost high impact activities Address value to future generations in assessment of benefits Utilise local knowledge
Implementation strategies	**Stakeholder participation**	Develop strategies for participation Stakeholder identification Stakeholder engagement Acknowledge previous history
	Working with nature strategies	Develop 'work with nature' strategies Allow natural hydrology and associated morpho-dynamics Remove hydrological barriers Retain existing vegetation Control invasive species Fence sensitive areas
	Integration & synergies with co-uses	Integrate with compatible co-uses to minimise opportunity costs Integrate access & recreation Incorporate event co-uses Develop aesthetic gains Tourism Cultural tourism Aquaculture Tangata whenua values
	Targeted investment (species and habitats)	Targeted investment in key species Invest in key fauna Invest in key flora Specific habitat enhancements Landscape manipulation options Improve microhabitats using shelter
	Planting	Planting Develop nursery models Make linkages to potential labour sources Nodal planting to assist species dispersal
	Educational opportunities	Develop educational aspects Establish educational partnerships Raise awareness of NZ species conservation Exemplar value
	Monitoring programme	Development of a monitoring programme Water quality & waterway monitoring
	Adaptive management	Adaptive management framework Staged approach to implementation Include interim uses

Assessment process

The ERO opportunities assessment indicates that there are a wide variety of potential benefits from ecological restoration activities (Orchard et al., 2017). Analysis of the data on restoration opportunities included the identification of 27 themes (Appendix A-3) each describing aspects of the potential benefits. These themes or the more detailed information gathered can be used as checklists for identifying appropriate assessment criteria to apply to a given location.

Although these will not be an exhaustive set of considerations all of these require attention in developing a comprehensive assessment approach. This is readily achieved by ensuring that the assessment criteria adopted to evaluate each area identified for ecological regeneration activities are comprehensive enough to include the key benefits that may be generated there. At the scale of the whole AORZ the multi-faceted nature of the societal benefits derived from natural environments would all need to be accounted for. To facilitate this in a structured way, ecosystem services frameworks may be useful (Daily et al., 2000). There are many frameworks for assessment available (Nelson et al. 2009; Crossman et al. 2012) and these can assist the evaluation of complex socio-ecological systems (Holling, 2001). An important reason to assess multiple ecosystem services simultaneously is to help identify tradeoffs between services in different scenarios (Carpenter et al., 2009). This is directly relevant to the goals of integrated assessment at the options development stage where the outcomes of alternative land uses for the same areas need to be compared.

One approach is to develop a coarse level assessment that can be refined later as more detailed information becomes available. The Common International Classification of Ecosystem Services (CICES) is an appropriate starting point for this by providing decision support for the selection of assessment criteria. CICES uses a hierarchical classification that can be adapted to specific situations and needs (Haines-Young & Potschin 2013). Coarse scale assessments can focus on a higher level of the hierarchy whilst the lower levels may help to identify indicators and other ways of measuring important sub-components.

An additional and important aspect is to ensure that information gaps can be addressed as far as practicable in preparing for the evaluation exercise. Again, the range of benefits to be addressed provides an indication of the breadth of the material required. This will be challenging to fulfil for some topics (e.g. the mental health benefits of increased exposure to forested landscapes), but is essential for a full understanding. Where no local data are available, proxy data obtained from elsewhere offer a potential avenue for quantifying some of these aspects. However this is not without pitfalls since the relevance of the comparison to the local conditions must be established. Local knowledge approaches may play a useful role and are probably the practical way to demonstrate the validity of these approaches. Participatory aspects may be extended to include seeking consensus on the correct figures to apply. This offers a mechanism for improving the level of buy-in for planning proposals that are derived from the results.

Co-uses

In building scenarios for ecological regeneration activities it is also important to consider the compatible co-uses. A useful distinction for assessment may be the identification and separation of compatible co-uses from activities of ecological restoration despite there being some overlap between the two. Using the example bees for instance, establishment of mānuka and other desirable flowering species and the introduction of the bees themselves are clearly biodiversity manipulations that contribute to the value of ‘ecological regeneration’ and these need not solely involve indigenous species. Related value-adding opportunities such as honey production and the marketing of ‘red zone honey’ might be identified as a co-use proposal despite that they are reliant on the restoration activities to some extent. An iterative approach to consider impacts on co-uses, and vice-versa, may

have advantages in terms of supporting attempts to optimise scenarios prior to their specification for assessment. Incompatible activities can be recognised in a similar manner and spatial overlay techniques used to incompatibilities that could lead to opportunity costs. Aggregated benefits of compatible co-uses may be quantified through a similar approach.

Quantifying benefits against their underlying spatial footprint also offers practical advantages for incorporating more detailed information on the benefits of specific proposals where available, provided the land use requirements are known. By adjusting the footprints of the various land use options different combinations can be tested and comparability between scenarios maintained. Where available, these more detailed sources of information should be included to add clarity to the description of each scenario that is tested notwithstanding that some competing proposals will have different levels of detail available. A remaining challenge is the comparison of singular proposals requiring large areas versus mosaics of many smaller ones. In these instances it may be better to adjust the assessment scale to that of the large proposal and perform an integrated assessment of scenarios to be tested in that area only. This will facilitate a direct comparison of the options for generating the greatest possible benefits in that area, and one or more preferred scenarios taken forward into the larger assessment.

The framework described here requires a process to facilitate the development of scenarios for cohesive land use options starting with logical areas within the AORZ followed by aggregation. This approach can be applied at a range of scales and resolutions to support integrated assessment processes at different stages of the planning cycle. At each step the scenarios are assessed and compared as alternative layers on the landscape.

Resilience assessment

The need to accommodate resilience to future change relates to the longevity of investments. Where this is reduced the impact on returns needs to be reflected in the form of the assessment. This introduces another level of complexity for developing reliable evaluation exercises and requires integration of effects of time. Based on the sea level rise scenarios in Appendix A-4 the approximate magnitude of inundation in different AORZ areas are illustrated in Figure 5-4 assuming a 1 m sea level rise over a 100 year planning horizon. Note that further work would be needed to quantify effects on aquatic and intertidal ecosystems under sea level rise.

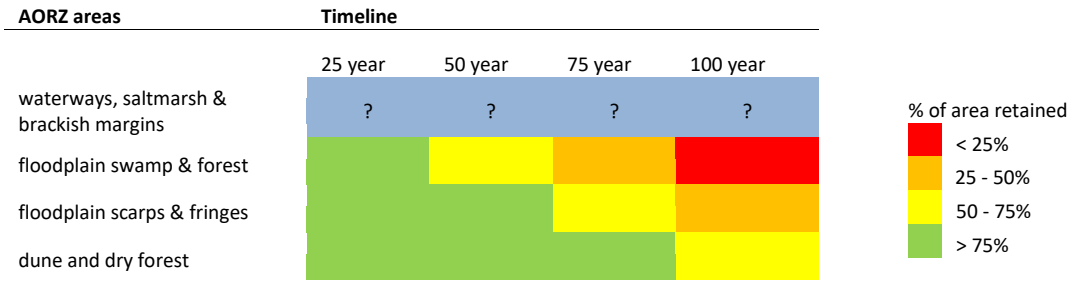

Figure 5-4. An indication of changes in the extent of the AORZ affected by tidal inundation based on current sea level rise predictions.

A conceptual framework for characterising an initial set of land use scenarios in their starting configurations is shown together with the potential activities related to adaptive management over time (Figure 5-5). In this example, the axes chosen for characterisation (intensity of human agency, and level of participation) are concepts derived from analysis of the major implementation strategy

themes identified in the ERO project dataset (Table 5-4). Other themes could be chosen to characterise these alternatives but the point here is to recognise their starting positions.

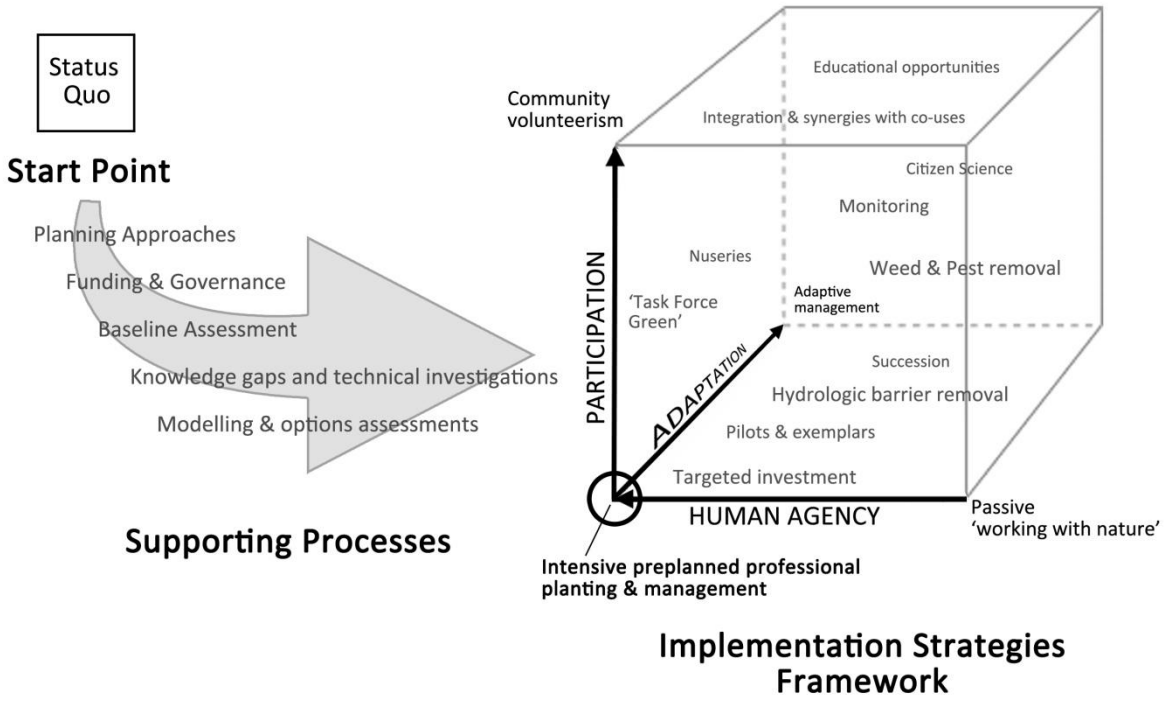

Figure 5-5. Conceptual framework for the integrated assessment of alternative land use scenarios accommodating different strategies for adaptation.

Under environmental change, differential effects will occur for each scenario as a consequence of different vulnerabilities. Some will relate to the level of exposure of the site to the change (inundated under sea level rise for example) whilst other aspects of vulnerability relate to sensitivity. Development of a resilience assessment framework requires accounting for the effects over time. An assessment framework for achieving this involves first constructing scenario models that account for the expected change. This can be done by specifying the points of interest in time and then modelling the new configuration of each spatially discrete unit of interest. In practice this requires modelling of the magnitude of change with the sea level rise scenarios provided here being an example. Impacts on the expected benefits of the starting configuration are then assessed using the spatial framework described earlier.

Ideally the future management of these lands would guarantee the maintenance aspects assumed in this model as an aspect of land use design. Purposefully modified units, such as those incorporating more intensive land uses, can be addressed in a similar manner by assuming that the management human activities include attention to the maintenance required. Where this is not the case the integrated assessment outputs can be adjusted accordingly. This approach recognises the important role ecological succession can play and also situates people at the centre of the process. By incorporating the human agency aspects and changes over time the assessment framework supports integrated management of the whole area as a linked socio-ecological system.

6. Conclusions

The focus of this report is on facilitating robust assessments of the ecological regeneration options presented by the AORZ. A specific objective was to develop an integrated assessment framework to support comparison of those options against each other and against alternative land uses.

The key findings are:

- Integrated assessment is a suitable approach for the evaluation of land use options to support planning

- There is no single or standard integrated assessment methodology. Rather, the term refers to a range of techniques that may involve different forms of extended Cost-Benefit Analyses (CBA) and Multiple-Criteria Analysis (MCA) and can incorporate approaches such as ecosystem services frameworks and participatory forms of assessment.

- The benchmarking forms of MCA are an appropriate output format for informing policy and plan development processes especially where used in an iterative cycle of assessments.

- Participatory aspects are the foundation of integrated assessments using MCA approaches wherever expert judgement is used as the scoring method. Community engagement exercises to support policy and plan development processes are a much wider set of considerations and do not substitute for involvement in assessment process. Effective methods are needed to incorporate stakeholder input directly in the design of the assessment. There are a range of contexts for this to occur including in the sourcing of baseline and other technical (and non-technical) material used to inform the assessment, in the specification of scenarios for assessment, in the rating methodology (e.g. workshops or surveys) used to conduct the assessment, and potentially in the design of the process itself. This may include attention to appropriate times and formats to ensure inclusivity, such as by accommodating tīkanga based components.

- There are considerable differences between the application of integrated assessment to the appraisal of existing documents (such as draft policies and plans) versus the evaluation of options such as land use comparisons (Figure 6-1). The use of integrated assessment to support options evaluations provides an opportunity to improve plan drafting processes.

- In options evaluation, the process of developing the options is critical. In complex planning processes such as those involving a high diversity of environments or anthropogenic interests, the specification of the options for assessment is likely to be the single most important step in delivering the best outcomes. Good ideas missed at that stage may be disabled or otherwise never revisited. For this reason the development of scenarios is a key exercise and should be inclusive of multiple perspectives and forms of knowledge. Input from, or the direct involvement of stakeholders can assist this. Complex scenario development is supported by iterative stepwise processes to identify the components that are most important for achieving the overall objectives. A sequence of integrated assessment activities can support the scenario development process and help improve the level of understanding and buy-in for major decision points (such as the elimination of options) along the way. These approaches can overcome common problems around the lack of stakeholder engagement early in plan drafting processes.

- Developing approaches that support the integration of assessment investments in both space and time presents an opportunity at this early stage in the regeneration of the AORZ. This will ensure consistency and help add value over time, as well as being essential for the implementation of adaptive approaches to management. International examples are available to illustrate some of the key benefits and appropriate strategies.

- An appropriate spatial framework can assist in the development of scenarios and improve the ability to identify the impacts, including both trade-off and synergies between overlapping land use options. This will support exploring and quantifying potential synergies between compatible co-uses as well as the opportunity costs of different competing uses at varying scales. A clear spatial basis in coarse scale assessments will also facilitate finer scale planning over time and ensure the compatibility of results to support an adaptive approach.

- Resilience to future change is an important component of long term planning. It can be addressed in the construction of scenarios and the design of assessment processes and their outputs. Resilience has been identified as one of the top-level considerations for regeneration planning of the Avon-Ōtākaro Red Zone (AORZ) as is appropriate. Exposure to sea level rise is a particular consideration for planning in the AORZ. Key implications include effects on ecological succession and consideration for the resilience of infrastructure to expected levels of change over the planning horizon, as required under the NZCPS.

- Ecological regeneration activities include blue and green infrastructure proposals that may potentially occupy a large proportion of the AORZ. In combination these land use options are likely to make a major contribution to the future value of a regenerated river corridor. The assessment framework applied to support planning must be fit for purpose to account for the potential benefits and enable meaningful comparisons to be made. The framework presented here will help in developing assessment processes to provide for these needs.

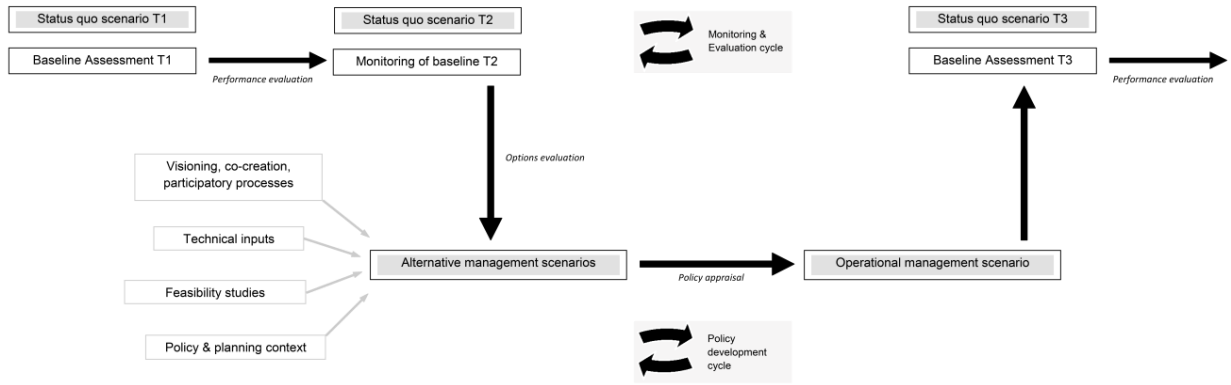

Figure 6-1. An integrated assessment framework for adaptive environmental management.

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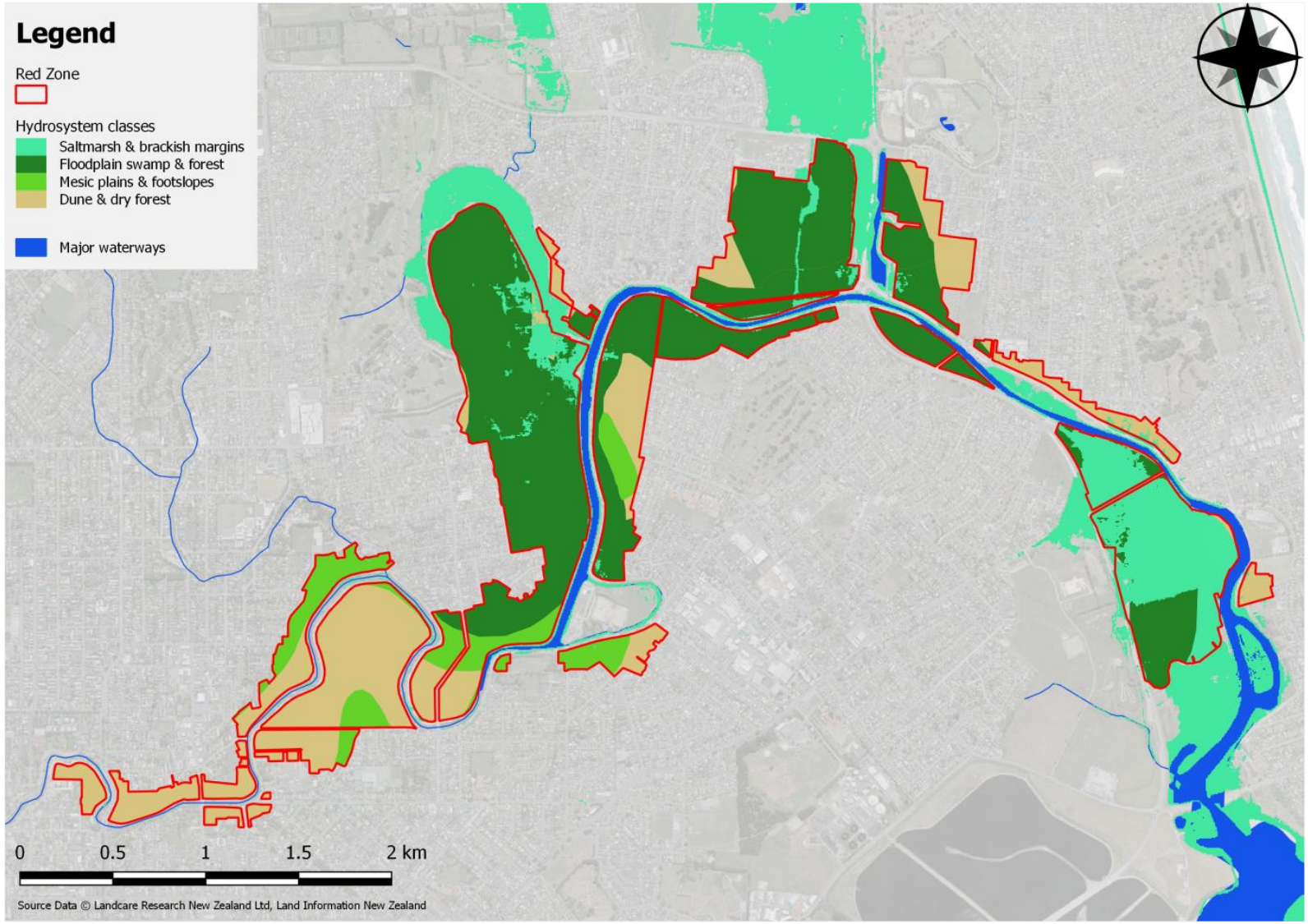
Appendix A-1. Floodplain restoration principles: conclusions and key recommendations for the AORZ.

- There are considerable opportunities for hydrologic restoration strategies to be applied to achieve ecological restoration objectives in the AORZ. These approaches are proven internationally and are consistent with a city-to-sea philosophy for river corridor regeneration that accommodates ongoing dynamics including ecological succession, climate change, and resilience to sea level rise.
- Due to the difficulty of producing accurate *a priori* predictions of complex eco-hydrological relationships and expectations for restoration and successional change, an adaptive management approach is recommended.
- A feature of prominent and successful river corridor restoration projects has been the assembly of a core science and information management team able to support the development and implementation of an adaptive management approach. Local and traditional knowledge, practitioner know-how, and technical expertise in ecosystem-based management and the restoration ecology of key taxa are some of the recommended knowledge and skills sets for inclusion. Attention to governance, outreach, science communication, and citizen science activities are additional dimensions that can support the successful implementation of adaptive management in practice.
- Evaluative assessments for the comparison of restoration options are facilitated by, and can occur at many different points within an adaptive management cycle. They may be employed to help refine or select a short list of options at strategic decision points before committing resources to greater levels of detail. These aspects may be readily included in the proposed Integrated Assessment activities and Better Business Case evaluations being developed to support the regeneration planning process for the AORZ.
- An adaptive approach can accommodate experimental and innovative trials conducted at small scales through making use of pilot and demonstration projects to inform the design and planning of larger scale initiatives.
- Close proximity to the central city provides many opportunities for community engagement, education, and experiential activities to feature prominently in the development, design, and implementation of restoration strategies. These have been shown to be the source of beneficial outcomes in other successful projects, including through the socialisation of restoration objectives, and by encouraging participation, buy-in, and ownership of the new management paradigms that may be implemented.
- The *process* of developing and implementing an adaptive management strategy could be a significant source of benefits in relation to overall project objectives. Attention to, and development of this process is an important component of identifying specifications for ecological restoration in the AORZ, consistent with a socio-ecological systems approach to managing common-pool natural resources. The objective of developing and implementing optimum restoration and regeneration activities lies at the centre of this process and is a dependent on it.
- Ecological restoration activities in the AORZ offer an unprecedented opportunity to address national priorities including the remediation of legacy effects on lowland biodiversity and associated cultural values. Through attention to design and integration between compatible activities and co-uses ecological restoration can be achieved alongside, or incorporated within other beneficial land use options.

Appendix A-2. A spatial framework describing the AORZ based on a hydrosystems approach (Orchard et al., 2017).



Appendix A-3. Thematic analysis of the potential benefits of ecological restoration in the AORZ (Orchard et al., 2017).

Environmental	biodiversity	habitat increased - habitat connectivity - wildlife - habitat for flagship species - rare taxa - sensitive taxa - halo effects - reduced edge effects - seed sources - reduced habitat for geese
	restored natural values	restored natural processes - restored hydrology - protection of springs - reduced urban heat effect - ecological connectivity
	water quality	improved water quality - pollution removal - sediment capture
Social	access	improved access via land & water
	aesthetics	improved aesthetics – novel design opportunities
	educational - experiential	educational opportunities - experience of nature - connection with nature - awareness of natural values - awareness of natural processes - social learning
	health benefits	physical health benefits - mental health benefits
	recreation	recreation opportunities - watersports - swimmability
	stormwater management	stormwater management - flood mitigation
	water supply	drinking water supply protection
Cultural	community identity - sense of place	sense of place - community engagement & volunteerism
	cultural values	cultural values - tangata whenua values - mahinga kai - pa harakeke & mara rongoa - tau koura
	heritage & history	awareness of history - connections with history
	wild harvest	wild harvest opportunities - fibre - safety of wild foods
Economic	adjacent land values	adjacent land values
	avoided costs	low site maintenance - forest bathing value
	branding & marketing	branding of Christchurch
	business opportunity	service business opportunities - attract business
	carbon	carbon sequestration - carbon credits
	employment	employment
	fisheries & aquaculture	fisheries - commercial fisheries – aquaculture - recreational fisheries
	forestry	sustainable forestry
	visitation	ecotourism - cultural tourism - fishing tourism - visitor attractions - event spaces
Resilience	food resilience	food resilience
	mental resilience	mental resilience
	natural hazards buffering	natural hazards buffering
	research & exemplar value	research value - exemplar value

Appendix A-4. Sea level rise scenarios for the AORZ simulated in 0.25 m increments relative to an elevation of 1.15 m LVD. Available from http://bit.ly/2oe0d7R