ASSESSING INDICATORS OF CULTURAL WELL-BEING IN AN URBAN STORMWATER DECISION SUPPORT SYSTEM

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ABSTRACT

Assessments of urban development projects often neglect, isolate or defer recognition and provision for manawhenua values. A decision support system (DSS) developed to evaluate outcomes of alternative urban development and stormwater management scenarios on freshwater and estuarine water bodies takes a different approach. Cultural well-being is considered as part of an integrated assessment of indicators of the four well-beings. Predictions of the levels of cultural well-being indicators rely on three sets of information: assessments by manawhenua of the extent of their interests in a catchment (for instance land ownership, significant sites and access to water bodies); assessment of the extent to which development proposals recognise and provide for these interests (for instance restoring degraded or lost waterbodies and providing for cultural uses); and results from water quality and stream ecological models embedded in the DSS. The indicators, assessment methods and associated DSS inputs were identified through hui with members of the central Canterbury Te Ngai Tuahuriri Rūnanga. Having been integrated into the DSS, the methods are being evaluated via a series of case studies of current and proposed urban development projects in the peri-urban areas around Christchurch. While the indicators are limited to giving a relative assessment of the extent to which urban development caters for manawhenua interests, and are in no way intended as a replacement for direct engagement, their value lies in providing a basis for at least a screening-level cultural assessment that is integrated and simultaneous with environmental, economic and social considerations.

KEYWORDS

Decision support system (DSS), cultural well-being, manawhenua, urban development, stormwater management.

PRESENTER PROFILE

Jonathan Moores is Group Manager of NIWA's Urban Aquatic Environments Group. He leads research on stormwater quality and its effects on receiving waterbodies, including predictive modeling studies and field-based investigations characterising stormwater quality and treatment device performance. He has previous regulatory, policy development and public liaison experience working in local government.

1 INTRODUCTION

NIWA and Cawthron Institute have led research to develop a decision support system (DSS) to help assess the impacts of urban development on attributes such as water and sediment quality; ecosystem health; and cultural, amenity and recreation values (Moores et al., 2014). The project, Urban Planning that Sustains Waterbodies (UPSW), has been part of the Resilient Urban Futures (RUF) research programme funded by the Ministry for Business, Innovation and Employment (MBIE).

The UPSW DSS operates within a framework of the 'four well-beings' (environmental, economic, social and cultural), making predictions of a range of indicators in each case. Indicators of environmental, economic and social well-being were developed in earlier phases of the project and have been demonstrated in case-study applications of the DSS (Moores et al., 2013; 2016). A key objective of the most recent phase of the project has been the development and incorporation of indicators of Māori cultural well-being in the DSS. This paper describes the development of the cultural well-being indicators, their integration in the DSS and the process by which the performance of the indicators for distinguishing between different urban development outcomes is being evaluated.

2 OVERVIEW OF THE DSS

The DSS allows comparisons of alternative urban development scenarios to be made by varying inputs representing land use change, stormwater management and related attributes (Figure 1). These inputs drive a suite of models which predict changes to biophysical attributes such as water and sediment quality and indicators of ecosystem health in rivers and estuaries (Moores et al., 2014). The Catchment Contaminant Annual Loads Model (C-CALM) estimates stormwater loads of sediments, copper, lead and zinc. Along with other inputs, these loads are used by: a Bayesian Belief Network (BBN) to predict seven indicators of stream ecosystem health; the Urban Stormwater Contaminants (USC; Green *et al.*, 2010) model to predict rates of estuary sediment and metal accumulation and grain size distribution; and the Benthic Health Model (BHM; Anderson *et al*., 2006) to predict a benthic invertebrate community health indicator score.

The outputs of these biophysical models are in turn used to assess changes in a range of ecosystem services, reported as indicators of social and economic well-being. Put simply, ecosystem services are "the benefits people obtain from ecosystems" (Millennium Assessment, 2003), which can be goods, such as food, or services, such recreational opportunities. A set of matrices acts as a look-up table for the prediction of five social well-being indicators (extraction; contact, partial contact and non-contact recreation; and 'place satisfaction'), based on scores ascribed by workshop participants to combinations of biophysical attributes such as water clarity, underfoot condition and ecosystem health. These attributes are also used in the assessment of an indicator of economic benefits, based on the results of studies of household willingness-to-pay for stormwater improvements. Economic well-being is assessed by comparison of these benefits with costs, estimated from catchment-scale stormwater-treatment and stream-management costing models. While the pilot DSS reports numeric values (scores) of all indicators, it also assigns an indicator 'level' in the range 1 – 5, with 5 being 'best', in order to allow communication of predictions to technical and non-technical audiences, respectively (Figure 2).

Figure 1: Structure of the DSS, prior to incorporation of cultural well-being indicators

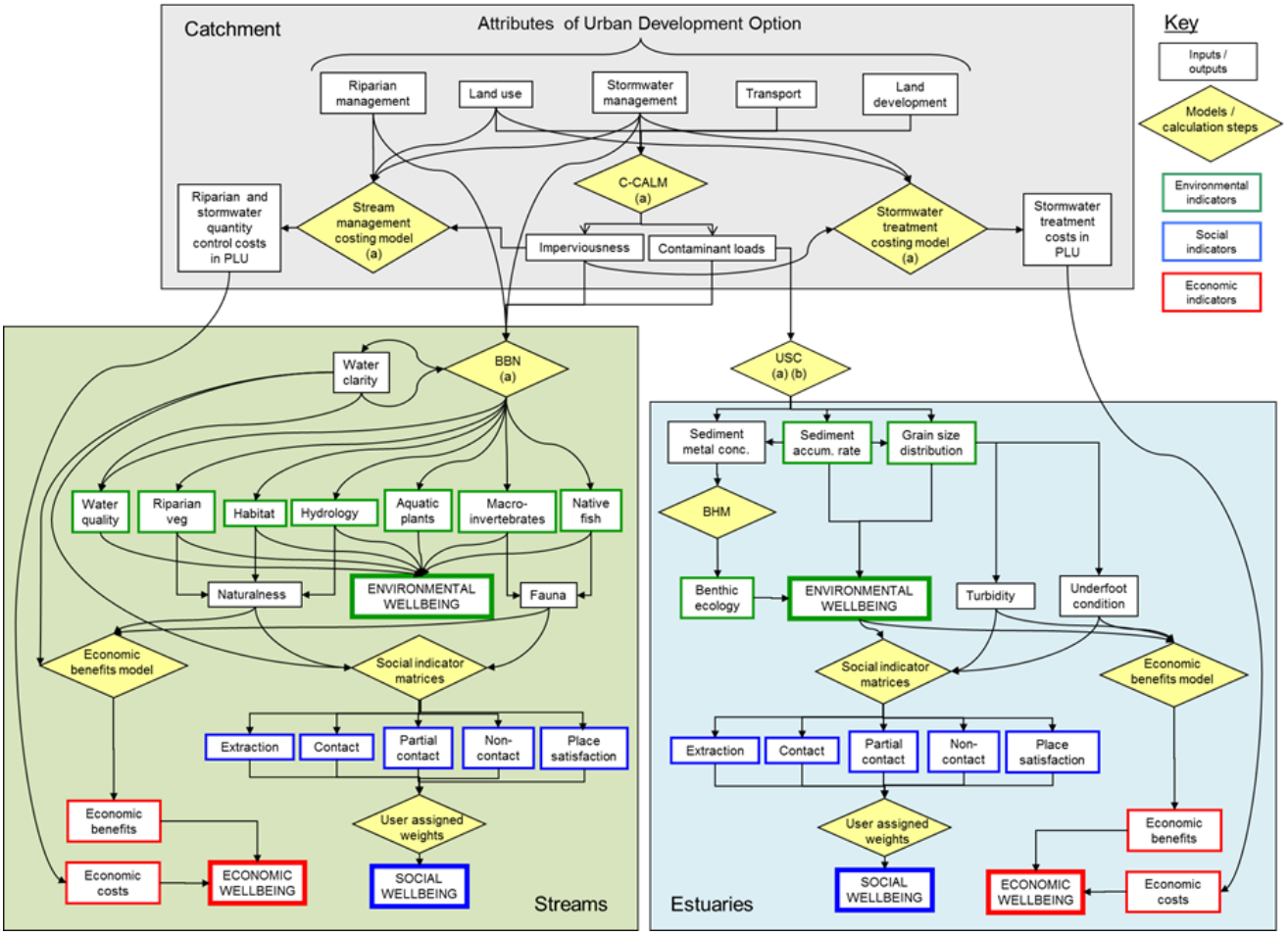
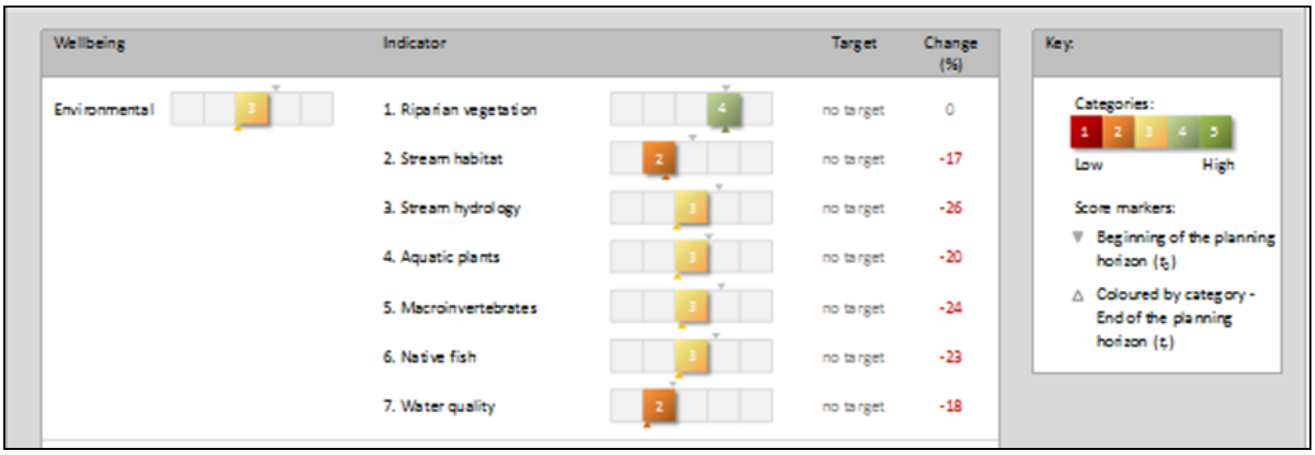


Figure 2: Example of predicted environmental well-being indicator levels



3 DEVELOPMENT OF CULTURAL WELL-BEING INDICATORS

3.1 METHODS

The integration of cultural wellbeing indicators into the DSS was fundamental given that recognition and provision for cultural associations is a matter of national importance pursuant to section 6e of the Resource Management Act 1991. Identification of the indicators and where they would be placed within the DSS was driven by four imperatives. Firstly, the process had to be grounded in the cultural beliefs, values, and practices of whanau members, which are described in multiple written texts including the

Mahaanui Iwi Management Plan (Mahaanui Kura Taiao, 2013). This requirement meant that the first task the team faced was a review of literature, including archival text. Secondly, the process had to explicitly enable the examination of water related issues and the identification of mitigations perceived by Māori as necessary to protect their range of cultural interests. Hui with whanau members enabled the research team to document the concerns of whanau with respect to the impacts of urban development on water bodies, and from there it was possible to list some of the components that whanau believe need to inform decision making. Thirdly, whanau had identified developments of various scales around North Canterbury that generated both positive and negative effects. This led to a retrospective assessment of a number of developments, using the indicators of interest to Māori.

Finally, it was important that cultural wellbeing was not seen as an 'add-on' or something separate from the rest of the science in the DSS. The intent, to recognise and provide for two 'world views' was a fundamental driver. In the next part of this paper, we describe the assessment components and indicators identified by whanau that were recommended for inclusion in the DSS.

3.2 ASSESSMENT COMPONENTS AND INDICATORS

Three strategies were implemented to recognise and provide for cultural interests within the DSS:

1. New cultural components were included in the assessment of the current state of a study area (Table 1);
2. New cultural components were added to the assessment of development scenarios, (Table 2); and
3. Indicators were added to the existing bio-physical component of the DSS to capture a cultural perspective (Table 3).

Because it is necessary to rate each of the assessment components, Table 1 illustrates how each component can be assigned to one of three levels according to the type and level of impact. Choosing one of the 'current state' assessment components, for many whanau their land holdings in a catchment, post-European settlement, have been reduced to interest in reserves and/or easements. Being able to utilise these land interests – for the purposes for which they were granted – may be dependent on their being sufficient quantities of high quality water:

- Fishing easements can only be used if the water quality and quantity sustains fish, and the site remains conducive to fishing.

- Reserves granted for residential purposes can only be used if whanau will have access to adequate supplies of potable water.

The combination of land alienation, and subsequent land use changes, has meant that whanau have experienced loss. Hence the inclusion of an indicator that is specific to "Lost waterbodies, sources of water, culturally significant waterbodies, wai tapu".

Whanau can provide the historical context that describes local understandings and observations of climate, temperatures, evaporation, humidity and rainfall, along with local explanations of changes to waterbodies, including the loss of parts of river systems or the loss of entire systems.

Table 1: Cultural well-being assessment components – current state

Component 1: Maori land, reserves and easements
Maori L, R or E likely to be adversely impacted by future development
Maori L, R or E adversely impacted could be remedied or mitigated
Maori L, R, or E could be restored or enhanced
Component 2: Source of water
Springs or potable water likely to be adversely impacted by future development
Adverse impacts on springs or potable water could be remedied or mitigated
Springs, potable water protected and enhanced (Water testing carried out)
Component 3: Lost waterbodies
Waterbodies remain lost and are potentially further damaged by any development
Waterbodies / past waterbodies could be partially restored by future development
Waterbodies / past waterbodies could be fully integrated and restored by future development
Component 4: Wai tapu
Wai tapu sites would be destroyed by future development
Wai tapu sites could be partially damaged by future development
Wai tapu sites could be protected or enhanced through future development
Component 5: Wahi tapu
Wahi tapu sites would be destroyed by future development
Wahi tapu sites could be partially damaged by future development
Wahi tapu sites could be protected or enhanced through future development
Component 6: Culturally significant waterbodies
Waterbodies could be potentially destroyed by future development
Waterbodies could be damaged by future development
Waterbodies are protected and fully restored by future development (Water quality testing)
Component 7: Waterbodies lost over time
All waterbodies have been lost
Some waterbodies have been lost
No waterbodies have been lost

Note: L, R and E are Lands, Reserves and Easements, respectively.

Finally, the DSS needs to enable decision makers to comply with the provisions of the National Policy Statement for Freshwater Management (NPS-FM), which states that water quality and quantity limits must reflect local and national values, one of which is wai tapu.

> *Wai tapu represent the places where rituals and ceremonies are performed. Rituals and ceremonies include, but are not limited to, tohi (baptism), karakia (prayer), waerea (protective incantation), whakatapu (placing of raahui), whakanoa (removal of raahui), and tuku iho (gifting of knowledge and resources for future generations). In providing for this value, the wai tapu would be free from human and animal waste, contaminants and excess sediment, with valued features and unique properties of the wai protected to some extent. Other matters that may be important are that identified catchments have integrity (there is no artificial mixing of the wai tapu) and identified taonga in the wai are protected.*

The second strategy for including cultural interests in the DSS was to add cultural assessment components to the development scenario inputs within the DSS, as shown in Table 2.

Table 2: Cultural well-being assessment components - development scenarios

Component 1: Recognition and provision for wai tapu
Wai tapu sites destroyed by development scenario
Wai tapu site damaged by development scenario but adverse effects are remedied or mitigated
Wai tapu sites are identified and enhanced through integration (place names, access, restoration) into development scenario
Component 2: Recognition and provision for wahi tapu
Wai tapu sites destroyed by development scenario
Wai tapu site are damaged but adverse effects are remedied or mitigated
Wai tapu sites are identified and enhanced through integration (place names, access, restoration) into the development scenario
Component 3: Recognition and provision for taonga species
Development scenario does not benefit taonga species
Development scenario likely to see no change in the abundance or health of taonga species.
Development scenario has taonga species prioritised and likely to see improvements to the abundance or health of taonga species.
Component 4: Recognition and provision for Maori lands, reserves, easements
Maori lands, reserves, easements likely to be adversely impacted by development scenario
Maori lands, reserves, easements not likely to be affected, but any adverse impacts could be remedied or mitigated
Maori lands, reserves, easements, and the futures opportunities to utilise, could be restored or enhanced
Component 5: Restoration intent
Development scenario doesn't integrate any restoration into current or future plans
Development scenario has some restoration within the design
Restoration fully integrated into all parts of the development scenario
Component 6: Recognition and provision for access
Development scenario has no public access
Development scenario provides public access to parts of the subdivision
Development scenario provides public access to all parts of the subdivision including amenities
Component 7: Species mix within the riparian zone
Riparian planting sparse – likely not to benefit taonga species
Native riparian planting is present – no change
Native riparian planting is expanded, species diversity expanded, long term management plan present and taonga species prioritised

These cultural assessment components are intended to highlight how a development strategy could start to mitigate the adverse effects on cultural wellbeing during the design phase. For example, often a developer proposes planting riparian margins. Opportunities to plant native species in riparian margins that have a utility value e.g. harakeke, raupo etc. could be explored. Often the focus is upon mitigating the effect of development on

stream function rather than also considering use of a species mix which recognises and provides utility and amenity values.

Inclusion of assessment components specific to the recognition and provision of access explicitly recognises that future cultural use of urban areas, which will directly impact cultural association and identity, is largely dependent on continued access to sites and resources.

The third strategy for including cultural interests in the DSS was to identify cultural well-being indicators that are informed by the assessment components described above. These indicators represent the generic cultural outcomes identified by whanau (Table 3). However, it is important to note that, ultimately, whanau will engage in urban water planning on a case-by-case basis to achieve specific outcomes that may not be represented by these generic cultural wellbeing indicators.

Table 3: Cultural outcomes sought by whanau and represented by the cultural well-being indicators in the DSS

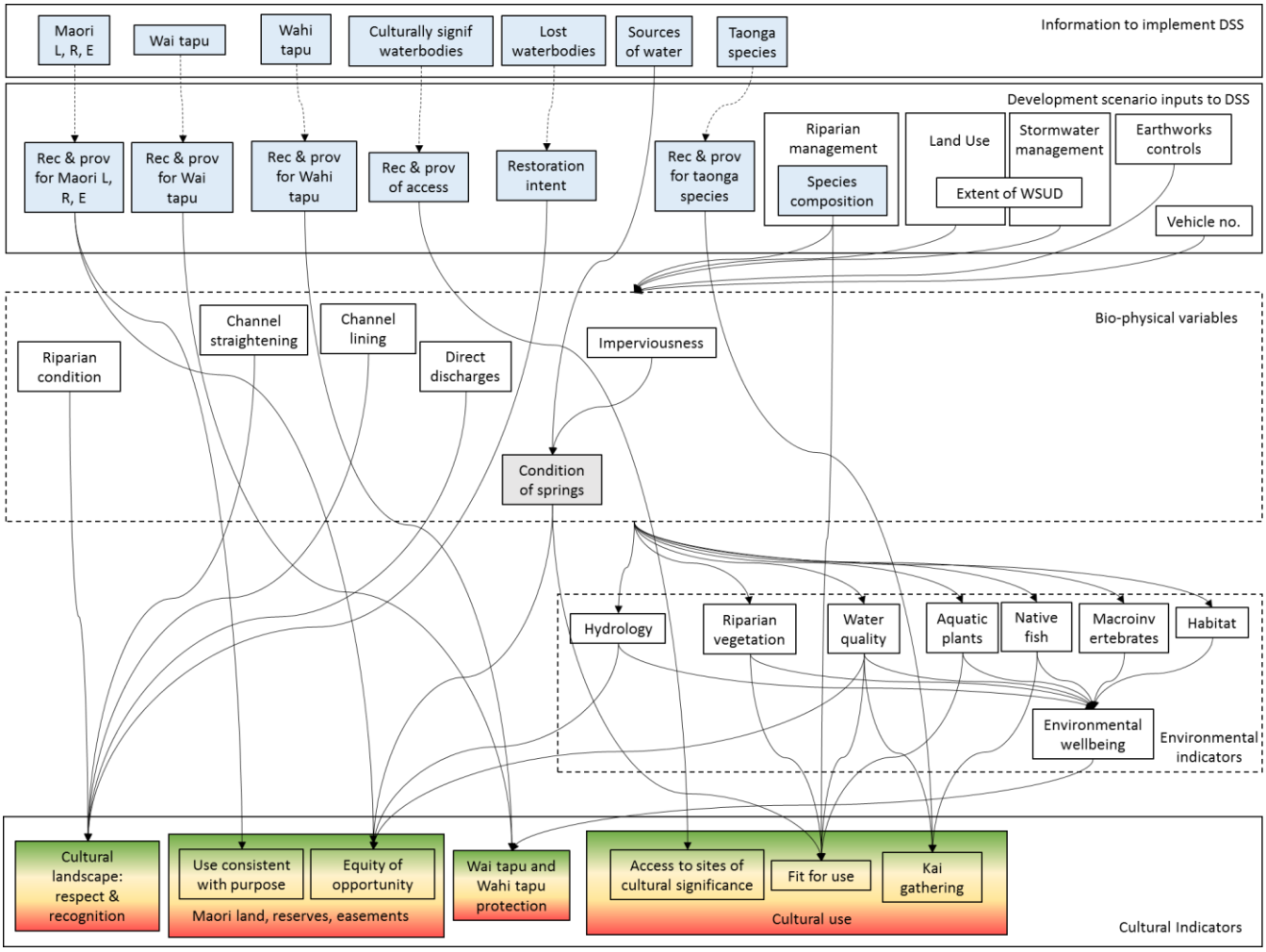
Outcomes	Sub-outcomes
Cultural landscape	Respect and recognition for significant sites
Maori lands, reserves and easement	Uses enabled consistent with purpose Equity of opportunity
Protection of culturally significant sites	Wai tapu protection Wahi tapu protection
Cultural use	Access to sites of cultural significance Sites are “fit for use” Gathering of kai and cultural materials

4 INTEGRATION IN THE DSS

The DSS makes predictions of the levels of the cultural well-being indicators based on three sets of information (Figure 3):

- assessments by manawhenua of the extent of their interests in a catchment;
- assessment of the extent to which development proposals recognise and provide for these interests; and
- results from water quality and stream ecological models embedded in the DSS.

Figure 3: Relationships between DSS inputs, model outputs and cultural well-being indicators. Shaded boxes indicate components of the DSS added as part of integrating the cultural well-being indicators



The first of these sets of information enters the DSS via a qualitative assessment (none, medium, high) of the level of the manawhenua interests (based on the assessment components detailed in Table 1).

The second set of information involves a similar qualitative assessment, but focusing on how well a proposed development scenario recognizes and provides for these interests (based on the assessment components detailed in Table 2). This includes assessing the extent to which a proposal provides access to culturally significant waterbodies, restores any lost waterbodies and provides cultural resources through the composition of riparian planting.

The DSS calculates the scores for some indicators based solely on the combination of these two sets of information. For example, the score for the indicator "Access to sites of cultural significance" reflects the extent of culturally significant waterbodies in a catchment and the level of access provided for in a development scenario.

However, the calculation of scores for the majority of indicators also takes account of bio-physical variables predicted by models embedded the DSS (including the scores of environmental well-being indicators) relating to:

- water quality;
- stream ecology;
- the extent of channel modification and direct stormwater discharges;
- hydrological modification; and
- the condition of springs.

For example, the score for the indicator "Equity of opportunity" reflects not only the extent of Māori lands, reserves and easements in a catchment and the level of recognition and provision for these in a development scenario, but also the condition of springs, hydrology and water quality. Clearly, if a development proposal is predicted to result in the loss of springs, reduced low flows, and poor water quality then these factors need to be taken into account when assessing implications for manawhenua to realise opportunities that are influenced by the availability (or not) of a water resource.

As is the case with the environmental, economic and social well-being indicators, the scores for the four cultural well-being indicators are presented on the DSS scorecard as levels lying in the range 1 (worst) to 5 (best). Scores for each of the additional sub-indicators (Table 1) are reported in a series of output files from the DSS, enabling more detailed comparisons of scenarios.

5 EVALUATION

5.1 ILLUSTRATIVE RESULTS

The performance of the cultural well-being indicators is being evaluated through a series of case studies of current and proposed urban development projects in peri-urban areas around Christchurch. The case study developments are: Ravenswood (Woodend); Te Whariki West (Lincoln); Liffey Springs (Lincoln); Highgate (Rangiora); and Stonebrook (Rolleston). Inputs to the DSS representing catchment, development and stormwater management characteristics of each case study area were obtained from: aerial photographs; GIS shapefiles representing land cover, zoning and stream networks; and subdivision and stormwater management planning documents.

Illustrative inputs to the DSS representing the extent of manawhenua interests and the level of recognition and provision for these interests in each development project were developed. While based in knowledge arising from a close relationship with the runanga, we emphasise that validation of these inputs is part of the evaluation currently in progress with manawhenua. The outputs obtained to-date from running the DSS with these inputs are therefore reported here on a purely illustrative basis.

Two development scenarios were run for each case study area:

(A) Adopting a 'status quo' development approach, using moderate levels of stormwater treatment and without any riparian planting; and

(B) Adopting a hypothetical alternative approach, using best-practice levels of stormwater treatment and with riparian planting throughout the catchment.

Table 4 presents the cultural and environmental well-being indicator levels predicted under each of these two scenarios for each case study area. Differences in the cultural well-being indicator levels across the five case study areas reflect differences in DSS

inputs relating to the extent of, and level of recognition and provision for: Maori lands, reserves and easements; wai tapu; wahi tapu; access to culturally significant waterbodies; restoration of lost waterbodies; taonga species; and cultural resources in riparian plantings.

Table 4: Illustrative cultural and environmental well-being indicator levels for case study development areas (range 1 (worst) to 5 (best))

	(A) Status quo development approach					(B) High level of stormwater treatment and riparian planting				
	Ravenswood	Te Whariki	Liffey Springs	Highgate	Stonebrook	Ravenswood	Te Whariki	Liffey Springs	Highgate	Stonebrook
Cultural well-being indicators										
Cultural landscape	1	1	1	1	1	3	3	3	1	1
Maori lands, reserves & easements	1	3	N/A	N/A	N/A	1	3	N/A	N/A	N/A
• Use consistent with purpose	1	3	N/A	N/A	N/A	1	3	N/A	N/A	N/A
• Equity of opportunity	1	3	N/A	N/A	N/A	1	3	N/A	N/A	N/A
Wai & wahi tapu protection	3	4	N/A	2	N/A	3	4	N/A	2	N/A
Cultural use	2	2	2	2	2	2	2	2	3	3
• Access to sites of significance	3	5	3	3	3	3	5	3	3	3
• Fit for use	2	1	2	2	2	2	1	2	2	3
• Kai gathering	2	1	2	2	2	2	1	2	2	3
Environmental well-being indicators										
Riparian vegetation	2	2	2	1	1	3	3	3	2	2
Stream habitat	3	3	2	1	2	5	5	4	3	3
Stream hydrology	2	3	1	1	1	3	5	2	1	1
Aquatic plants	3	3	3	3	3	5	5	5	5	5
Macroinvertebrates	2	2	1	1	1	2	3	2	1	1
Native fish	2	2	2	2	2	3	3	3	3	3
Water quality	2	1	2	2	2	2	1	2	2	3

The contrast between the Te Whariki and Ravenswood developments provides a notable example of the influence of these DSS inputs, with the former assessed as scoring more highly in terms of the "Maori lands, reserves & easements" indicator and the latter scoring more highly in terms of the "Cultural use" indicator.

These contrasting indicator scores reflect, for example, the assessment that:

- in the Ravenswood catchment,
    - the extent of Maori lands, reserves & easements is 'high' but the level of recognition or provision for these in the development project is 'low';
    - the extent of taonga species is 'high' and the level of recognition or provision for these in the development project is also 'high'; and

- in the Te Whariki catchment,
    - the extent of Maori lands, reserves & easements is 'high' and the level of recognition or provision for these in the development project is 'medium'; and
    - the extent of taonga species is 'high' but the level of recognition or provision for these in the development project is 'none'.

The influence of bio-physical variables on indicator levels is illustrated by comparing the results for scenarios (A) and (B). In almost all cases, the levels of environmental well-being indicators are higher in scenario (B) than scenario (A) reflecting the positive influence of stormwater treatment and riparian planting[1]. These higher levels have a knock-on effect on some, but not all, of the cultural well-being indicator levels. For instance, the "Cultural landscape" indicator is higher in three case study areas under scenario (B), reflecting the inclusion of extensive riparian planting (compared to none under Scenario (A)). In the Stonebrook case study area the "kai gathering" and "fit for use" sub-indicators are both higher under Scenario (B) than Scenario (A) because of improvements in the water quality and riparian vegetation indicator scores. Where cultural well-being indicators ("Maori lands, reserves & easements" and "Wai and wahi tapu") are the same under the two scenarios, this indicates that improved bio-physical conditions alone are insufficient to overcome the influence of DSS inputs representing the level of recognition and provision for these manawhenua Interests.

While emphasizing that these results are illustrative, being the subject of a current evaluation with manawhenua, they demonstrate the ability of the cultural well-being indicators to distinguish between different development approaches based on both how well they recognize and provide for manawhenua interests and predictions of bio-physical variables characterising water quality and stream ecology.

5.2 VALIDATION

Having developed a structure by which the DSS represents relationships between the cultural components and the other indicators/components, and having run the DSS to produce a series of case study assessments, the next stage of the process is to ground truth the results through discussions with whanau. The purpose of this is to see how well the assessments made by the DSS correspond with the experience of manawhenua and the usefulness of the cultural well-being indicators for integrating cultural perspectives in urban development planning processes.

6 CONCLUSIONS

A series of indicators of cultural well-being for assessing the effects of urban development scenarios on receiving water bodies have been developed through hui with the central Canterbury Te Ngai Tuahuriri Rūnanga. The indicators aim to provide an assessment of the extent to which urban development recognizes and provides for manawhenua interests and values, including: opportunities for resource use; access to culturally

[1] An exception is the water quality indicator, which in all but one case study area is the same under both scenarios. This reflects an important aspect of the water quality indicator, in that it is influenced not only by levels of urban stormwater contaminants but also by contaminants derived from rural land uses (Moores et al., 2016). In mixed urban-rural land use catchments, the DSS predicts that higher levels of stormwater treatment improve some aspects of water quality (by lowering metal concentrations, for instance) but, depending on the relative proportions of areas of urban and rural land use, overall water quality may not change sufficiently to result in an improvement in the indicator level.

significant waterbodies; restoration of lost waterbodies; wai and wahi tapu protection; and the availability and quality of cultural resources.

Following integration into the UPSW DSS, complementing indicators of environmental, economic and social well-being, the performance of the indicators is being evaluated through a series of case studies of current and proposed urban development projects in the peri-urban areas around Christchurch. The assessment is being conducted by engaging with manawhenua to review and validate DSS inputs and outputs. Illustrative results demonstrate the ability of the cultural well-being indicators to distinguish between different development approaches based on both how well they recognize and provide for manawhenua interests and predictions of bio-physical variables characterising water quality and stream ecology.

While the indicators are limited to giving a relative assessment of the extent to which urban development caters for manawhenua interests and are in no way intended as a replacement for direct engagement, their value lies in providing a basis for at least a screening-level cultural assessment that is integrated and simultaneous with environmental, economic and social considerations.

ACKNOWLEDGEMENTS

Members of Te Ngai Tuahuriri Rūnanga who participated in hui and discussed subdivisions within their takiwa: the impacts both positive and negative, and the opportunities for improving urban development.

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