

An ecosystem services approach to determining suitable land-uses for red-zoned land in Sumner, Christchurch

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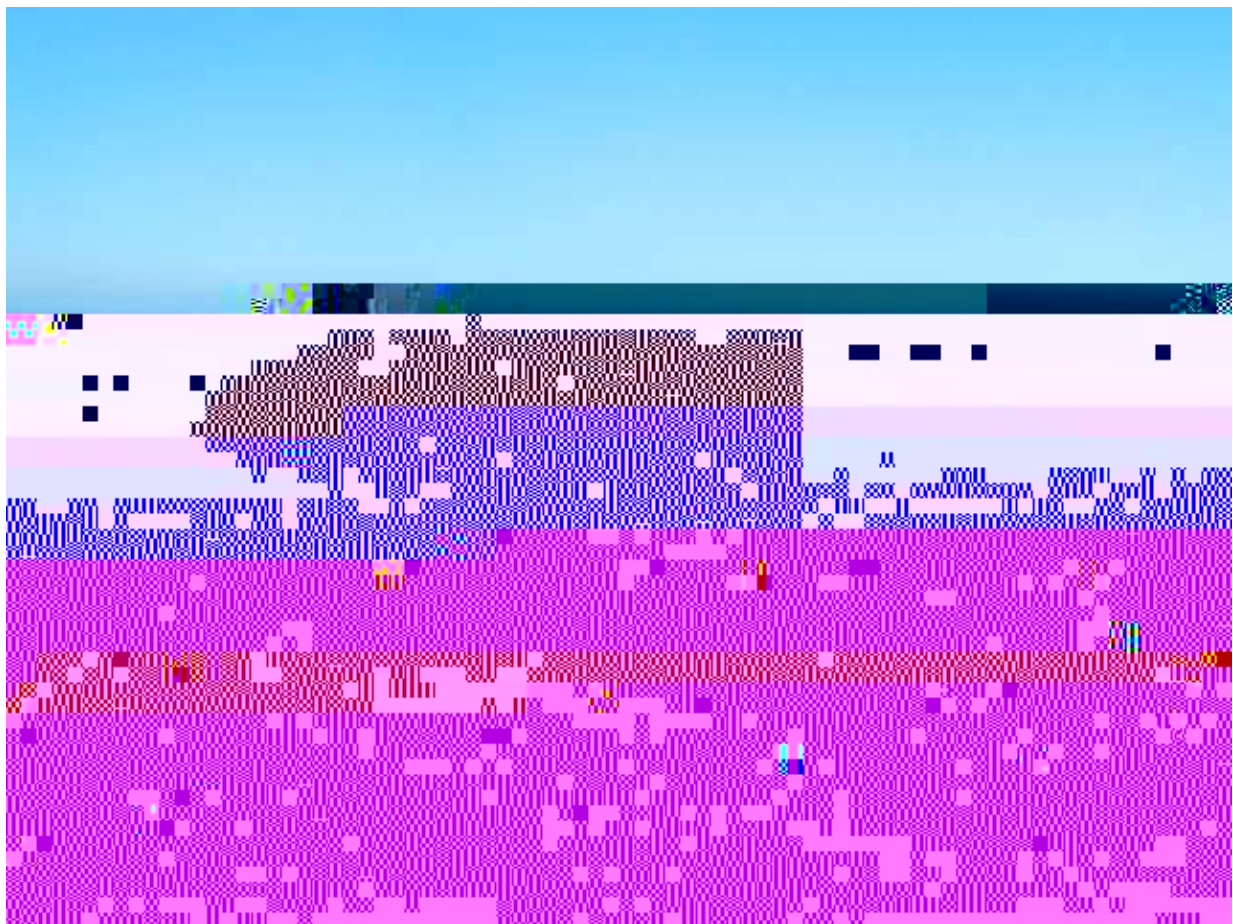


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Introduction

Sumner is a seaside community located to the south east of central Christchurch (figure 1). Significant areas of land around Sumner were affected by the 2010-2011 Christchurch earthquake sequence. The Canterbury Earthquake Recovery Authority (CERA) has classified some areas in Sumner as „red-zoned . This is due to the ongoing risk of rockfall, rockroll and cliff collapse, posing significant risk to life (CERA, 2013). The red-zoned land consists of steep cliffs, and a lesser area of flat (formerly residential) land along Wakefield Avenue and Heberden Avenue. These areas are identified in figure 2. The risks associated with these areas are ongoing and fundamental to the feasibility of any future use of the land. This research investigates the potential uses for this land. This project was conducted in conjunction with Habitat Sumner, a research group formed to gather information to assist local organisations involved in projects such as recreation improvements, environmental restoration and local food production.

Research question

The overarching research question is: “What are the ecosystem services provided by the feasible land-uses of the red-zoned land in Sumner?”

Aims and objectives

The aim of this report is to identify feasible land use options for utilising and remediating the red-zoned areas in Sumner.

This was achieved through:

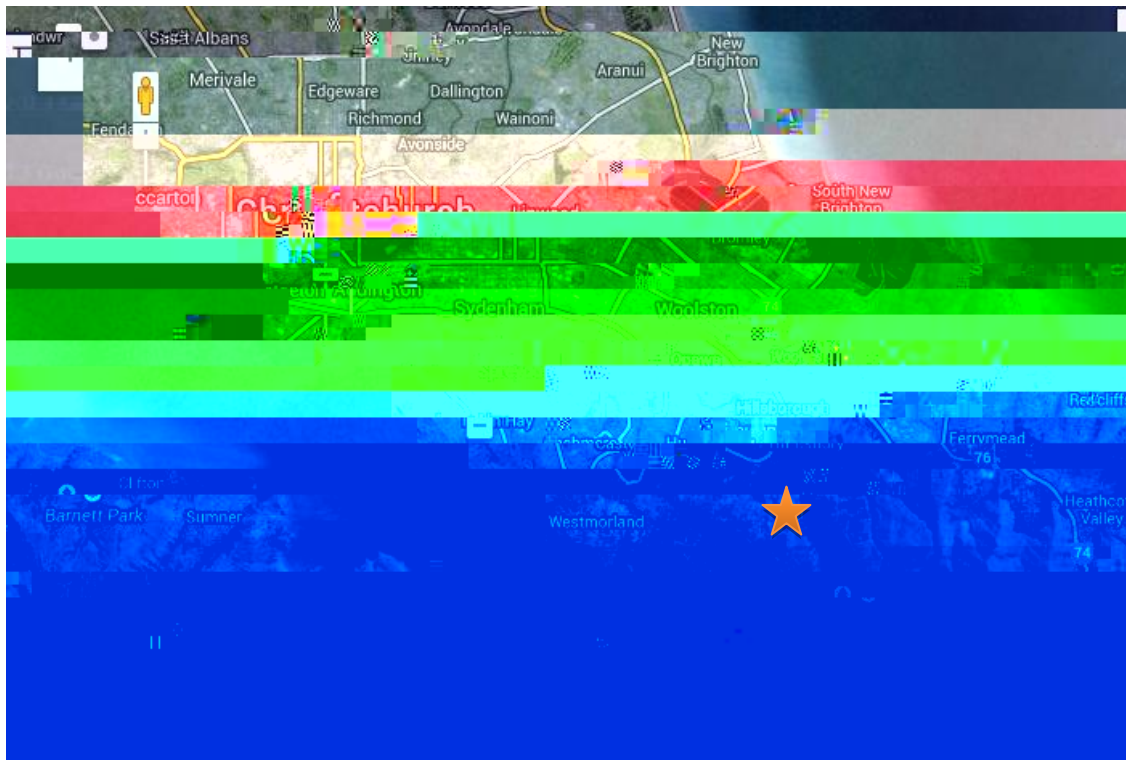


Figure 1: The orange star indicates the location of Sumner, Christchurch, New Zealand. Retrieved from <https://maps.google.co.nz/>



Rationale of the ecosystem services concept

The Millennium Ecosystem Assessment (MEA) has identified that the Earth's ecosystems enhance the well-being of humans by the services they provide (MEA, 2005; Chapin et al., 2009; Costanza et al., 2007). The MEA developed the ecosystem service framework as a means to manage the human demands for ecosystem services and the capability of ecosystems to continue to provide these services (MEA, 2005).

Bolund and Hunhammer (1999) determined that ecosystem services generated by urban ecosystems will be site-specific. This will be important to consider in the assessment of ecosystem services for Sumner. Research by Dinnie, Brown and Morris (1993), and Aitkinson, Doick, Burningham and France (2013) regarding developing urban green spaces contributed to a more complete understanding of the concept.

Methodology

This research project has been conducted in two parts. The first part was an ecosystem services

uncertainty around the long-term plans for red-zoned land, and what may appear unfeasible now could become feasible in the long term.

The ecosystem services analysis involved using current literature to generate a list of common ecosystem services. These were then reduced to eleven services most relevant to Sumner. Further research was then conducted to determine the presence of these ecosystem services in each potential land-use.

In the second part of the research process a survey was used to ascertain the views of the Sumner Community. The first part of the survey contained a series of statements that related to each of the ecosystem services that were identified as most relevant to Sumner. These statements asked the participant to rank, on a scale of 1-5, how strongly they agreed with the statement. The purpose of this part of the survey was to quantify the value that Sumner residents attribute to each of the ecosystem services identified. The second part of the survey asked for feedback on the land-use options that were identified as most feasible for the red-zoned land. The survey was distributed via the online survey tool SurveyMonkey to a database of approximately 600 Sumner residents.

The results of the ecosystem services analysis and the community survey were then compiled to generate a concept map of the most desirable and ecosystem service-enhancing land-uses, and where these could be placed in the red-zone.

Definition of Ecosystem Services

Ecosystem services are defined as the benefits human populations derive from the environment (Millennium Ecosystem Assessment [MEA] 2005a). The use of ecosystem services is growing rapidly and a large proportion of these services are being degraded or used unsustainably (MEA, 2005a). Eleven ecosystem services were identified as important to consider for the local Sumner Community.

The services were divided into three categories; provisioning, regulating and cultural services. Provisioning services are the products obtained from ecosystems. Regulating services are the benefits obtained from the regulation of ecosystem processes. Cultural services are the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development reflection, recreation, and aesthetic experiences (MEA, 2005a).

Provisioning services

Food has been selected as an important service for the Sumner area because Habitat Sumner

Recreation has been defined to include land-based recreational opportunities relevant to Sumner, such as walking and biking tracks, and gardening. This is because all of the red-zoned areas are on land.

Cultural Services

Community identity has been defined as the sense of belonging and non-material benefits provided by the surrounding landscapes. This was an important service to assess because this project aims to assist the local community.

Cultural and spiritual enhancement refers to ecosystem services that influence people's sense of kaitiakitanga (guardianship) for the environment (Chappin, 2009). This is particularly relevant when considering opportunities for mahinga kai (Panelli & Tipa, 2009).

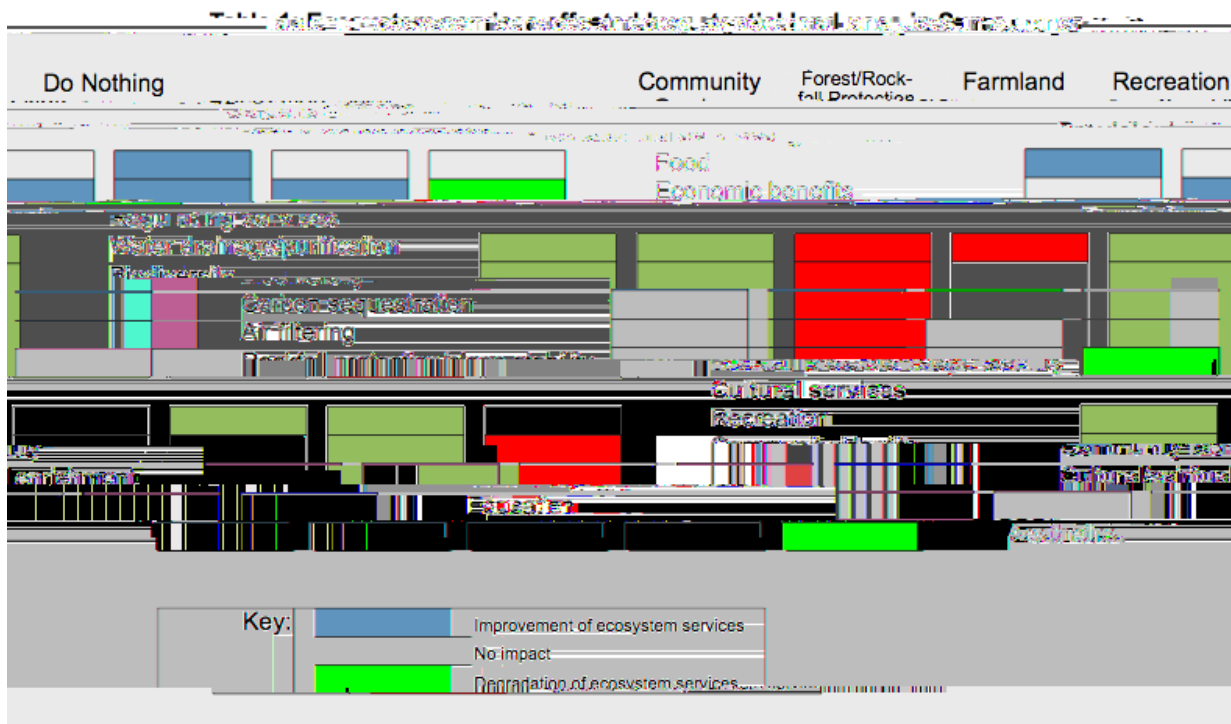
Education has been defined as both the inherent knowledge gained from a land use (for example gardening) and personal educational experience, such as being exposed to natural landscapes.

Aesthetic value is an important service to include in local environments (MEA 2005a). Aesthetic value was included in this assessment because of the current unattractive state of the Sumner red-zoned areas.

Results and Discussion

Ecosystem services analysis

From observations of the red-zoned sites, combined with background research, the following land-uses have been identified as being feasible options for the red-zoned land in Sumner. Table 1 shows a summary of the overall assessment of the impact of these land-uses on ecosystem services. The desktop analysis of ecosystem services has been approached with the main focus of determining the impact of five possible land-uses on the Sumner environment and community.



Community gardens

Community gardens are cared for by the community and provide fresh organic produce for members of the community. They provide a way for people to become more involved in their local community and learn key gardening skills.

A study by Calvet-Mir et al. (2012) sought to find out what ecosystem services were provided by home gardens. While these are on a slightly larger scale than home gardens, they have many of the same benefits and ecosystem services.

Provisioning

The number of trees able to produce fruit would determine the value of the food ecosystem service. Forest ecosystems can increase tourism (Dymond et al., 2013), provide timber for sale and provide local fuelwood, enhancing the economy.

Regulating

The role of trees in carbon uptake through the process of photosynthesis is well understood and documented (Carswell et al., 2012). Urban trees can act as biological filters, intercepting and removing particulate matter which is of concern for human health (Beckett et al., 2000). Studies show that trees can reduce erosion (Dymond et al., 2013; Thompson et al., 2011) and reduce land slide occurrence (Douglas et al., 2013). Douglas et al. (2013) concludes that there was no significant difference between species. Vegetation, such as urban forests have been shown to act as biological filters for water (Zhang et al., 2011). Bremley and Farley (2010) and Thompson et al. (2011) found that native forests contain the most native biodiversity and supporting services. Exotic forests have more biodiversity than degraded land (Bremer & Farley, 2010).

Cultural

Education and recreation are not present in forests. The Ngai Tahu

Regulating

Nutrient inputs from fertilisers have widespread negative effects on water quality (Foley et al., 2005). Farmland results in the loss of native habitats, especially degrading the services of

the ground alters soil structure, reducing its capacity to hold water, eventually leading to erosion and soil degradation (Hong Kong University, 2013).

Cultural

Parks allow people to be active on their own and serve as a gathering place for social groups and clubs (Han et al., 2013). Studies have recognised the importance of recreation as a basis of culture (Smith and Godbey, 1991). Physical recreation is a doorway to learning (Kemp et al., 2013). Aesthetics relate very strongly to the surrounding vegetation.

Doing Nothing

This option was chosen as a base-line against which to compare the other land-uses, to see the relative advantages of each of the other options, and to determine how strongly the community feels about changing the current state of the red-zoned areas.

Provisioning

Provision of food depends on the composition of plants originally in the area. Land abandonment leads to a decrease in local land values (Turcu, 2012).

Regulating

Vegetation intercepts surface runoff flows. The vegetation currently in the red-zones will therefore have a role in water drainage. Biodiversity, air filtering and carbon sequestration will increase as plants regenerate (Bradshaw, 2000). Slopes with significant rockfall debris tend to remain unstable (Bradshaw, 2000).

Cultural services

Recreation will not be enhanced as areas will remain inaccessible and potentially dangerous. Social problems manifest in areas with a poor physical and environmental setting such as derelict land (Turcu, 2012). Derelict land does not provoke positive feelings (Turcu, 2012). If left in its current state, the red-zoned areas will remain decrepit and visually unappealing.

Survey results, discussion and implications

The survey was distributed to the Sumner Community online via Survey Monkey, and has received a total of 37 responses over a period of three weeks. The following figures (3-6) display demographic information of the participants who responded to the survey.

Figure 3: Demographic information of the gender of the Sumner Community

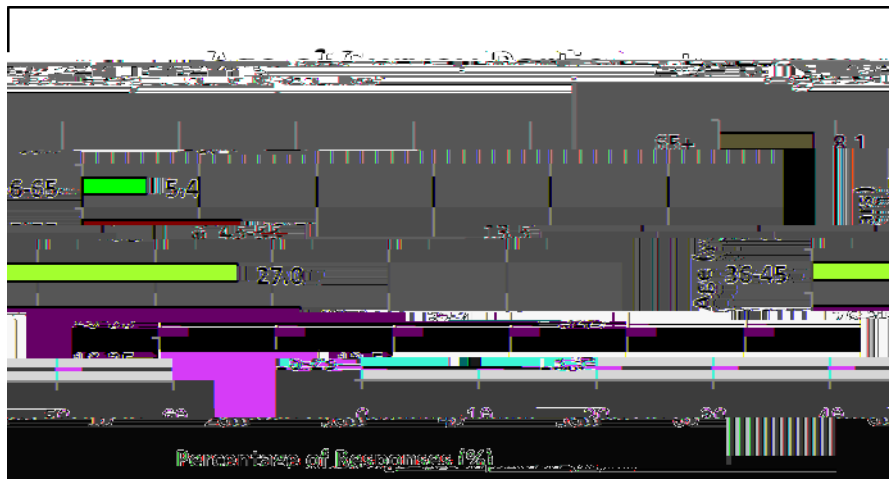


Figure 5: Demographic Information of the age of Sumner Community Survey Participants

Figure 6

From the 2006 Census data, it can be found that the 37 participants who responded to the survey are a moderately representative sample of the Sumner population, despite the small sample size. The number of participants corresponds to approximately 1% of the total Sumner population. The median age of the survey sample was representative of that of the Sumner population. However, the percentage of female responses is over-representative of the population. The summary table (table 2) details the key demographic features of the sample in comparison to the population.

Table 2: Summary table of the Key demographic features of the Survey sample and the Sumner Population data sourced from stats.govt.nz.

	Survey Participants	Total Sumner Population (2006 Census data)
Number of People	37	3981
Median Age Group	26 - 35	15 – 64
Mean Age	36	38
% Females	76%	51%
% Males	24%	49%

The purpose of the first part of the survey was to gauge response about the importance of different services provided by ecosystems to the Sumner Community. The data collected was qualitative in nature and reflected the opinion of the participants (figure 7).

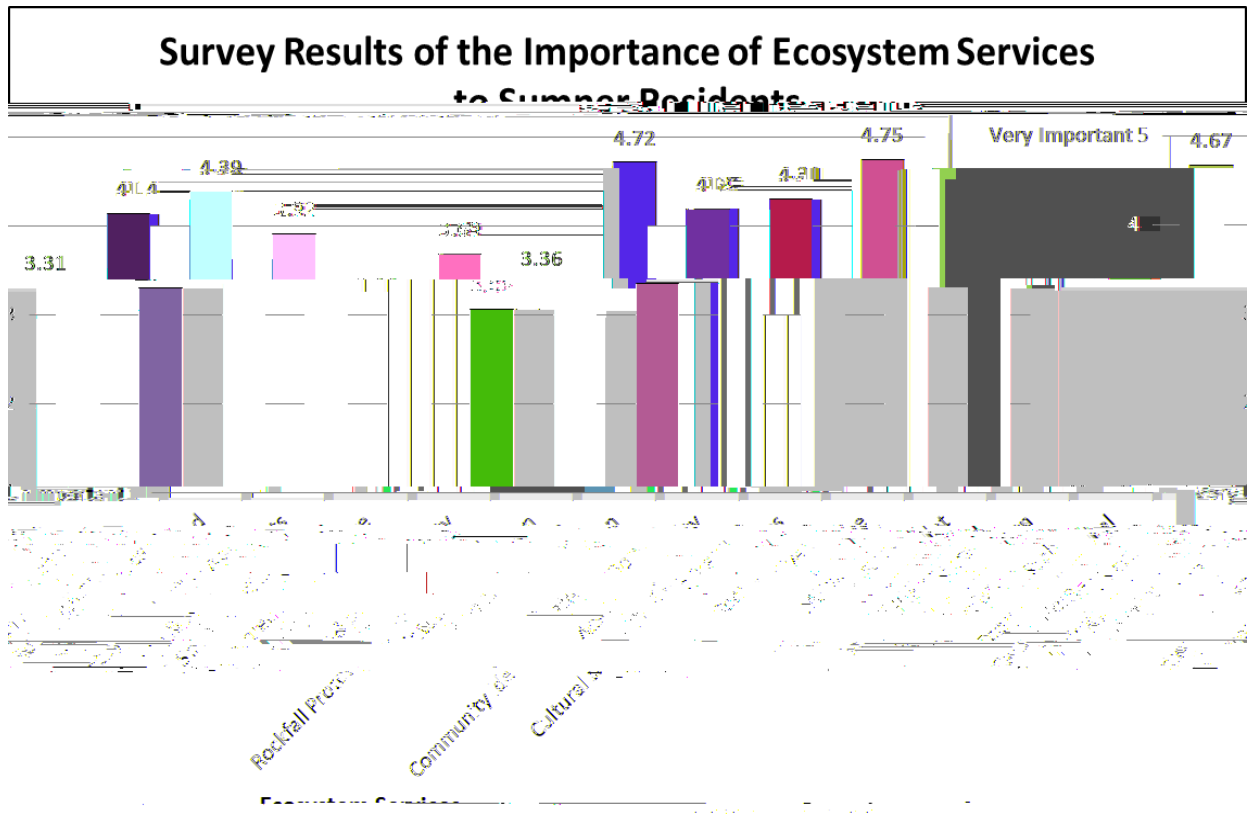


Figure 7: Sumner Community survey results of the importance of individual ecosystem services to residents.

Participants ranked community identity and sense of place, food, and aesthetic appeal with the highest importance (figure 7). A number of comments made by the participants also expressed a strong desire for food forests and community gardens, along with the planting of native forests. These comments reinforce the importance of the top three ecosystem services, but also the strong value placed on biodiversity, education, and rainwater drainage. Air filtration and economic benefits were considered the least important services. The mean response of participants regarding whether air pollution in Sumner was a concern to them was „neutral , suggesting that the residents do not want forestation primarily for the regulatory services it would provide, but instead for provisioning and human based services such as aesthetics and education. Some of the comments left by participants expressed an interest in remediating the red-zoned land for displaced businesses, however the majority indicated a strong preference for

recreation facilities such as cycle ways and walkways. Converting the red-zone areas into farmland and leaving it as it is are the least desired options. This is reflected by the ecosystem services survey results.

In summary, the results obtained from the survey provide a useful insight into the preferences of the Sumner residents in regard to the future of the red-zoned land. The survey results were used to identify the most important ecosystem services and the most desired land uses.

Combining the results of the ecosystem services analysis and survey

When comparing the land use options with reference to the ecosystem services assessment, community gardens and forest/rock fall protection are the most beneficial to implement (figure 9). Both land uses improve eight ecosystem services and cause no degradation. Recreation and farmland mostly improve ecosystem services, but degrade a number of services at the same time (figure 9). The „do nothing land use is the worst option, both improving and degrading the same number of services (figure 9).

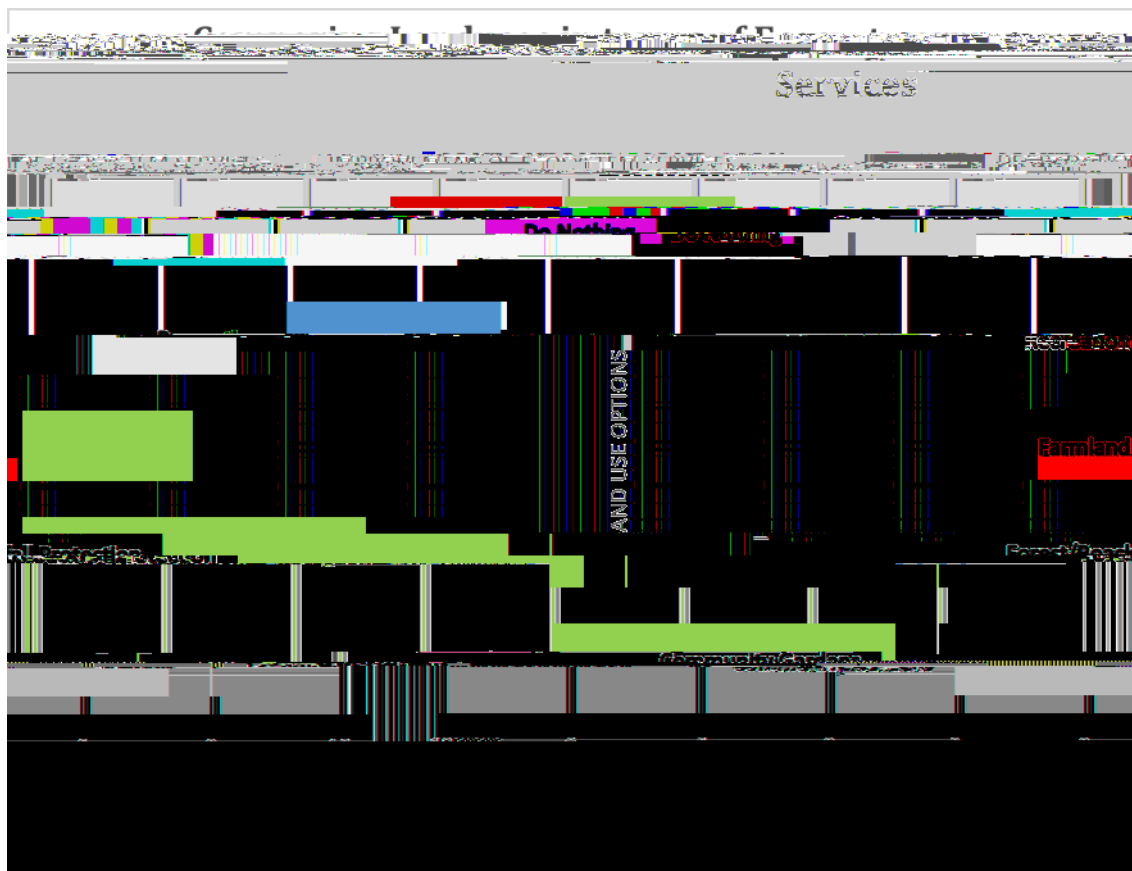


Figure 9: The comparison of land uses in terms of ecosystem services. This figure shows the number of ecosystem services improved (green) or degraded (red) by a specific land use.

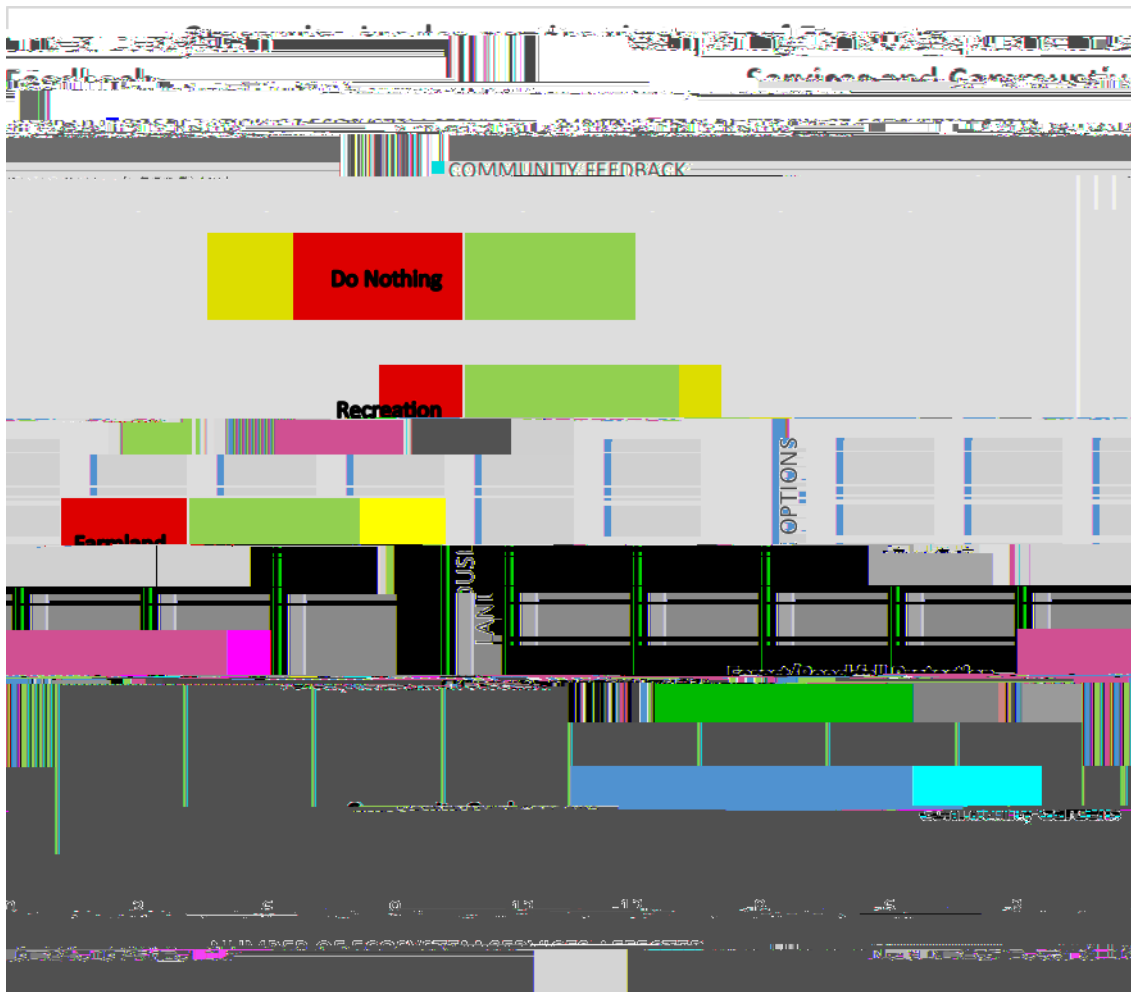






Figure 10: The comparison of land uses in terms of ecosystem services and community feedback. This figure shows the number of ecosystem services improved (green) or degraded (red) by specific land uses, giving extra weighting to the most highly valued ecosystem services. The three services most valued by the community (aesthetic appeal, community identity and sense of place, and food) were given a double weighting shown in yellow.

Figure 10 shows the comparison of the land use options with reference to the ecosystem services assessment and community feedback. The ecosystems services most valued by the community were given extra weighting. This figure shows that implementing community gardens would improve the ecosystem services the most, followed closely by forest and rockfall protection. Recreation and farmland have the same positive impact, but recreation has a less degrading impact on ecosystem services. Doing nothing is more degrading than beneficial for ecosystem services.

 **Native & Exotic Forest:** Much of the red-zoned land is cliff slope, cliff bottoms and the run-out zone of potential rock fall hazards. The most suitable option for these locations is forestation, providing some rockfall protection. The topography and hazardous nature of these sites indicates that any other land use is likely to be unfeasible.

 **Rock Fall Protection:** Rock fall protection is required on both sides of the Sumner Valley where there is a considerable hazard to underlying land and houses. This could be a combination of protection forest and structural measures.

 **Recreation:** These sites have been chosen to correspond with the extension of existing walkways and cycle tracks in Sumner. The feasibility of this land-use is contingent on the extent of the rockfall risk in these areas.

 **Community Gardens:** Potential sites for community gardens are located along Wakefield and Heberden Avenues on land that was formerly residential. These areas have been chosen as they have flat topography and are located away from the immediate run-out zone of the cliff. There is still considerable rock fall hazard on these sites so further risk assessment is required.

Limitations

The most significant limitation of the results stems from the short time-frame that was available to conduct the study. This restricted the extent of the investigation in a number of ways, in particular by limiting the number of responses obtained during the survey period. With more time, the survey could have been distributed to a greater proportion of the Sumner Community to receive a larger sample. However, as noted above, the sample obtained was a relatively adequate representation of the Sumner population.

The limited time frame also prevented any response being obtained from CERA. Information from the CERA website was not site-specific, resulting in uncertainty as to the feasibility of the land-uses identified.

An important step of successful environmental assessment is early consultation and engagement with communities (Baker et al., 2013). Due to the nature of this research, this was not considered beneficial and was instead left until the final stages to provide community feedback to accompany the ecosystem services analysis.

Initial confusion about the objective of the study reduced the time frame further. The initial focus was on the feasibility of different land-uses. After the limited response from CERA regarding the risk associated with red-zoned land, combined with feedback from Habitat Sumner, the research was modified to focus on an ecosystem services analysis. This was a complex concept that is not readily understood without background knowledge. This issue was mitigated during the survey by describing ecosystem services in a series of simple statements.

Acknowledgements

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References

- Aitkinson, G. Doick, K.J. Burningham, K. France, C. (2013). Brownfield regeneration to greenspace: Delivery of project objectives for social and environmental gain. *Urban Forestry & Urban Greening*.
- Beckett, K., Freer-Smith, P. H., & Taylor, G. (2000). The capture of particulate pollution by trees at five contrasting urban sites. *Arboricultural Journal*, 24(2-3), 209-230.
- Bolund, P., Hunhammer, S., 1999. Ecosystem services in urban areas. *Ecological Economics* 29 293-301.
- Bradshaw, A. (2000). The use of natural proc

- Colding, J. (2007). „Ecological land-use complementation for building resilience in urban ecosystems. *Landscape and Urban Planning*, 81(1–2), 46-55. doi: <http://dx.doi.org/10.1016/j.landurbplan.2006.10.016>
- Cole & Knight (1990). Impacts of recreation on biodiversity in wilderness. *Natural Resources and Environmental Issues*, Vol. 0, Article 6.
- Costanza, R., d'Arge, R., deGroot, R., Farber, S., Grasso, M., Hannon, B., . . . VandenBelt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, 387(6630), 253-260.
- Costanza, R., Paruelo, J., Raskin, R., Sutton, P., vandenBelt, M., d'Arge, R., O'Neill, R. (1997). The value of the world's ecosystem services and natural capital. *Nature*, 387 (6630), 253-260.
- Dinnie, E. Brown, M. Morris, S. (2013). Community, cooperation and conflict: Negotiation the social well-being benefits of urban greenspace experiences. *Landscape and Urban Planning*, 112, 1-9.
- Dorren, et al. (2004) Integrity, Stability and management of protection forests in the European Alps. *Forest Ecology and Management*. Vol 195, pp 165 - 176.
- Douglas, G. B., McIvor, I. R., Manderson, A. K., Koolaard, J. P., Todd, M., Braaksma, S., & Gray, R. A. J. (2013). Reducing shallow landslide occurrence in pastoral hill country using wide- spaced trees. *Land Degradation and Development*, 24(2), 103-114.
- Dymond, J. R., Ausseil, A-GE., Kirsch

Kemp, Smith, DeKoven, Segal,. (2013). Play, Creativity and Lifelong Learning. Retrieved from http://www.helpguide.org/life/creative_play_fun_games.htm

Millennium Ecosystem Assessment (

Turcu, C (2012). Local experiences of urban sustainability: Researching Housing Market
Renewal interventions in three English neighbourhoods. *Progress in Planning*, 78(3),
101-150.

Zhang, J., Yu, M., Shan, Q., Chen, G., W(04.14 Tm[()]>2(ha)(,)Yo[El)3(a)-5(rc11(y)n M., S)Y.G., 7(&)8(a)4(