

Exploring immersive visualization for ecosystem services analysis and tradeoffs

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Introduction

- ▶ First year Ph.D. student at Victoria University of Wellington, New Zealand.
- ▶ B.Sc. in Computer Science and Mathematics and an M.Sc. in Computer Science.
- ▶ Research interests include data visualization and usability testing.
- ▶ Supervisors are Dr Craig Anslow and Dr Mairéad de Róiste.

Motivation

- ▶ Planning land use requires the input of experts in several domains, including land owners, geo-spatial analysts, community groups, and regional councils.
- ▶ Modelling ecosystem services with software can assist with predicting the effect of implementing a land use change to improve particular ecosystem services and identify where land use should be conserved.

Visualization

- ▶ A data visualization system shows visual representations of data which assist with an understanding of the dataset [5].
- ▶ Immersion can make visualization systems more effective to analyse data.
- ▶ Future work is needed for evaluating which immersive and non-immersive visualizations are better for different groups of domain-specific experts.

PhD Research: Immersive Visualization for Land Utilization

- ▶ My current research project is about immersive visualization of ecosystem services. The visualization system aims to make the data more understandable to stakeholders from different backgrounds during land use management decision making.

PhD Research: Immersive Visualization for Land Utilization

- ▶ Immersive analytics systems can create a “sense of presence” and build engagement while exploring data [2]
- ▶ Immersive virtual reality/augmented reality (VR/AR) could improve user engagement and understanding of ecosystem services tradeoffs in a virtual world compared to a visualization system without immersion.

PhD Research: Immersive Visualization for Land Utilization

- ▶ This research project will involve designing, implementing, and usability testing an immersive/non-immersive visualization system for land use data which augments the LUCI toolbox.¹

¹Land use is how humans manage, alter and conserve the ecosystem services and goods provided by the land [4]

PhD Research: Immersive Visualization for Land Utilization

- ▶ LUCI is a model of ecosystem services². The services include flood risk, flood mitigation, agricultural production [3].
- ▶ LUCI takes input data from an elevation grid, stream networks, annual rainfall, annual evaporation, spring additions and abstractions, land cover, and soil data.
- ▶ Data are inherently geographic, data sources such as annual rainfall are surfaces which overlay the mapped region being analysed.

²Ecosystem services are the “conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life” [1].

Why LUCI?

- ▶ LUCI performs analysis at a farm scale so decisions can be made based on visualizing the output data.
- ▶ LUCI developers are available to discuss the research project and the requirements of the visualization tool.

LUCI: examples of generated output

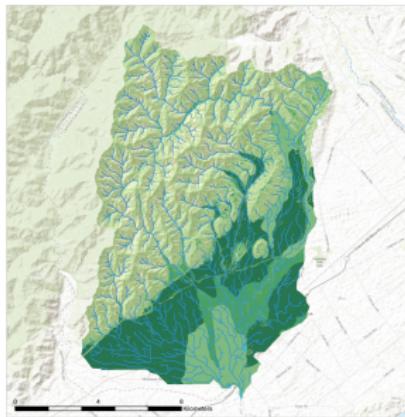


Figure: Predicted optimal agricultural utilisation for the Mangatarere catchment generated by LUCI.

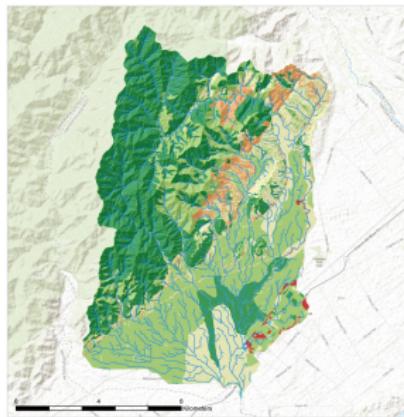


Figure: Agricultural productivity vs carbon tradeoff map generated by the LUCI ecosystem services tradeoff tool using an equal arithmetic method.

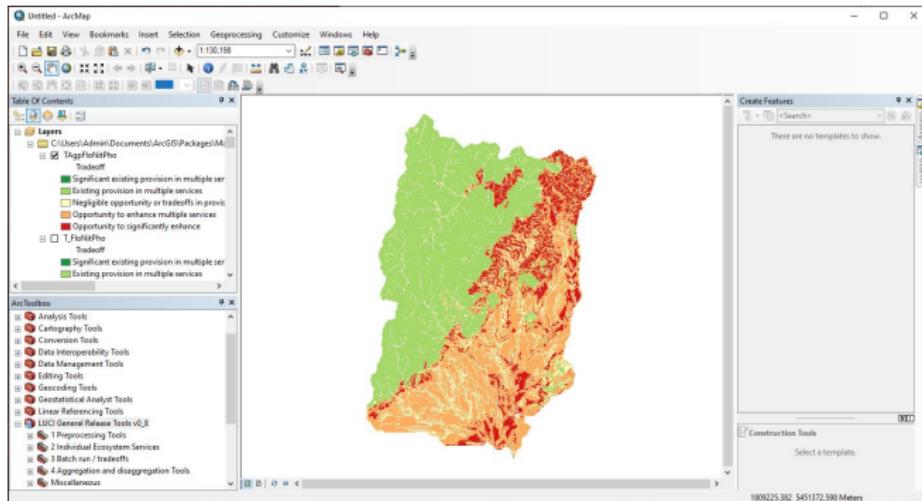
Who uses LUCI?

- ▶ LUCI developers.
- ▶ Geo-spatial analysts at regional councils.
- ▶ Community Groups.

Immersive Visualization for Land Utilization: Current Problems

- ▶ When analysing land use change with LUCI, The results of an ecosystem services analysis before and after a land use change are compared.
- ▶ Currently it is difficult to understand how the size of a land use change would affect the size of a change in ecosystem services.
- ▶ Data visualizations communicating more information about the values behind the categorization of optimality for the ecosystem services could assist with the analysis of ecosystem services.

Immersive Visualization for Land Utilization: Current Problems



Research Questions

- ▶ **How can immersive visualizations improve the comparison of the impact of land use change for multiple ecosystem services?**

Research Questions

- ▶ How effective is immersive visualization for facilitating communication between different stakeholder groups analysing the impact of land use change on ecosystem services?

Future Work: System Design

- ▶ The system design needs to reflect the requirements of different groups performing analysis with LUCI.
- ▶ Interviews will be performed to gather the requirements of different user groups.
- ▶ A prototype system will be implemented based on the visualization requirements identified.

Prototype Visualization

- ▶ The rasterized image draped over the elevation model is a tradeoff map of agricultural production and nitrogen.

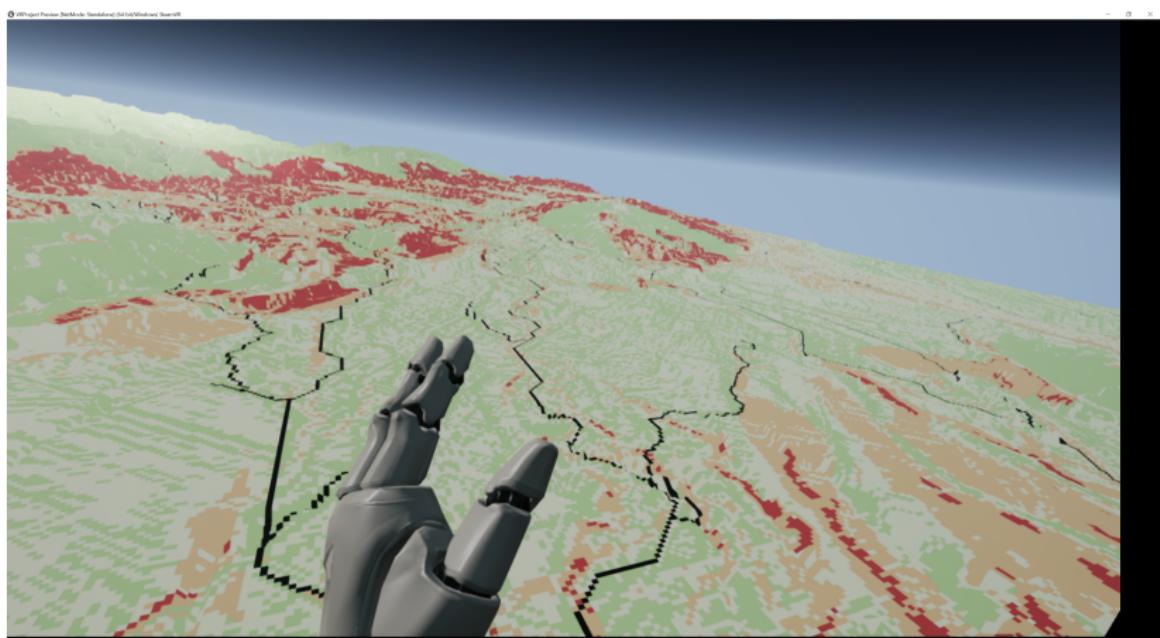


Figure: An ecosystem services tradeoff map in VR draped over a DEM

Future Work: Evaluation

- ▶ Create Case studies for each user group.
- ▶ Perform a usability study with a small number of participants.
- ▶ Compare the experiences of different user groups to answer the research questions.

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